

Exploring the Sequence of Establishing Derived Relational
Responding in Children with Global Developmental Delay



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Abstract

The current research comprised two studies to investigate the emergence of derived relational responding in children with Global Developmental Delay (GDD). In Study 1, four children diagnosed with Autism Spectrum Disorder (ASD) and one child with Down's syndrome, were exposed to verbal assessments (the Verbal Behaviour Milestones Assessment and Placement Program, VB-MAPP; the Kaufman Brief Intelligence Test, K-BIT; and the Peabody Picture Vocabulary Test, PPVT) following which they were exposed to relational responding testing and training in the following sequence: co-ordination, distinction, comparison, opposition and hierarchy. All children demonstrated different levels of verbal and relational responding competencies however overall an intervention based on RFT was found to be successful in establishing relational responding in accordance with the targeted frames. In Study 2, four participants with ASD were exposed to a training sequence identical to that used in Study 1 however the location of comparison and opposition were alternated. Results found that participants in Study 2 demonstrated significantly better performances in the emergence of comparison relations than those in Study 1 suggesting that the manipulated sequence may have had an effect. Results also support the previously suggested developmental sequence of the emergence of derived relational responding with evidence of some relational frames emerging before others found. Furthermore results provide evidence of a relationship between relational responding and verbal ability.

-Chapter 1-

Exploring the Sequence of Establishing Derived Relational Responding in Children with Global Developmental Delay

Early Intervention (EI) is an area of education and psychology which has been the focus of much interest and research. Early Intervention involves the delivery of an educational and therapeutic service to individuals whose development is at risk of negative medical or environmental influences (Jourbish & Khurram, 2010). Spiker, Hebbeler, Wagner and Mc Kenna (2000) completed a review of 52 published reviews of EI and found that over 90% of studies reported significant improvements in language, social, cognitive and emotional skills in children with developmental disabilities.

Early Intensive Behavioural Intervention (EIBI) is a branch of EI that is based on the science of Applied Behaviour Analysis (ABA). As such, EIBI programmes employ the basic principles and tactics of behaviour analysis while focusing on deficits in an individual's behavioural repertoires (Cooper, Heron, & Heward, 2007). The success of EIBI gained recognition in the aftermath of Lovaas' influential study in 1987, in which substantial social, cognitive and behavioural gains were associated with an EIBI programme delivered to 19 preschool children with ASD. Furthermore, a follow-up study indicated that these gains were retained at age 11 (McEachin, Smith, & Lovaas, 1993). Numerous subsequent studies have provided further support for the benefits of EIBI (Ben-Itzhak, Lahat, Burgin, & Zachor, 2008; Eikeseth, Smith, Jahr, & Eldevik, 2002; Eldevik, Hastings, Jarh, & Hughes, 2012; Fava et al., 2012; Flanagan, Perry, & Freeman, 2012; Howard, Sparkman, Cohen, Green, & Stanislaw, 2005; Howlin, Magiati, Charman, & Maclean, 2009; Remington et al., 2007; Smith, Groen, & Wynn, 2000). At a broader

level, research has also found that EIBI programmes improve children's access to less restrictive environments (Fenske, Zalski, Krantz, & McClannahan, 1985); provide direct benefits to caregivers and families (Smith, 1999); and benefit society as a whole (Dillenberger, 2011).

A Behavioural Approach to Language Training

Language is naturally one of the main areas of focus in remedial education for children with developmental disabilities (Sundberg & Michael, 2001). Indeed, the emergence of spontaneous language before six years of age is one of the best predictors of good outcomes for this population (Szatmari, Bryson, Boyle, & Streiner, 2003). Traditionally, EIBI programmes for children with developmental disabilities target language skills using Skinner's (1957) theory of verbal behaviour. Typical measurement packages for assessing and targeting Skinner's verbal operants include the Parsons Language Sample (Spradlin, 1963) and the more recent VB-MAPP (Sundberg, 2008). These are often included in Individualised Educational Plans (IEPs).

Skinner's Verbal Behaviour. Skinner theorised that language is learned behaviour that is acquired, extended and maintained by the same variables and principles as other behaviour (Skinner, 1957). Specifically, for Skinner, learning language is operant behaviour conditioned through reinforcement from another individual (Skinner). What differentiated this account from traditional non-behavioural approaches to language development, which were structurally based, was the distinction of the behaviour of the speaker vs. the listener. Skinner distinguished primarily between speaker and listener behaviours as separate repertoires, although he recognised that they overlap.

Skinner proposed a functional account of language development in terms of the functional relations among operants and their antecedents and consequences, including motivating variables (Skinner, 1957). This unit of analysis is known as the verbal operant and Skinner identified seven elementary verbal operants. These include: mands (requesting an item); tacts (labelling an item); echoics (repeating what is said); intraverbals (responding to the verbal behaviour of another); textuials (reading or writing); transcription (spelling); and text copying (Skinner). According to Skinner, the response form of a mand is controlled by motivational variables. The response form of a tact is controlled by non-verbal stimuli. And the response form of all the other verbal operants is controlled by verbal stimuli. Skinner also proposed that these basic verbal operants have the capacity to generate more complex forms of verbal behaviour such as metaphors and humour.

For the purposes of intervention or training, Skinner argued that each verbal operant should be trained separately due to their functional independence (Skinner, 1957). That is, one cannot assume that a child who has acquired a word that functions as a tact can also use that word as a mand. In teaching language, one can only expect children to emit functional mands if the relevant words are taught in the presence of the correct controlling variables for manding (i.e. motivation). Indeed, Skinner proposed that the inability to transfer words across the various verbal operant functions is a characteristic of developmental disability and an essential target for language training (Skinner).

The success of broad intervention programmes using Skinner's analysis of verbal behaviour is well-established (Braam & Sundberg, 1991; Brown et al., 2000; Kahng, Hendrickson, & Vu, 2000; Lerman et al., 2005; Sundberg & Michael, 2001).

Furthermore, a body of empirical evidence also supports the success and utility of establishing Skinner's various verbal operants (Arntzen & Almas, 2002; Braam & Poling, 1983; Drash, High, & Tudor, 1999; Miguel, Carr, & Michael, 2002; Richman, Wacker, & Winborn, 2001; Sundberg, Loeb, Hale, & Eigenheer, 2002; Sundberg, Michael, Partington, & Sundberg, 1996; Winborn, Wacker, Richman, Asmus, & Geier, 2002). However, criticisms of Skinner's theoretical account of language are well publicised. In short, Chomsky (1959) argued that Skinner's account fails to explain more complex areas of language and cognition, such as problem-solving and metaphors because it ultimately fails to capture the generativity that characterises language. More applied concerns have also been raised regarding language training programmes based on Skinner's approach.

Language training programmes based on Skinner's analysis of verbal behaviour have been criticised due to the heavy reliance on separately training each verbal operant (Luciano, Rodriguez, Manas, & Ruiz, 2009). This approach has been claimed to facilitate rigidity and lack the facilitation of generalized responding. This concern was expressed by McEachin et al. (1993) who concluded that one of the main limitations of Skinner's approach is the limited attainment of a range of generalized repertoires. Similarly, Chomsky (1959) argued that training each verbal operant separately facilitates rigidity and impairs, rather than enhances, generativity.

Sidman (1971) was one of the first behavioural researchers to account for this generativity of language. Sidman (1971, 1977, Sidman & Cresson, 1973) found that after training participants with developmental disabilities to match dictated names to the corresponding picture and the pictures to their corresponding printed words the

individuals were capable of naming the pictures, orally reading the text and matching words to pictures and pictures to words in the absence of direct instruction. Sidman referred to these novel, emergence relations as equivalence relations. In summary, Sidmans work on stimulus equivalence proposed that the training of two simple conditional discriminations ($A < B$ and $B < C$) leads to the derivation of four additional derived relations ($B > A$, $C > B$, $A < C$ and $C > A$). Sidman highlighted the importance of these phenomena for our understanding of language and cognition and how they may be utilised in the development of language training programmes. While Sidmans research remained focused on the relational frame of equivalence RFT attempted to further expand Sidmans research on equivalence (Hayes et al., 2001).

Relational Frame Theory

Relational Frame Theory (RFT) is built centrally on the process of *derived* relational responding (Hayes, Barnes-Homes, & Barnes-Holmes, 2001). Derived relational responding refers to responding to stimuli and events in a manner that is *not* controlled by the physical features of the stimuli. For example, rhesus monkeys can be explicitly trained to respond to two stimuli relationally through selecting the taller of the two (Harmon, Strong, & Pasnak, 1982). However, this relational responding is referred to as *non-arbitrary* because it is controlled by the physical properties of the stimuli. This form of relational responding is not believed to be a verbal process and most living organisms, when trained, are capable of responding in this way (Hayes et al.).

For RFT, the process of *arbitrarily applicable relational responding* is the basis of language and cognition (Hayes et al., 2001). Its establishment commences when young children learn to name objects (Barnes, 1994). During natural parent-

child interactions, naming behaviours are directly reinforced. Imagine, for example, a parent asking the child "Where's the ball?" and the child points to the ball. The parent will likely reinforce the pointing with verbal praise. This interaction is known as a name-object relation. On another occasion, the reverse may occur where the parent asks the child "What's this" while holding up a toy car. If the child responds correctly with "car", verbal praise will likely follow. This is known as an object-name relation. Given this type of history with direct reinforcement for both object-name and name-object relations, children begin to derive these relations in novel contexts without direct reinforcement. For example, the parent may now ask "Where's the car?" and the child will point correctly to the car, even though this specific relation has never been directly training.

For RFT, there are a number of different relational frames, although all have the same three defining properties: mutual entailment, combinatorial entailment and transfer/transformation of functions (Hayes et al., 2001). *Mutual entailment* refers to the relations that occur between two events or stimuli. For example, if an individual is instructed that A is the same as B ($A=B$), s/he will readily derive the mutually entailed relation that B is the same as A (i.e. $A=B$ then $B=A$). *Combinatorial entailment* describes relations that occur among three or more stimuli. For example, if an individual is instructed that A is less than B ($A<B$) and B is less than C ($B<C$), then s/he will readily derive the combinatorially entailed relation of A less than C ($A<C$; i.e. $A<B$, $B<C$ then $A<C$). The *transfer/transformation of functions* involves functions of one stimulus transferring to another by virtue of the relation between them. For example, if an individual is taught that A is the same as B ($A=B$) and A is given the function of a conditioned punisher, then by virtue of the relation of coordination between A and B (including the derivation that $B=A$), B would acquire a

derived punishing function of equal magnitude to the function that was directly attached to A (Hayes et al.).

RFT argues that in the establishment of AARR the relational behaviour of early learners must come under appropriate forms of contextual control. That is, in the development of AARR children must learn to attend to contextual cues such as "Same" and respond appropriately. These contextual cues allow the learner to differentiate between the relevant and irrelevant features of the task. For RFT this contextually controlled relational responding is established through early language interactions such as those outlined above. From an RFT perspective it is due to contextual cues that we learn to arbitrarily apply relational responses to stimuli. Contextual cues, such as "same", "different" or "opposite", specify both the relevant relations and the functions to be transformed in a relational frame.

The relational frame of co-ordination. The frame of co-ordination appears to be the first and most basic relational frame to which infants are exposed in early natural language (Hayes et al., 2001; Lipkins, Hayes, & Hayes, 1993; Luciano, Gómez-Becerra, & Rodríguez-Valverde, 2007). Frames of co-ordination are also referred to as similarity and sameness, and are synonymous with Sidman's concept of equivalence (Hayes et al.). Co-ordination relations involve responding by arbitrarily applying the relational cue "is" or a similar cue. In other words, "is" specifies that the relation is co-ordinated. Using the same example as above, an individual may be taught $A=B$, in which the 'equals sign' is a contextual cue that specifies responding to A and B as the same (i.e. they are co-ordinated). If taught that $A=B$, then one can readily derive the mutually entailed relation of $B=A$.

Similarly, if one is taught $A=B=C$, one will derive the mutually entailed relation $C=B$ and the combinatorially entailed relations $A=C$ and $C=A$.

Co-ordination relations appear to be established through multiple-exemplar training, and there is considerable support for this effect in experimental and applied contexts (Barnes-Holmes, Barnes-Holmes, & Smeets, 2001; Dunne, Foody, Barnes-Holmes, Barnes-Holmes, & Murphy, 2011). For example, Barnes-Holmes et al. (2001) demonstrated that exemplar training successfully facilitates the transformation of functions in accordance with mutually entailed co-ordination relations in typically-developing children.

One of the first studies investigating co-ordination relations in children with developmental disabilities was conducted by O'Connor, Rafferty, Barnes-Holmes and Barnes-Holmes (2009). The study demonstrated the utility of multiple-exemplar training in establishing derived co-ordination relations among words, their related objects and their related pictures. Similar effects were more recently reported by Dunne et al. (2011) in a sample of children with autism who showed very weak performances on the target relations prior to exemplar training.

The relational frame of distinction. Responding in accordance with the relational frame of distinction involves deriving differences between stimuli. In this case, the contextual cue that controls difference or distinction responding is often "is different from" or such like (Luciano et al., 2009). At one level, distinction relations are more complex than co-ordination relations because the dimension of difference is not always specified. For example, if one is instructed that "flies are different to mammals" they will not know exactly in what ways two stimuli differ. Because this lack of specification applies to mutually entailed distinction relations, it also applies

to combinatorially entailed distinction relations. For example, if one is also instructed that "mammals are different to birds", they cannot know if flies and birds are the same or exactly how they might differ.

In the only existing study of distinction relations, Dunne et al. (2011) attempted to establish these in two children with autism. This research first investigated whether the two children could respond in accordance with non-arbitrary relations of co-ordination and distinction. For example, given two identical pictures and a third different picture, a participant was asked: "Show me the pictures that are the same/different". These non-arbitrary relations were examined across a range of stimulus dimensions (e.g. colour, length, texture and shape). Arbitrary relations were then targeted with both mutually and combinatorially entailed relations. Consider an example of the former. In the presence of two identical boxes, a participant was instructed "Box A is the same as Box B" and asked "Are they different?". The results demonstrated that one of the children readily passed all tests of non-arbitrary and arbitrary distinction relations, while the second child required extensive training on combinatorially entailed distinction relations.

The relational frame of opposition. Responding in accordance with the relational frame of opposition involves the abstraction of a dimension along which stimuli can be distinguished, but in a manner that is oppositional and not purely distinct. This requires applying the relational cue "is opposite to", but again the dimension of opposition is not often specified, although it may be derived. Consider, for example, an individual who is told "Cold is opposite to hot". The dimension being applied here is temperature. Co-ordination relations are believed to form the basis of opposition relations because in many cases the combinatorially entailed

relations within a frame of opposition are co-ordinated (Hayes et al., 2001). For example, if an individual is told that A is opposite to B and B is opposite to C, then it can often be assumed that A and C are the same.

The first study to examine relational responding in accordance with opposition was conducted with young typically-developing children by Barnes-Holmes, Barnes-Holmes and Smeets (2004). Participants were required to select the most valuable from four possible coins, when instructed, for example, as follows: “A buys many, and A is opposite to B, B is opposite to C, and C is opposite to D”. While all participants failed baseline tests, exemplar training was used to successfully established highly generalised derived performances in all children.

Dunne et al. (2011) conducted the first study to examine opposition relations in children with ASD. After first establishing yes/no responding, non-arbitrary opposition relations were assessed. This involved presenting two opposite items (e.g. a big ball and a small ball) and asking participants firstly to "Show me the big/small one" following which they were asked to "Show me the opposite of big/small". These non-arbitrary relations were examined across a range of stimuli dimensions (e.g. big vs. small; long vs. short; wet vs. dry). Once established, arbitrary opposition relations were then targeted using the same 10 dimensions targeted in non-arbitrary trials. Consider an example of the former. In the presence of two identical objects a participant was instructed “If this one is smooth, show me the smooth one” following which they were instructed “If this one is rough, show me the opposite of rough”. The results demonstrated that all children required various levels of training on both non-arbitrary and arbitrary trials however all were successful in acquiring the targeted relations.

The relational frame of comparison. Responding in accordance with the relational frame of comparison involves applying qualitative or quantitative relationship among stimuli or events (Hayes et al., 2001). Opposition relations are believed to form the basis of comparison relations (Hayes et al.). For example, comparison between "big" and "small" implies that the two are opposite because one is big and the other is small. The contextual cue for comparison relations depends on the dimension being implied. There are different types of comparison relations which are, in part, defined by the dimension along which the relation applies (e.g., size or quantity).

Consider the experimental trials presented by Barnes-Holmes, Barnes-Holmes, Smeets, Strand, and Friman (2004) who successfully employed MET to establish comparative more-than less-than relations in three typically-developing children. Participants were firstly trained on AB relations which involved training participants to select the coin (from two possible options) that buys more sweets. Take for example the following instruction: "Coin A buys less than coin B, so which coin would you take to buy as many sweets as possible"? Participants were then trained on BC relations which were identical to AB relations, but now compared coin B with new coin C. A third coin was then introduced and participants were trained on ABC relations. Consider the following instruction: "If coin A buys less than coin B, and if coin B buys less than coin C, which coin would you take to buy as many sweets as possible"? This was followed by an ABC test with novel stimuli. The results demonstrated that MET was successful in establishing comparison relations and related generalization in young children. Berens and Hayes (2007) replicated these findings with four typically developing children and demonstrated generalisation across stimuli and trial-type.

The first study to examine the development of comparison relations in children with developmental disabilities was conducted by Gorham, Barnes-Holmes, Barnes-Holmes and Berens (2009). Gorham et al. attempted to generate repertoires of more-than and less-than in five typically developing children and three children with ASD using the same procedure as Barnes-Holmes et al. (2004). Results found that while these children demonstrated positive outcomes, they required extensive explicit training on A-B, B-C, A-B-C, and A-B-C-D relations. The children with ASD required more extensive training than their peers in B-D relations.

Further research examining comparative frames using a similar methodology was conducted by Dunne et al. (2011) with two children with ASD. Results found that participants required varying levels of training however were successful in establishing comparison relations.

The relational frame of hierarchy. The relational frame of hierarchy involves responding to the relational cue of "is a member of", "belongs to", "contains" or such like. Consider the following task. An individual is presented with a stimulus array that contains two cars, five boats and four trains, and is asked: "Are there more cars than vehicles?" Responding correctly requires this individual to know that the category of vehicle contains cars and does or doesn't also contain trains and boats.

Only one previous study has examined hierarchal relations from an RFT perspective. Dunne (2011) examined the development of hierarchal relations in a sample of two participants with ASD. Non-arbitrary hierarchy relations were first assessed by presenting participants with a range of items belonging to two categories for example; types of sweets and types of instruments. Participants were first

required to divide the items into categories. Participants were then tested on the frame of distinction within categories. This involved asking participants questions about the two categories such as "Are toys different to items you find in the kitchen". The two categories were then split into two further categories (for example sweet vs. non-sweet foods, the instruments into instruments you can blow into vs. instruments you can't blow into) and participants were required to sort the items into four categories. Finally combinatorial entailment was examined whereby the participant was required to answer specific questions to test combinatorial entailment between all categories, when a new picture was introduced. For example the Researcher held up one of the pictures e.g. marshmallow and examples of the following questions were asked "Where would you put the marshmallow?", "Is the marshmallow more like sweet food or non-sweet food?", "Can you play a marshmallow?". One participant passed all parts of testing and one participant failed distinction between categories however training was successful in establishing this skill.

Derived Relational Responding and Verbal Ability

Much research attempting to train relational frames, such as that presented above has been conducted with the dual recognition of the important relationship between relational responding and verbal ability. This has been highlighted by researchers attempting to explore the relationship between derived relational responding and verbal competence. In simple terms, this is an important question because as a theory of language and cognition RFT would predict that relational responding would correlate with verbal ability (i.e. because relational responding is the core process of language). Indeed, this prediction is supported by a number of

studies (Dunne, 2011; Luciano et al., 2007; O'Hora, Pelaez, & Barnes-Holmes, 2005).

Exploring this relationship with verbally-sophisticated adults, O' Hora et al. (2005) investigated the relationship between verbal ability and relational responding in a sample of typically developing monolingual and bilingual college students. These researchers first exposed participants to a complex relational task, an empirical model of instructional control following which they were tested on vocabulary, arithmetic, and digit-symbol encoding subtests of the Wechsler Adult Intelligence Scale (WAIS). Results found that participants who scored higher on verbal subsets had better performances on the relational task.

Examining the development of both relational responding and language skills in typically developing children allows for a close examination of the correlations which may exist between these two pivotal skills. For example, Lipkens, Hayes and Hayes (1993) tracked the development of a very young child between the age of 16 months and 27 months. During this time the researchers gave the child a number of experiences relevant to derived relational responding and also tested the child for the derivation of relations. Results found that the participant demonstrated mutually entailed relations as early as 17 months while combinatorially entailed relations emerged later. These findings suggest that there is a developmental trend in relational responding. Further research examining the development of language and relational responding skills in early learners by Pelaez, Gewirtz, Sanchez and Mahabir (2000) found that infants can derive relations like stimulus equivalence before they acquire language.

Attempting to train relational responding in typically developing children may allow researchers to identify deficits where they exist and further explore this relationship. A study by Cassidy, Roche and Hayes (2011) used multiple-exemplar training to establish a range of relational frames in young typically developing children which subsequently correlated with improved performances on the Wechsler Intelligence Scale for Children (WISC). These researchers designed two studies aimed at investigating the role of automated multiple-exemplar relational training in raising children's general intellectual skills. In the first of two studies, four participants were first exposed to WISC measures following which they were exposed to multiple exemplar training in stimulus equivalence and the relational frames of same, opposite, more than and less than across a number of sessions and weeks. When compared to a no treatment control group participants showed significant improvements in full-scale IQ following stimulus equivalence training and a further increase following relational training. In the second study an improved multiple-exemplar-based relational frame training sequence was administered to eight children with a range of educational and behavioural difficulties. Results found a significant improvement in WISC measures across the group. These results provide support for the importance of complex relational skills in intelligent cognitive behaviour while also suggesting a behavioural intervention to improve general cognitive functioning. However these data are preliminary and much more extensive research in this area is required.

Exploring this relationship with children with disabilities Devany, Hayes and Nelson (1986) studied the relation between language use and stimulus equivalence. Children were assigned to one of three groups of participants: typically developing children, children with a developmental disability who used speech or sign

spontaneously and participants with developmental disability who didn't. Participants were then taught a series of four related conditional discriminations following which they were tested to determine if classes of equivalence stimuli had formed. Results found that all of the typically developing children and the children with developmental disabilities who had language formed equivalence classes while participants who did not have language did not form equivalence classes. The researchers concluded that even though the exact nature of the relation between stimulus equivalence and language remains to be clarified their findings support the view that stimulus equivalence is a phenomenon with direct relevance to language development. An additional series of studies examining the development of relational responding in children with ASD found that participants at the higher levels of verbal ability required less training on frames of co-ordination, distinction, comparison and opposition than those with lower verbal ability (Dunne et al., 2011).

Educational Implications of RFT

Given its now substantive evidence base and with the emergence of a large amount of research supporting the area of RFT, calls have been made to incorporate RFT into traditional EIBI programmes (Moore, 2009). A recent review conducted by Rehfeldt (2011) of published studies in the area of derived stimulus relations between 1992 and 2009 found a lack of application of this technology to the applied setting. The necessity to reform EIBI programmes, more specifically language training programmes, has been made following a number of critics outlining the limitations of the traditional verbal behaviour approach (Chomsky, 1959; Lerman et al., 2005; Luciano et al., 2009). Training in derived stimulus relations has been identified as a possible intervention for the establishment of generalization skills in

children with developmental delays which traditional programmes have been claimed to lack (Luciano et al.). In order to produce significant improvements in modern day EIBI programmes for children with developmental disabilities it has been recommended to identify the core relational frames and develop intervention programmes targeting their fluid and flexible development (Barnes-Holmes et al., 2001). This may be done by incorporating multi exemplar training, the testing of novel untrained stimuli which do not have common properties to the trained set, training in bi-directional stimulus to promote learning and programming the transition from non-arbitrary to arbitrary stimuli (Luciano et al.).

RFT places considerable emphasis on non-arbitrary relational responding as a precursor for arbitrary relational responding and suggests that the former facilitates the latter (Barnes & Roche, 1996; Hayes et al., 2001). Previous research (Hayes et al.; Steele & Hayes, 1991) has found that a crucial aspect of establishing contextual control in relational responding is that relational responding is reinforced along a specified physical dimension. That is, non-arbitrary relational responding provides an important historical context for establishing its arbitrary counterpart. It is therefore hoped that in the presence of the specific contextual cue such as "same", "different", "opposite" etc. contextual functions for the cue will be established which may then generalise from non-arbitrary to arbitrary relations (Dymond & Whelan, 2010). A number of studies have found success using this approach to establish arbitrary applicable relational responding in individuals with deficits (Barnes-Holmes et al., 2004; Berens & Hayes, 2008; Cassidy et al., 2011; Dymond et al., 2007; Gorham et al., 2009; Vitale, Barnes-Holmes, Barnes-Holmes, & Campbell, 2008; Whelan and Barnes-Holmes, 2004).

A training sequence for establishing relational responding. Although it is fairly clear which relational frames are essential to the development of language and higher cognition (Rehfeldt & Barnes-Holmes, 2009), there is little or no empirical evidence to suggest the sequence in which these might emerge or should be trained for optimal effects (Dunne, 2011). Rehfeldt and Barnes-Holmes suggested a possible training sequence that went as follows: co-ordination; distinction; opposition; comparison and hierarchy.

It is widely held that co-ordination relations are established (and should be targeted) first, because they are the most basic of frames from which the others emerge (Hayes et al., 2001). It is often suggested that distinction relations emerge thereafter because one must appreciate that something is not the same before being able to derive that it is different (Rehfeldt & Barnes-Holmes, 2009). It is then suggested that opposition emerges because one would find it difficult to know that two stimuli were opposite without first determining that they were different. That is, opposition is a rather extreme type of distinction. Comparison relations appear to follow thereafter because one would have to understand the variations of distinction and opposition in order to then appreciate several ways in which two stimuli might be different, while at the same time being similar along a specific dimension. That is, apples are redder than peaches but both are fruits. Hierarchical relations are more complex than the others listed thus far because they involve containment, which can occur at many levels. Similar to the apples and peaches example, these two stimuli are similar in some ways, different in others, but grouped together in an overarching category of fruits. In short, it would seem that hierarchical relations incorporate the other relations; hence the latter should be established before the former.

Several previous studies have explored various sequences or chains of relational frames, but none have done so systematically and only very few have trained a number of frames consecutively. For example, Dunne et al. (2011) trained co-ordination, opposition, distinction, comparison and finally hierarchy in a group of children with ASD. Results found that ten participants were successful in acquiring the relational frame of co-ordination, with four participants subsequently acquiring the relational frame of opposition and two participants further acquiring the relational frames of distinction, comparison and hierarchy in that order. Although the reported research did not systematically manipulate the sequence, the findings did not appear to suggest that the training requirements decreased steadily across the four frames, thus implying that the earlier frames did not greatly facilitate the subsequent frames. However, clearly a much more systematic manipulation is needed.

The Current Research

The current research was one of the first studies to systematically explore the establishment of an extensive relational responding testing and training sequence in a sample of nine children with GDD. Specifically, Study 1 sought to establish derive relational responding in four children with ASD and one child with Downs syndrome in the following sequence: co-ordination (same/different), distinction, comparison (big/small), opposition and hierarchy. Study 2 sought to establish derive relational responding in a sample of four children with ASD using a manipulated sequence to that used in Study 1 in order to examine the impact of the training sequence on the acquisition of relational responding. That is, participants were exposed to relational responding testing and training in the following sequence: co-

ordination (same/different), distinction, opposition, comparison (big/small), and hierarchy. In addition, the putative relationship between derived relational responding and verbal ability was examined by firstly examining the impact of relational responding training on participant's verbal scores and secondly examining the predictive influence of verbal scores on relational responding performances across both studies.

-Chapter 2-

Method

Participants

A total of five children (Ps 1-5) participated in Study 1. All had been independently diagnosed with GDD. Four of the children (Ps 1, 2, 3 and 5) also had a diagnosis of ASD and one participant (P4) had a diagnosis of Down's syndrome. All participants were male and were aged between 4 years, 0 months and 5 years, 4 months. All participants attended full-time at the same early intervention centre for children with Developmental Disabilities in Wicklow, Ireland.

Ethical Approval

The current research was approved by the ethics committee in the department of psychology at the National University of Ireland, Maynooth. All behavioural procedures and assessments were conducted by the researcher, under the supervision of a fully qualified Board Certified Behaviour Analyst (BCBA). This researcher adhered to the ethical guidelines provided by the Code of Ethics of the Psychological Society of Ireland (PSI), the Conduct Guidelines of the Behaviour Analyst Certification Boards, the American Psychological Association (APA) Guidelines on Test Users' Qualifications, the British Psychological Association (BPS) Code of Good Practice for Psychological Testing (2010) and the Principles for the Use of Published Psychological Testing in Research (BPS, 2005). In general, strong ethical consideration was given to the fact that all participants were under the age of 18 years and had a diagnosis of a GDD. The primary ethical issues of concern in this research project are outlined below.

Informed voluntary consent. Due to the participants in the current study being a young population with GDD they were not required to sign a consent form therefore signed parental/guardian consent was required for participation in this study. An information sheet (see Appendix 1) and a consent form (see Appendix 2) were delivered to the parents/ guardians of all potential participants. Information sheets provided detailed information on the nature of the study. In the development of the participant information sheet it was necessary to explain the research project in a non academic language in order to ensure all parents/guardians were fully aware of what the research project entailed. This was important as if parents/guardians did not fully understand procedural details it may obscure their ability to provide fully informed consent. Any parents who wished to allow their child to participate were asked to read the information sheet and return a signed informed consent form. Included as part of the information sheet and consent form was information regarding the right to withdraw consent at any time without adverse effects. Also, approximately half way through the data collection process a continued consent form was sent home to the parents of each participant. This form reminded parents of the study and offered them the chance to withdraw their consent at that point should they have wished. No participant was allowed to participate in the current study without parental/guardian consent being received.

Participant assent. In addition to parental/ guardian consent participant verbal assent was secured prior to the commencement of each experimental session. The participants assent was secured by asking him/her prior to the commencement of trials, in the participant's respective

communication system, if s/ he would like to work with the Researcher e.g. "X would you like to work with me today?". In addition, throughout all sessions participants' behaviours were monitored for signs of distress or boredom (e.g. crying, excessive yawning, or increased problem behaviour) and all trials were terminated at once if distress was evident. If a participant indicated that he did not want to work with the researcher on three consecutive occasions, participation was terminated.

Qualifications for conducting verbal assessments. As this research project required the conduction of formal verbal assessments, the PPVT and the K-BIT, it was necessary for Researcher to consider qualifications to perform such assessments. The Researcher was deemed qualified to use these tests given the test manufactures recommendations. In addition, guidelines set out by the American Psychological Associations Task Force for test user qualifications (APA, 2000; see Appendix E) stipulate that students with a level of training equivalent to that obtained by the Researcher may use such tests for research purposes provided the results from these tests do not guide or influence clinical decisions. In the current case the test scores will be used for research purposes only and will not be used to guide clinical decisions hence Researcher was considered suitably qualified.

In accordance with the guidelines set out by the APA (APA, 2000) individual results from the PPVT-IV and the K-BIT we're not made available to either the school or parents as doing so may result in clinical decisions being made based upon them. It was not the intention of this research project to guide any clinical or teaching decisions. If a parent requested access to the

test results, a formal written request was required (in accordance with current Freedom of Information legislation). Access was always accompanied by formal written advice from the researcher and supervisor that the test scores should not be used to guide clinical or other important decisions because the researcher was insufficiently experienced to interpret test results for this purpose.

Practice effects. An issue of ethical consideration in the conduction of verbal assessments was the possibility of practice effects on future verbal assessments being conducted by the educational team within the intervention centre. It was therefore necessary for researcher to outline in the parental information sheet and consent form that there is a possibility of practice effects from such assessments. Parental information sheets advised parents to exclude their child if they were due to have a formal IQ assessment within the next 6 months to prevent practice effects. If parents/ guardians still wished for their child to partake in the current research project they were required to confirm that they were aware of the possibility of this effect.

Data protection. All data was anonymised from the point of collection through the use of pseudonyms and will remain that way in all future research presentations or publications. All data collected was transferred onto a computer file and hard copies of data collection sheets were shredded. Data was stored on an encrypted hard drive using the Microsoft “encryption file system” which is available on all versions of windows. A key code to identify participants to their pseudonyms was also stored on an encrypted drive. All data will be kept by the Researcher and

stored safely for the appropriate length of time. These data will be retained for a minimum of five years as is consistent with research practices. After which time data will be permanently destroyed or deleted. All intended use of data was outlined in the initial consent form. Should further use be needed additional consent forms will be sent to the participants parents/guardians.

Setting

Each session was conducted within the same quiet classroom within the intervention centre. Each child participated individually, accompanied only by the Researcher. During all trials, the Researcher was seated beside the child at a small table. The maximum duration of a session was 25minutes, with no more than four sessions per week. This session time frame was similar to that of each participant's normal school work schedule. Participants were provided with frequent breaks during research sessions with the frequency and duration of breaks individualised and in line with other programmes. Participants were also given the option of asking to take a break during research sessions if they were feeling tired. Researcher was cognisant of the participants performance throughout the research sessions and in the event that a participant appeared tired breaks were given during which time the participant was given free play time.

Materials

The materials employed in Study 1 comprised of three printed standardised psychometric measures (i.e. the VB-MAPP; the K-BIT; and the PPVT), as well as a relational responding training sequence.

Verbal Behavior Milestones Assessment and Placement Program.

The VB-MAPP contains a criterion-referenced assessment of verbal competency that is derived from Skinner's (1957) analysis of verbal behaviour. The VB-MAPP Milestones Assessment contains 170 learning and language milestones categorised across three developmental levels: Level 1: 0-18 months old; Level 2: 18-30 months; and Level 3: 30-48 months. The three levels assess the following target skills: mands; tacts; echoics; intraverbals; listener behaviour; motor imitation; independent play; social skills; social play; visual perceptual responding; matching-to-sample responding; linguistic structure; group and classroom skills; and early academic competencies (Sundberg, 2008). For each level each target skill area has five items to be scored using both direct testing and observations. An example of a mand test item is "Spontaneously emits 15 different mands without training" (Level 2); an example of a tact test item is "Tacts 10 items when asked for example, what am I doing?" (Level 2); an example of a test item for intraverbal is "Completes 25 fill-in-the-blank phrases" (Level 2) and an example of a test item for visual perceptual responding is "Matches non-identical objects (3D) to pictures (2D) and/or vice versa in a messy array of 10 containing 3 similar stimuli, for 25 items" (Level 2).

The VB-MAPP generates a numerical score in addition to classifying participants into levels of ability. Scores are added up across each skill set and across all levels. Participants are classified into levels based on the level within which the majority of their scores fall i.e. Level 1, 2 or 3. For example if a respondent demonstrates competence to criterion (scoring at least 4 in a skill area) in all target areas of Level 1 but not in Level 2, s/he is

automatically categorised as Level 2. The maximum score on the milestones assessment is 170 with the maximum level being Level 3.

Kaufman Brief Intelligence Test. The K-BIT is a measure of intelligence for individuals from 4 years to 90 years. The test comprises of two subtests, vocabulary and non-verbal Matrices. Vocabulary is assessed through verbal knowledge and riddles. An example of the vocabulary subsection is the participant is presented with a page on the test easel with a picture of a bed and asked "What is it?". Non verbal ability is assessed by matrices. An example of this is the participant is presented with a picture of a car and five additional pictures (truck, frying pan, sun, fruit and zip) are presented below. The examiner points to the car and asks "This one goes with which one?" (The correct answer being the truck).

Three possible outcomes are generated by scoring the K-BIT: a verbal composite based on the total score of the vocabulary subtest; a non-verbal composite based on the matrices subtest and an IQ composite (based on a summary of the two subtest composites). Based on the IQ composite scores can be interpreted. The lowest possible IQ composite score is 40, the highest possible score is 160 and the mean score is 100, with a standard deviation of 15. Participants can be divided into descriptive categories based on this IQ composite score. The KBIT provides the following descriptive categories: scores falling under 69 are considered to below the lower extreme; scores falling between 70-79 are considered to be well below average; scores falling between 80-89 are considered below average; scores falling between 90-109

are considered to be average and scores between 110-119 are considered to be above average.

Peabody Picture Vocabulary Test. The PPVT provides a measure of verbal ability through the assessment of receptive vocabulary for individuals aged between 2 years, 6 months and 90 years. An example of a test trial on the PPVT is the participant is presented with a page on the test easel with a picture of a baby, a cat, a balloon and a tree and asked "Point to baby".

In scoring the PPVT the participants raw scores are calculated and converted into an age based standard score. The lowest possible standard score on the PPVT is 20, the highest possible score is 160 and the mean score is 100, with a standard deviation of 15. The PPVT can be interpreted based on percentiles, normal curve equivalents (NCE), stanines, age and grade equivalents and growth scale value (GSV). The PPVT provides descriptive categories within which participants can be placed based on standard scores. The PPVT categorise standard scores falling between 20 and 70 as extremely low; scores between 70 and 85 as moderately low; scores between 85 and 100 as low average; scores between 100 and 115 as high average; scores between 115 and 140 as moderately high and scores between 140 and 160 as extremely high scores.

Relational Responding. The sequence of relational responding testing and training used in the current study is similar to that which has been used in previous RFT-based research (e.g. Dunne, 2011). This sequence, as currently employed, targeted five relational frames, presented as both non-

arbitrary and arbitrary relations. The target frames comprised of: co-ordination; distinction; comparison; opposition and hierarchy (in that order). For each frame participants were first tested and only received training thereafter if they failed to reach an accuracy criterion of 90% correct responding. Because the materials for each frame may differ considerably, each section below that describes the relevant test/training sequence contains its own materials section.

Programmed Consequences

All VB-MAPP, K-BIT, PPVT and relational responding testing/training trials were presented as a test and there were no programmed consequences for correct or incorrect responding. A correct response in each of these required the participant to emit the appropriate non-verbal or verbal response within 5 seconds of the instruction. Hence, an incorrect response was one that did not correspond to the correct answer or which occurred after a delay of 5 seconds. Although these were test trials, specific contingencies were in place for various forms of on-task behaviour and these delivered either verbal praise (e.g. “Nice listening”) or a tangible reinforcer (e.g. Sweets). The schedule of reinforcement was individualised and conducted in accordance with each child’s existing schedules for learning across all programmes. During relational responding training trials, positive reinforcement in the form tangibles and corrective feedback were provided on each trial. A range of items were utilised as tangible reinforcement (e.g. Sweets, iPad, toys).

Inter-observer Agreement

For the purposes of inter-observer agreement (IOA) and procedural integrity, an independent observer with training in behaviour analysis recorded 30% of all trials. Inter-observer agreement was calculated by comparing the total number of correct responses recorded by the Researcher and by the observer per session (see Cooper, Heron, & Heward, 2007). Agreement across sessions ranged from 90% to 100%, with a mean overall agreement of 96%.

Experimental Sequence

The current study contained an array of standardised measures, as well as an extensive series of testing and training in relational responding. For illustrative purposes, the experimental sequence is summarised in Figure 1 below.

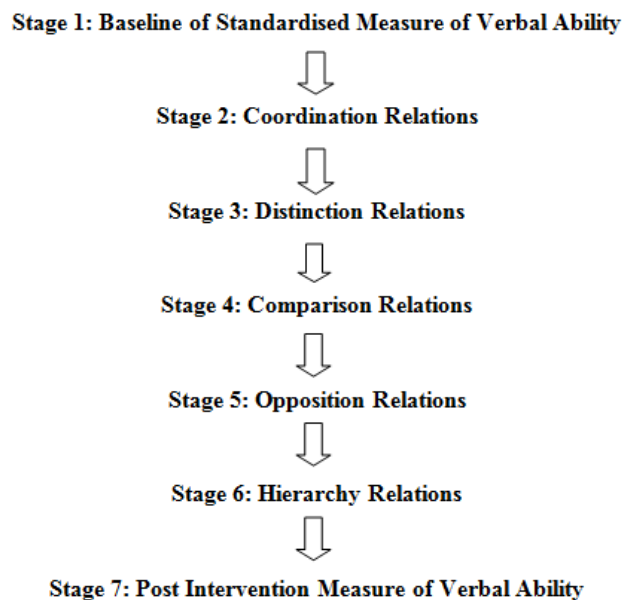


Figure 1. Experimental sequence used in Study 1.

Procedure










The current study comprised of 8 stages, some with a number of phases.

Stage 1: Baseline of standardised measures of verbal ability. All participants conducted the three standardised measures in the same sequence, with the VB-MAPP first, followed by the PPVT and finally the K-BIT. All of these measures were presented according to their written guidelines. An example of a VB-MAPP test item is "Tacts 10 items when asked what am I doing?" (Level 2, Tact). An example of a PPVT test item is a page from the test easel containing 4 pictures: girl happy, girl sad, girl crying and girl laughing and the examinee is asked "Point to girl crying". An example of a K-BIT test item is a page from the test easel with a picture of a bridge and examinee is asked "What is it?".

Stage 2: Co-ordination relations. There were two main phases in the presentation of the relational responding co-ordination testing. That is, Phase 1 targeted non-arbitrary co-ordination relations, first testing identical stimuli and then moving along the stimulus gradient to testing with non identical stimuli which are in the same category and Phase 2 targeted arbitrary co-ordination relations. Each of the two separate phases commenced with test trials and only contained training trials if inadequate test performances (i.e. less than 90% correct) were recorded (i.e. if training was required). In addition all the target relational performances were first tested/ trained as non-arbitrary relations followed by arbitrary relations. A sample of materials used in Stage 2 is presented in table 1 below.

Table 1

Example of Stimuli Used in Stage 2

Phase	A	B	C
Phase 1: Non-arbitrary Identical Stimuli			
Phase 1: Non-arbitrary Stimuli in Same Category			
Phase 2: Arbitrary Stimuli			

Phase 1: Testing non-arbitrary co-ordination relations. The testing of non-arbitrary co-ordination involved four different stimuli sets: two sets of non-arbitrary identical stimuli and two sets of non-arbitrary non identical stimuli belonging to the same category.

Testing non-arbitrary relations with identical stimuli always involved two sets of stimuli each with three members (Sets 1 and 2; three identical dogs and three identical houses). These comprised of one stimulus designated as stimulus A (e.g. A1), one was designated as stimulus B (e.g. B1) and one designated as stimulus C (e.g. C1). Testing always involved three stimuli, the sample stimulus (e.g. A1; identical dog) and two comparisons one of which was an identical match to the sample stimuli (e.g. B1 and B2; identical dog and car). Two comparison stimuli were placed on the table in front of the participant (e.g. B1 and B2). The Researcher presented the participant with a sample stimulus (e.g. A1) along with the vocal instruction "Find same". A correct response required the participant to pick up or touch the correct

comparison (e.g., selecting B1 in the presence of A1) within a 5 second response period. The location of the correct comparison was counterbalanced across trials with 2 trials with the correct comparison on the left, 2 trials with the correct comparison on the right and 6 trials in which the location was mixed randomly. All test trials were presented in blocks of 10 trials with two blocks of trials being administered testing two different stimuli sets (Sets 1 and 2). A pass on the non-arbitrary test of co-ordination relations involved reaching a mastery criterion of 90% correct responding. If this criterion was not reached participants proceeded immediately to training of the same relations using the same stimulus test. If this criterion was reached, participants proceeded immediately to further testing. Training trials were presented in the same way as test trials however prompting and corrective feedback was utilised. Prompts were faded as the participant began to respond independently. In some cases, counterbalancing the location of comparison stimuli was not done until participants had passed testing on trials in which the stimuli remained in the same location. Training trials continued until participants were capable of reaching criteria on a novel stimuli set.

The testing of non-arbitrary co-ordination relations with non identical stimuli which belong to the same category also involved two sets of stimuli each with three members (Sets 1 and 2; three non identical dogs and three non identical houses). One stimulus was designated as stimulus A (e.g. A1), one designated as stimulus B (e.g. B1) and one designated as stimulus C (e.g. C1). Testing always involved three stimuli, the sample stimulus (e.g. A1; non

identical dog) and two comparisons one of which was a non identical match to the sample stimuli (e.g. B1 and B2; non identical dog and car).

A-B training and testing. Participants were presented with the sample A stimulus (e.g. A1; dog) and two comparison stimuli (e.g. B1 and B2; dog and car) were placed side by side on the table in front of the participant. The Researcher presented a vocal verbal instruction "Find same". A correct response involved the participant pointing to, touching, or picking up the appropriate comparison within 5 seconds (e.g., selecting B1 in the presence of A1). Trials were presented in a block of 10. The location of the correct comparison was counterbalanced across trials with 2 trials with the correct comparison on the left, 2 trials with the correct comparison on the right and 6 trials in which the location was randomly mixed. The mastery criterion was 90% correct responding. Participants were then tested using a more similar comparison stimulus (e.g. B3; a cat). Again, the mastery criterion was 90% correct responding. Participants were then tested using a novel stimuli set (e.g. A4-B4-B5; two non identical houses and a barn) and were tested similarly to the first testing sequence. Participants were required to reach a mastery criterion of 90% accuracy on a test of the A-B relations before proceeding.

If participants did not reach the accuracy criterion they received training on the stimuli set which they failed. This training was conducted in the same way as with the identical non-arbitrary trials in the above section. Training continued until participants were capable of passing a novel stimuli set.

B-C testing and training. Testing and training of B-C relations (B1-C1 and B4-C4) was identical to A-B trials. Participants were required to reach a mastery criterion of 90% accuracy on a test of the B-C relations before proceeding.

B-A and C-B testing and training. Testing and training of mutually entailed relations was identical to A-B trials however each test comprised of six blocks of 10 trials as follows: 10 of B1-A1-B2; 10 of B1-A1-B3; 10 of B4-A4-B5; 10 of C1-B1-B2; 10 of C1-B1-B3 and 10 of C4-B4-B5. Participants were required to reach a mastery criterion of 90% on each trial type before proceeding.

C-A and A-C testing and training. Testing and training of combinatorially entailed relations was similar to B-A and C-B trials with six blocks of 10 trials as follows: 10 of C1-A1-B2; 10 of C1-A1-B3; 10 of C4-A4-B5; 10 of A1-C1-B2; 10 of A1-C1-B3 and 10 of A4-B4-C5. Participants were required to reach a mastery criterion of 90% on each trial type before proceeding.

Phase 2: Arbitrary testing/training. The testing of arbitrary coordination relations always involved three sets of stimuli each with three members (Sets 1, 2 and 3; car, ball, watch; #, %, £ and 3 identical red blocks). These comprised of one stimulus designated as stimulus A (e.g. A1), one designated as stimulus B (e.g. B1) and one designated as stimulus C (e.g. C1). Testing always involved three stimuli, the sample stimulus (A1) and two comparisons (B1 and C1).

Arbitrary trials followed the same format as non-arbitrary trials using arbitrary stimuli. Participants were first presented with three arbitrary symbols (A1-B1-C1; car, ball and watch). Two comparison stimuli (B1-C1; ball and watch) were placed on the table in front of the student. Participants were presented with a sample stimulus (e.g. A1; car) and the Researcher pointed to one of the two comparison stimuli and instructed "This one is the same". Participants were then asked "Find same". A correct response required the participant to pick up or touch the correct comparison (e.g. selecting B1 in the presence of A1) within a 5 second response period. As with non-arbitrary trials, there were six different trial types tested: A-B; B-C; B-A; C-B; A-C and C-A. The locations of the stimuli were counterbalanced across trials. There was a total of 60 test trials conducted per stimuli set. The mastery criterion was 90% correct responding per block. If this criterion was not reached participants proceeded immediately to training of the same relations using the same stimulus test. If this criterion was reached, participants proceeded immediately to further testing.

Participants were then presented with a different stimulus set (A2-B2-C2; £, %, #) and a similar testing training procedure. Again the mastery criterion was 90% correct responding per block. If this criterion was not reached participants proceeded immediately to training of the same relations using the same stimulus test. If this criterion was reached, participants proceeded immediately to further testing using an additional novel stimuli set (A3-B3-C3; three identical red blocks) where again the mastery criterion was 90% correct responding per block. It should be noted that all aspects of the stimuli were identical. The colour of the stimuli was kept constant in order to

ensure stimulus control by colour was not interfering. Participants were required to follow the Researchers instruction and visually track the location of each stimulus in order to know which concept was being applied to each stimulus. If participants passed this test they proceeded to the next relational frame. If they did not pass the novel stimuli set they received training until they were capable of passing a novel stimuli set on the first exposure.

On establishment of the frame of co-ordination the next targeted frame was distinction.

Stage 3: Distinction relations. There were four main phases in the presentation of the relational responding distinction testing. That is, Phase 1 targeted non-arbitrary distinction relations, first testing identical stimuli and then moving along the stimulus gradient to testing with non identical stimuli which are in the same category; Phase 2 targeted arbitrary distinction relations; Phase 3 targeted non-arbitrary and arbitrary same/different relations and Phase 4 targeted combinatorially entailed same/different relations. Each of the four separate phases commenced with test trials and only contained training trials if inadequate test performances (i.e. less than 90% correct) were recorded (i.e. if training was required). In addition all the target relational performances were first tested/ trained as non-arbitrary relations followed by arbitrary relations. The same materials were used in Stage 3 as were used in Stage 2.

Phase 1: Testing non-arbitrary distinction relations. The testing of non-arbitrary distinction always involved four different stimuli sets: two sets

of non-arbitrary identical stimuli and two sets of non-arbitrary non identical stimuli belonging to the same category.

Testing non-arbitrary relations with identical stimuli involved two stimuli sets (Sets 1 and 2; three identical dogs and three identical houses). These comprised of one stimulus designated as stimulus A (e.g. A1), one designated as stimulus B (e.g. B1) and one designated as stimulus C (e.g. C1). Testing always involved three stimuli, the sample stimulus (e.g. A1; identical dog) and two comparisons one of which was an identical match to the sample stimuli (e.g. B1 and B2; identical dog and car). Two comparison stimuli were placed on the table in front of the participant (e.g. B1 and B2). The Researcher presented the participant with a sample stimulus (e.g. A1) along with the vocal instruction "Find different". A correct response required the participant to pick up or touch the correct comparison (e.g. selecting B1 in the presence of A1) within a 5 second response period. The location of the correct comparison was counterbalanced across trials with 2 trials with the correct comparison on the left, 2 trials with the correct comparison on the right and 6 trials in which the location was mixed randomly. All test trials were presented in blocks of 10 trials with two blocks of trials being administered testing two different stimuli sets (Set 1 and 2). The mastery criterion was 90% correct responding. If this criterion was not reached participants proceeded immediately to training of the same relations using the same stimulus test. If this criterion was reached participants proceeded immediately to further testing. Training trials were presented in the same way as test trials however prompting and corrective feedback was utilised. Prompts were faded as the participant began to respond independently. In

some cases, counterbalancing the location of comparison stimuli was not done until participants had passed testing on trials in which the stimuli remained in the same location. Training trials continued until participants were capable of reaching criteria on a novel stimuli set.

The testing of non-arbitrary distinction relations with non identical stimuli which belong to the same category also involved two sets of stimuli each with three members (Sets 1 and 2; three non identical dogs and three non identical houses). One stimulus was designated as stimulus A (e.g. A1), one designated as stimulus B (e.g. B1) and one designated as stimulus C (e.g. C1). Testing always involved three stimuli, the sample stimulus (e.g. A1; non identical dog) and two comparisons one of which was a non identical match to the sample stimuli (e.g. B1 and B2; non identical dog and car).

A-B training and testing. Participants were presented with the sample A stimulus (e.g. A1; dog) and two comparison stimuli (e.g. B1 and B2; dog and car) were placed side by side on the table in front of the participant. The Researcher presented a vocal verbal instruction "Find different". A correct response involved the participant pointing to, touching, or picking up the appropriate comparison (e.g., selecting B1 in the presence of A1) within 5 seconds. Trials were presented in blocks of 10. The location of the correct comparison was counterbalanced across trials with 2 trials with the correct comparison on the left, 2 trials with the correct comparison on the right and 6 trials in which the location was mixed. The mastery criterion was 90% correct responding. Participants were then tested using a more similar comparison stimulus (e.g. B3; cat). Again, the mastery criterion was 90%

correct responding. Participants were then tested using a novel stimuli set (A4-B4-B5; two non identical houses and a barn) and were tested similarly to the first testing sequence. Participants were required to reach a mastery criterion of 90% accuracy on A-B relations before proceeding.

If participants did not reach the accuracy criterion they received training on the stimuli set which they failed. This training was conducted in the same way as with the identical non-arbitrary trials in the above section. Training continued until participants were capable of passing a novel stimuli set.

B-C testing and training. Testing and training of B-C relations (B1-C1 and B4-C4) was identical to A-B trials. Participants were required to reach a mastery criterion of 90% accuracy on a test of the B-C relations before proceeding.

B-A and C-B testing and training. Testing and training of mutually entailed relations was identical to A-B trials however each test comprised of six blocks of 10 trials as follows: 10 of B1-A1-B2; 10 of B1-A1-B3; 10 of B4-A4-B5; 10 of C1-B1-B2; 10 of C1-B1-B3 and 10 of C4-B4-B5. Participants were required to reach a mastery criterion of 90% on each trial type before proceeding.

C-A and A-C testing and training. Testing and training of combinatorially entailed relations was similar to B-A and C-B trials with six blocks of 10 trials as follows: 10 of C1-A1-B2; 10 of C1-A1-B3; 10 of C4-A4-B5; 10 of A1-C1-B2; 10 of A1-C1-B3 and 10 of A4-B4-C5. Participants

were required to reach a mastery criterion of 90% on each trial type before proceeding.

Phase 2: Arbitrary testing/training. The testing of arbitrary distinction relations always involved three sets of stimuli each with three members (Sets 1, 2 and 3; car, ball, watch; #, %, £ and 3 identical red blocks). These comprised of one stimulus designated as stimulus A (e.g. A1), one designated as stimulus B (e.g. B1) and one designated as stimulus C (e.g. C1). Testing always involved three stimuli, the sample stimulus (A1) and two comparisons (B1 and C1).

Arbitrary trials followed the same format as non-arbitrary trials using arbitrary stimuli. Participants were first presented with three arbitrary symbols (e.g. A1-B1-C1; car, ball and watch). Two comparison stimuli (e.g. B1-C1; ball and watch) were placed on the table in front of the participant. Participants were presented with a sample stimulus (e.g. A1; car) and the Researcher pointed to one of the two comparison stimuli and instructed "This one is the different". Participants were then asked "Find different". A correct response required the participant to pick up or touch the correct comparison (e.g. selecting B1 in the presence of A1) within a 5 second response period. As with non-arbitrary trials, there were six different trial types tested: A-B; B-C; B-A; C-B; A-C and C-A. The locations of the stimuli were counterbalanced across trials. There was a total of 60 test trials conducted per stimuli set. The mastery criterion was 90% correct responding per block. If this criterion was not reached participants proceeded immediately to training

of the same relations using the same stimulus test. If this criterion was reached, participants proceeded immediately to further testing.

Participants were then presented with a different stimulus set (A2-B2-C2; £, %, #) and a similar testing training procedure. Again the mastery criterion was 90% correct responding per block. If this criterion was not reached participants proceeded immediately to training of the same relations using the same stimulus test. If this criterion was reached, participants proceeded immediately to further testing using an additional novel stimuli set (A3-B3-C3; three identical red blocks) where again the mastery criterion was 90% correct responding per block. It should be noted that all aspects of the stimuli were identical. The colour of the stimuli was kept constant in order to ensure stimulus control by colour was not interfering. Participants were required to follow the Researchers instruction and visually track the location of each stimulus in order to know which concept was being applied to each stimulus. If participants passed this test they proceeded to the next relational frame. If they did not pass the novel stimuli set they received training until they were capable of passing a novel stimuli set on the first exposure.

Phase 3: Testing non-arbitrary same/different relations. The testing of non-arbitrary same/different relations always involved two different stimuli sets (Sets 1 and 2; three non identical dogs and three non identical houses). These sets comprised of one stimulus designated as stimulus A (e.g. A1), one designated as stimulus B (e.g. B1) and one designated as stimulus C (e.g. C1). Testing always involved three stimuli, the sample stimulus (e.g. A1; non identical dog) and two comparisons one of which was a non

identical match to the sample stimulus (e.g. B1 and B2, non identical dog and car). On each trials two comparison stimuli were placed on the table in front of the participant (B1 and B2; non identical dog and car). The Researcher presented the participant with a sample stimulus (e.g. A1) along with the vocal instruction "Find same/ different". A correct response required the participant to pick up or touch the correct comparison (e.g. selecting B1 in the presence of A1) within a 5 second response period. The location of the correct comparison was counterbalanced across trials with 2 trials with the correct comparison on the left, 2 trials with the correct comparison on the right and 6 trials in which the location was mixed randomly. The instruction of "Find same/different" was also randomly mixed, with five same trials and five different trials. All test trials were presented in blocks of 10 trials with two blocks of trials being administered testing two different stimuli sets (Set 1 and set 2). The mastery criterion was 90% correct responding. If this criterion was not reached participants proceeded immediately to training of the same relations using the same stimulus set. If this criterion was reached, participants proceeded immediately to further testing.

Phase 4: Testing combinatorially entailed same/different relations.

The testing of combinatorially entailed same/different relations always involved one stimuli set (three identical red triangles). These comprised of one stimulus designated as stimulus A (e.g.A1), one designated as stimulus B (e.g. B1) and one designated as stimulus C (e.g. C1). Testing always involved three stimuli: the sample stimulus (A1) and two comparisons (B1 and C1). It should be noted that all aspects of the stimuli were identical. The colour of the stimuli was kept constant in order to ensure stimulus control by colour

was not interfering. Participants were required to follow the Researchers instruction and visually track the location of each stimulus in order to know which concept was being applied to each stimulus.

Participants were first presented with three arbitrary symbols (A1-B1-C1; three identical red blocks). Two comparison stimuli (e.g. B1-C1) were placed in front of the student. Participants were presented with a sample stimulus (e.g. A1) and Researcher pointed to one of the two comparisons and instructed "This one is the same". The researcher then pointed to the other object and instructed "And this one is different". Each trial was made up of three components. First the Researcher asked the participant to "Find same" and then the Researcher asked the participant to "Find different". A third component of the testing involved the researcher pointing to the two objects on the table and asking the participant "Are they the same or different?". There were a total of 12 test trials. Therefore, participants were required to make a total of 36 responses. A correct response required the participant to emit the correct answer within 5 seconds. The location of the same and different stimuli were counterbalanced across trials with 3 trials the same stimulus on the left, 3 trials with the same stimulus on the right and 6 trials in which the location was randomly mixed. The mastery criterion was 11/12 correct responses. If this criterion was reached, participants proceeded immediately to further testing.

If this criterion was not reached participants proceeded immediately to separate testing of co-ordination and distinction relations using the same stimuli set. Each test involved 10 test trials with 10 trials testing co-







ordination and 10 trials testing distinction. The accuracy criterion was 90% correct responding. If participants failed this component of testing they returned to the corresponding stage of training. For example, if a participant failed the co-ordination test they returned to Stage 2. If participants passed co-ordination and distinction testing separately they were tested on mixed trials. If participants failed this component of testing they received training utilising prompting and corrective feedback until criterion was reached and they were capable of passing a novel stimulus set.

On establishment of the frame of distinction the next targeted frame was comparison.

Stage 4: Comparison relations. There were three main phases in the presentation of the comparison relations testing. That is, Phase 1 targeted yes/no responding; Phase 2 targeted non-arbitrary comparison relations and Phase 3 targeted arbitrary comparison relations. Each of the three separate phases commenced with test trials and only contained training trials if inadequate test performances (i.e. less than 90% correct) were recorded (i.e. if training was required). In addition all the target relational performances were first tested/ trained as non-arbitrary relations followed by arbitrary relations. A sample of materials used in Stage 4 is presented in table 2 below.

Table 2

Example of Stimuli Used in Stage 4

Relation Type	A	B	C
Non-arbitrary			
Arbitrary			

Phase 1: Yes/No testing or training. The testing of YES/NO responding always involved 10 trials. At the beginning of the trial the Researcher held up a common item (e.g. dog, cat, house, boy, and chair) and asked "Is it a (correct/incorrect name of item)?". A correct response required the participant to respond "Yes" or "No" within 5 seconds. Yes/ No trials were randomly mixed. The accuracy criterion was 90% correct responding.

Phase 2: Non-arbitrary testing/training. The testing of non-arbitrary comparison relations always involved the presentation of two stimuli: one which was physically bigger and one which was physically smaller (big jelly snake and a small jelly snake). Two stimuli were placed on the table in front of the participant and the Researcher asked the participant to "Show me big" and "Show me small". There were a total of 20 test trials. For the first block of 10 trials 5 of the trials involved the stimuli being presented in a way in which $A > B$ and 5 of the trials involved stimuli being presented in a way in

which $A < B$. The second block of 10 trials involved the location of the bigger and smaller stimuli being mixed randomly. A correct response required the participant to point to or touch the correct stimulus within 5 seconds. The mastery criterion for this part was 90% correct responding per block of trials. If this criterion was not reached the participants proceeded immediately to training of the same relations using the same stimulus set. If this criteria was reached participants proceeded immediately to further testing.

Once participants reached the mastery criteria they were then presented with 20 trials in which the Researcher asked the participants "Which one is the biggest?" and "Which one is the smallest?". Again, for the first block of 10 trials 5 of the trials involved the stimuli being presented in a way in which $A > B$ and 5 trials in which stimuli were presented as $A < B$. The second block of 10 trials involved the location of the bigger and smaller stimuli being mixed randomly. A correct response required the participant to point to or touch the correct comparison within 5 seconds. The mastery criterion for this part was again 90% correct responding. If this criterion was not reached the participants proceeded immediately to training of the same relations using the same stimulus set. If this criteria was reached participants proceeded immediately to further testing.

Participants were then tested with a novel stimulus set (a big straw and a small straw) and the mastery criterion was again set at 90% correct responding. If this criterion was not reached the participants proceeded immediately to training of the same relations using the same stimulus set. Explicit training continued until participants were capable of passing a novel

stimulus set on the first presentation. If this criteria was reached participants proceeded immediately to further testing.

Participants were then presented with the same stimuli (a small jelly snake and a big jelly snake) across two blocks of 10 trials however in this phase the Researcher asked the participant "Is this one bigger than this one?" and "Is this one smaller than that one?". For the first block of 10 trials 5 of the trials involved the stimuli being presented in a way in which $A > B$ and 5 trials in which stimuli were presented as $A < B$. The second block of 10 trials involved the location of the bigger and smaller stimuli being mixed randomly. A correct response required the participant to answer "Yes" or "No" accordingly to the trials presented by the researcher. Mastery criterion was 90% correct responding. If this criterion was not reached the participants proceeded immediately to training of the same relations using the same stimulus set. If this criterion was reached participants proceeded immediately to further testing.

Introduction of combinatorial entailment. The testing of combinatorial entailment involved the introduction of a third stimulus. All three stimuli were different sizes: smallest; middle and biggest. There were two different trial types: $A < B < C$ and $A > B > C$. The three stimuli were placed on the table in front of the participant. The Researcher asked the participant questions such as "Is this jelly snake bigger than this jelly snake/", "Is this jelly snake smaller than this one?" until each combination of bigger-smaller relations were tested. There were 24 questions asked in total. A correct response required the participant to answer "Yes" or "No" within 5 seconds.

The mastery criterion was 90% correct responding. If this criterion was not reached the participants proceeded immediately to training of the same relations using the same stimulus set. If this criterion was reached participants proceeded immediately to further testing.

Phase 3: Arbitrary testing/training. The testing of arbitrary comparison relations always involved the presentation of two identical stimuli labelled A and B (two identical red blocks). It should be noted that all aspects of the stimuli were identical. The colour of stimuli was kept constant in order to ensure stimulus control by colour was not interfering. Participants were required to follow the Researchers instruction and visually track the location of each stimulus in order to know which dimension was being applied to each stimulus. The stimuli were presented horizontally from left to right. There were four different trial types: $A > B$; $B < A$; $A < B$ and $B > A$. During all trials the Researcher pointed to one block and said "This one is big" and then to the other and said "This one is small". The Researcher then asked four questions "Show me the big one", "Show me the small one", "Which one is the biggest?" and "Which one is the smallest?". A correct response required the participant to touch or point to the correct comparison within 5 seconds. There were a total of 16 test trials with four trials for each of four trial types. The mastery criterion was 90% correct responding. If this criterion was not reached the participants proceeded immediately to training of the same relations using the same stimulus set. If this criterion was reached participants proceeded immediately to further testing.

The Researcher then presented the same stimuli and asked "Is this one bigger than this one?" or "Is this one smaller than this one?". A correct response required the participant to point to or touch the correct comparison within 5 seconds. As above there were four trial types: $A > B$; $B < A$; $A < B$ and $B > A$. There were a total of 16 test trials, four trials for each of four trial types, with the location of the bigger and smaller stimuli mixed randomly across testing. For each trial type there were two trials which asked "Is this one bigger than this one?" and two trial types which asked "Is this one smaller than this one?". Mastery criterion was 90% correct responding. If this criterion was not reached the participants proceeded immediately to training of the same relations using the same stimulus set. If this criterion was reached participants proceeded immediately to further testing.

Introduction of combinatorial entailment. The testing of combinatorial entailment involved the introduction of a third identical stimulus. The three identical stimuli were presented to the participant (three identical red blocks). The stimuli were presented horizontally from left to right with 12 trials involving $A < B < C$ and 12 trials $A > B > C$. The participant was instructed "we are going to play a game. You want a jelly snake. This jelly snake is the biggest (A) and this jelly snake is smaller than that one (B) and this jelly snake is the smallest (C). Which jelly snake would you want?". A correct response required the participant to point to or touch the correct comparison within 5 seconds. The mastery criteria was 20/24 correct responses. If this criterion was not reached the participants proceeded immediately to training of the same relations using the same stimulus set. If





this criterion was reached participants proceeded immediately to further testing.

On successful training of the relational frame of comparison the next targeted frame was opposition.

Stage 5: Opposition relations. There were two main phases in the testing of opposition relations. That is, Phase 1 targeted non-arbitrary opposition relations and Phase 2 targeted arbitrary opposition relations. Each of the two separate phases commenced with test trials and only contained training trials if inadequate test performances (i.e. less than 90% correct) were recorded (i.e. if training was required). In addition all the target relational performances were first tested/ trained as non-arbitrary relations followed by arbitrary relations. A sample of materials used in Stage 5 is presented in table 3 below.

Table 3

Example of Stimuli Used in Stage 5

Relation Type	Stimulus Dimension	
Non-arbitrary		
Arbitrary		

Phase 1: Non-Arbitrary testing/training. The testing of non-arbitrary opposition relations always involved the presentation of a pair of non

identical pictures (a happy and a sad face). Participants were asked to select the appropriate stimulus when asked "Show me the happy one" and "Show me the sad one". This was done for a single block of 10 trials with 5 trials for each dimension mixed across the block. A correct response required the participant to point to or touch the correct comparison within 5 seconds. Mastery criterion was 90% correct responding. If this criterion was not reached participants proceeded immediately to training of the same relations using the same stimulus test. If this criterion was reached, participants proceeded immediately to further testing.

Participants were then asked "Show me the opposite of happy" and "Show me the opposite of sad". This testing block involved 10 trials with 5 of each dimension mixed throughout. A correct response required the participant to point to or touch the correct comparison within 5 seconds. Mastery criterion was 90% correct responding. If this criterion was not reached participants proceeded immediately to training of the same relations using the same stimulus test. If this criterion was reached, participants proceeded immediately to further testing.

Phase 2: Arbitrary testing/training. The testing of arbitrary opposition relations always involved the participant being presented with two arbitrary stimuli (two identical red blocks). It should be noted that all aspects of the stimuli were identical. The colour of stimuli was kept constant in order to ensure stimulus control by colour was not interfering. Participants were required to follow the Researchers instruction and visually track the location of each stimulus in order to know which dimension was being applied to each

stimulus. The Researcher pointed to one block and instructed "This one is happy" and then pointed to the other block and instructed and "This one is sad". Two blocks of 10 trials were tested. For the first block of 10 trials the Researcher asked the participant "Show me the happy one" or "Show me the sad one". Two trials involved the happy stimuli being placed on the left, two trials involved the happy stimulus being placed on the right and six trials involved the location being mixed randomly. The second block of 10 trials involved the Researcher asking the participant to "Show me the opposite of happy" or "Show me the opposite of sad". Again two trials involved the happy stimuli being placed on the left, two trials involved the happy stimulus being placed on the right and six trials involved the location being mixed randomly. A correct response required the participant to point to or touch the correct stimulus within 5 seconds. The accuracy criterion set as 90% correct responding per block. If this criterion was not reached participants proceeded immediately to training of the same relations using the same stimulus test. If this criterion was reached, participants proceeded immediately to further testing.









On successful training of the relational frame of opposition the next targeted frame was hierarchy.

Stage 6: Hierarchy relations. There were two main phases in the testing of hierarchal relations. That is, Phase 1 targeted non-arbitrary hierarchy relations and Phase 2 targeted arbitrary hierarchy relations. Each of the two separate phases commenced with test trials and only contained training trials if inadequate test performances (i.e. less than 90% correct)

were recorded (i.e. if training was required). In addition all the target relational performances were first tested/ trained as non-arbitrary relations followed by arbitrary relations. A sample of materials used in Stage 6 is presented in table 4 below.

Table 4

Example of Stimuli Used in Stage 6

Relation type	Pictures			
Non-arbitrary	A	B	C	D
				
Arbitrary				

Phase 1: Non-arbitrary testing/training. The testing of non-arbitrary opposition always involved participants being presented with 10 objects which belonged to two categories (5 food items which were vegetables and 5 animals that live on the farm). Participants were presented with two containers and asked to sort the items. Correct responding required the participant to sort the items into two separate categories. Mastery criterion was 90% correct responding. If this criterion was not reached participants proceeded immediately to training of the same relations using the same stimulus test. If this criterion was reached, participants proceeded immediately to further testing.

Introduction of combinatorial entailment. The testing of combinatorial entailment involved the Researcher introducing novel stimuli

(savoury food items and animals from the zoo) from either category and asking the participant "Which box would you put this in?". Correct responding required the participant to sort the items into the correct categories. The mastery criterion was 90% correct responding with 5 novel pictures from each category. If this criterion was not reached participants proceeded immediately to training of the same relations using the same stimulus test. If this criterion was reached, participants proceeded immediately to further testing.

Phase 2: Arbitrary testing/training. The testing of arbitrary hierarchy always involved participants being presented with two identical containers in addition to two identical stimuli (two identical red blocks). It should be noted that all aspects of the stimuli were identical. The colour of stimuli was kept constant in order to ensure stimulus control by colour was not interfering. Participants were required to follow the Researchers instruction and visually track the location of each stimulus in order to know which category was being applied to each stimulus. The Researcher pointed to one box and said "This one is animals". The Researcher then pointed to the other box and said "This one is food". The Researcher pointed to one of two identical stimuli and said "If this one was a __ where would it go?". 5 different items from each category were tested. Correct responding required the participant to sort the items into the correct categories. The mastery criterion was 90% correct responding. If this criterion was not reached participants proceeded immediately to training of the same relations using the same stimulus test. If this criterion was reached, participants proceeded immediately to further testing.

Introduction of combinatorial entailment. The testing of combinatorial entailment involved the Researcher presenting two boxes and labelling one food and one an animal. The Researcher then asked "If this one was a ___ where would it go?". The participant was tested with 5 novel stimuli for each category. Correct responding required the participant to place the novel items into the correct categories. Mastery criterion was 90% correct responding. If this criterion was not reached participants proceeded immediately to training of the same relations using the same stimulus test. If this criterion was reached, participants proceeded immediately to further testing.

Stage 7: Post-intervention standardised measures of verbal ability. All participants were re-administered with the same three standardised measures used during baseline in the same sequence, with the VB-MAPP first, followed by the PPVT and finally the K-BIT.

Results

The primary aim of Study 1 was to examine the emergence of relational responding in five participants with ASD and/or GDD. The data on participants' acquisition of each relational frame forms the bulk of the current results section. A secondary aim of Study 1 was to examine the relationship between verbal ability and relational responding. The data relating to this aim will be presented at the end of the results section.

Stage 2: Co-ordination Relations

Table 5 shows performances on conditional discrimination tests, as well as the number of training trials required for each participant to reach criteria on the conditional discrimination training.

Table 5

Number of correct test responses and number of required training trials in non-arbitrary and arbitrary co-ordination relations

P	Phase 1: Non-Arbitrary									Phase 2: Arbitrary					
	Identical (20)	A-B Test (10)	A-B Teach. (10)	A-B Retest (10)	B-C Test (10)	B-A Test (30)	C-B Test (30)	C-A Test (30)	A-C Test (30)	A-B Test (10)	B-C Test (10)	B-A Test (30)	C-B Test (30)	C-A Test (30)	A-C Test (30)
1	20	30	-	-	30	30	30	30	30	30	30	30	30	30	30
2	20	30	-	-	30	30	30	30	30	30	30	30	30	30	30
3	20	30	-	-	30	30	30	30	30	30	30	30	30	30	30
4	20	30	-	-	30	30	30	30	30	30	30	30	30	30	30
5	20	0	40	30	30	30	30	30	30	30	30	30	30	30	30

-Indicates not required

All five participants passed the first non-arbitrary test of identical stimuli with perfect performances. Participants 1-4 also passed the A-B test similarly, while

Participant 5 emitted no correct responses. However, after 40 training trials he reached criterion and then passed a second exposure to the A-B test perfectly using the same stimuli set followed by a test using a more similar comparison and finally a novel stimuli set. All five participants passed B-C, B-A, C-B, A-C-A and A-C test trials with perfect performances. Similarly, all five participants passed arbitrary trials (A-B, B-C, B-A, C-B, C-A and A-C).

Stage 3: Distinction Relations

Table 6 shows performances on the non-arbitrary conditional discrimination tests, as well as the number of training trials required for each participant to reach criteria on the conditional discrimination training.

Table 6

Number of correct test responses and number of required training trials in non-arbitrary distinction relations

Phase 1: Non-Arbitrary													
P	Identical Test (20)	Teach (10)	Retest (20)	A-B Test (10)	A-B Teach (10)	A-B Retest (10)	B-C Test (10)	Teach (10)	Retest (10)	B-A Test (30)	C-B Test (30)	C-A Test (30)	A-C Test (30)
1	20	-	-	30	-	-	30	-	-	30	30	30	30
2	20	-	-	30	-	-	30	-	-	30	30	30	30
3	20	-	-	30	-	-	30	-	-	30	30	30	30
4	20	-	-	7	10	30	8	40	10	-	-	-	-
-	-	-	-	-	-	-	1	10	30	30	30	30	30
5	0	10	20	0	20	30	0	30	10	-	-	-	-
-	-	-	-	-	-	-	0	10	30	30	30	30	30

- Indicates not required

Participants 1-4 passed the non-arbitrary test of identical stimuli with perfect performances while Participant 5 emitted no correct responses. However, after 10 training trials he reached criterion and then passed a second exposure of the same

stimuli set with perfect performance. Participants 1-3 passed the A-B test, while Participant 4 emitted 7 correct responses and Participant 5 emitted no correct responses. Participant 4 required 10 training trials to reach criterion and then passed a second exposure perfectly using the same stimuli set followed by a test using a more similar comparison and finally a novel stimuli set. Participant 5 required 20 training trials to reach criterion however likewise he then passed a second exposure of the same stimuli set in addition to testing using a more similar comparison stimuli and a novel stimuli set. Participants 1-3 also passed the B-C test with perfect performance, while Participant 4 emitted 8 correct responses and Participant 5 emitted 0 correct responses. Participant 4 required 40 training trials to reach criterion on re-exposure to the same stimuli set. Participant 4 then failed the test using a more similar comparison, emitting 1 correct response. Participant 4 required 10 training trials to reach criterion on the same stimuli set on the second exposure and pass a novel stimuli set. Participant 5 required 30 training trials to reach criterion on the same stimuli set however he then failed testing using a more similar comparison stimuli. Participant 5 required 10 training trials to reach criterion on the same stimuli set on the second exposure and pass a novel stimuli set. All five participants passed B-A, C-B, A-C-A and A-C test trials with perfect performances.

Table 7 shows performances on arbitrary conditional discrimination tests, as well as the number of training trials required for each participant to reach criteria on the conditional discrimination training.

Table 7

Number of correct test responses and number of required training trials in arbitrary distinction relations

Phase 2: Arbitrary								
P	A-B Test (10)	A-B Teach (10)	A-B Retest (10)	B-C Test (10)	B-A Test (30)	C-B Test (30)	C-A Test (30)	A-C Test (30)
1	30	-	-	30	30	30	30	30
2	30	-	-	30	30	30	30	30
3	30	-	-	30	30	30	30	30
4	3	10	30	30	30	30	30	30
5	30	-	30	30	30	30	30	30

-Indicates not required

Four participants passed the A-B test with perfect performances, while Participant 4 emitted 3 correct responses. However, after 10 training trials he reached criteria on the same stimuli set and pass a novel stimuli set. The five participants passed B-C, B-A, C-B, C-A and A-C test trials with perfect performances

Table 8 shows performances on the non-arbitrary and arbitrary co-ordination and distinction mixed conditional discrimination tests, as well as the number of training trials required for each participant to reach criterion on the conditional discrimination training.

Table 8

Number of correct test responses and number of required training trials in non-arbitrary and arbitrary co-ordination and distinction mixed trials

Phase 3: Non - Arbitrary		Phase 4: Arbitrary						
P	Test (10)	Arbitrary Test (12)	ID Same Test (12)	ID Diff Test (12)	S/D Test (12)	Teach ID S/D mix (10)	Teach "Are they S/D?" (10)	Retest (12)
1	20	12	-	-	-	-	-	-
2	20	0	3	5	0	10	10	12
3	20	0	12	12	0	-	10	12
4	20	0	12	12	0	-	10	12
5	20	0	12	12	0	-	10	12

- Indicates not required

All five participants passed the first non-arbitrary test of same/different mixed trials with perfect performances. Participant 1 also passed arbitrary mixed trials similarly, while Participants 1-4 emitted 0 correct responses. Participant 2 emitted 3 correct responses on the arbitrary test of identifying same and 5 correct responses on the arbitrary test identifying different while all other participant passed this test. However, after 10 training trials he reached criteria. Participants 1-4 emitted 0 correct responses on identifying deriving the same/different relation. However, after 10 training trials all participants reached criteria and passed the re-test of arbitrary same/different mixed trials.

Stage 4: Comparison Relations

Table 9 shows performances on the non-arbitrary and arbitrary conditional discrimination tests, as well as the number of training trials required for each participant to reach criteria on the conditional discrimination training.

Table 9

Number of correct test responses and number of required training trials in non-arbitrary and arbitrary comparison relations

Phase 1		Phase 2: Non-Arbitrary						Phase 3: Arbitrary				
P	Yes/No (10)	Big/small (20)	Bigger/smaller/biggest/smallest (20)	Is this one bigger/smaller (20)	Teach (10)	Retest (20)	CE (24)	Bigger/smaller/biggest/smallest (16)	Is this one bigger/smaller (16)	Teach (10)	Retest (16)	CE (24)
1	10	20	40	5	70	40	24	16	16	-	-	24
2	10	20	40	6	210	40	24	16	8	10	16	24
3	10	20	40	5	260	40	24	16	16	-	-	24
4	10	20	40	20	-	-	24	16	16	-	-	24
5	10	20	40	20	-	-	24	16	6	10	16	24

- Indicates not required

All five participants passed the first non-arbitrary test Yes/No responding with perfect performances. All five participants also passed identifying the big/small stimuli and identifying the bigger/smaller/biggest/smallest stimuli. Participants 4 and 5 also passed the comparison of "Is this one bigger/smaller" similarly, while Participants 1 and 3 emitted 5 correct responses and Participant 2 emitted 6 correct responses. Participant 1 required 70 training trials to reach criterion on the same stimuli set and pass a test using novel stimuli, Participant 2 required 210 training trials to reach criterion on the same stimuli set and pass a test using novel stimuli and Participant 3 required 260 training trials to reach criterion on the same stimuli set

and pass a test using novel stimuli. However, all participants then passed testing of combinatorial entailment perfectly.

All five participants then passed the first arbitrary test identifying the bigger/smaller/biggest/smallest stimuli with perfect performances. Participants 1, 3, 4 and 5 the passed the comparison of "Is this one bigger/smaller" in addition to combinatorial entailment trials. Participant 2 emitted 8 correct responses in identifying the bigger/smaller/biggest/smallest stimuli however 10 test trials were sufficient for this participant to reach criterion on the same stimuli test and similarly pass combinatorial entailment trials.

Stage 5: Opposition Relations

Table 10 shows performances on conditional discrimination tests, as well as the number of training trials required for each participant to reach criteria on the conditional discrimination training.

Table 10

Number of correct test responses and number of required training trials in non-arbitrary and arbitrary opposition relations

P	Dimension set	Phase 1: Non-Arbitrary				Phase 2: Arbitrary			
		Dimension (10)	Opposites (10)	Teach (10)	Retest (10)	Dimension (10)	Opposites (10)	Teach (20)	Retest (10)
1	Happy/Sad	10	0	20	10	10	10	-	-
2	Happy/Sad	10	0	20	10	10	10	-	-
3	Happy/Sad	10	0	80	10	10	0	40	10
4	Happy/Sad	10	0	60	10	10	4	20	10
5	Happy/Sad	10	0	50	10	10	8	20	10

- Indicates not required

All five participants passed the first component of testing which involved the abstraction of non-arbitrary dimensions. Participants 1-5 then required training on non-arbitrary opposites in which the participant was required to "Find the opposite of _". An average of 46 training trials were required to reach criterion and pass a retest on the same stimuli set. All participants passed the first component of arbitrary testing which involved the abstraction of the arbitrary dimension. Participants 1 and 2 passed the abstraction of arbitrary opposites however Participants 1, 2 and 3 required training with an average of 20 training trials using the same stimuli set required for participants to reach criteria on arbitrary opposites.

Stage 6: Hierarchy Relations

Table 11 shows performances on non-arbitrary and arbitrary tests, as well as the number of training trials required for each participant to reach criteria on training.

Table 11

Number of correct test responses and number of required training trials in non-arbitrary and arbitrary hierarchy relations

P	Phase 1: Non-Arbitrary				Phase 2: Arbitrary			
	Test (10)	Teach (10)	Retest (10)	CE (10)	Test (10)	Teach (10)	Retest (10)	CE (10)
1	3	20	10	10	10	-	-	10
2	4	20	10	10	10	-	-	10
3	10	-	-	10	10	-	-	10
4	7	10	10	10	10	-	-	10
5	4	30	10	10	0	20	10	10

- Indicates not required

One participant (P3) passed all components of both non-arbitrary and arbitrary hierarchy. Participants 2-5 required training on non-arbitrary hierarchy. Participants 1 and 2 required 20 training trials to reach criteria on re-exposure to testing using the same stimuli set. While Participant 4 required 10 training trials and Participant 5 required 30 training trials to reach criterion and pass the retest using the same stimuli set. All participants passed combinatorial entailment trials. Participants 1-4 passed arbitrary hierarchy trials while Participant 5 required 20 training trials before reaching criterion on the retest. All participants passed arbitrary combinatorial entailment trials.

Relationship between Verbal Ability and Relational Responding

There were two components involved in examining the relationship between verbal ability and relational responding. Firstly, participant's verbal ability was measured pre- and post-relational responding testing/training. The difference between scores were analysed to determine if training in relational responding had an impact on verbal ability. Secondly, the predictive influence of prior verbal scores on performance throughout the sequence of relational responding testing/training was examined. The results of these analyses will be presented in the remaining text.

Table 12 shows the overall scores of verbal ability per participant on the PPVT-IV, the K-BIT and the VB-MAPP at pre- and post-relational testing/training.

Table 12

Results of overall scores on the standardised verbal assessments at pre- and post-relational testing/training in Study 1

P	K-BIT (160)			PPVT-IV (160)			VB-MAPP (170)		
	Pre	Post	Diff.	Pre	Post	Diff.	Pre	Post	Diff.
1	101	81	-20	81	92	+9	121	164.5	+43.5
2	83	89	+6	89	90	+1	101	145	+44
3	96	88	-8	88	87	-1	92	137	+45
4	65	79	+14	79	82	+3	105	140	+35
5	86	88	+2	88	78	-10	91.5	136	+44.5

Results from baseline of standardised measures of verbal ability show that on the K-BIT assessment two participants (Ps1 and 3) were categorised as average (scoring between 90-100), two participants (Ps2 and 5) were categorised as below average (scoring between 80-89) and one participant was categorised as below the lower extreme (P4) (scoring below 69) at pre relational testing/ training. In addition, only one participant (P1) scored above the mean average score across the assessment (100). On post-relational testing/training measures of verbal ability two of the five participants (Ps1 and 3) showed a decrease in the overall score from pre-to post-relational testing/training. While the mean decrease across participants was 14, the children's scores decreased between 8 and 20 points. Three participants (Ps 2, 4 and 5) showed an increase in the overall score. The mean increase in scores across participants was 7 with participant's scores increasing between 2 and 14 points.

Results from baseline of standardised measures of verbal ability shows that on PPVT assessment two participants (Ps1 and 4) were categorised as moderately low (scoring between 70 and 85) and three participants (Ps 2, 3 and 5) were categorised as low average (scoring between 85 and 100) at pre relational testing/training. No participant reached the mean average score on the PPVT (100). On post relational testing/training two of the five participants (Ps 3 and 4) showed a decrease in the overall score from pre-to post relational testing/training while three participants showed an increase in the overall score. The mean decrease in scores was 5.5 with participant's scores decreasing between 1 and 10 points. Three participants (Ps 1, 2 and 4) showed an increase in the overall score. The mean increase in scores across participants was 6.5 with participant's scores increasing between 1 and 9 points.

Results from baseline of standardised measures of verbal ability shows that on the VB-MAPP assessment three participants (Ps1, 2 and 3) were classified in Level 3 (the highest possible level on the VB-MAPP) and two participants (Ps 4 and 5) were classified as Level 2 at pre relational testing/training. The maximum score on the VB-MAPP assessment is 170. No participant scored the maximum score on the VB-MAPP assessment. On post relational testing/training measures all participants showed a considerable increase in the overall score from pre-to post relational testing/ training. The mean increase in scores was 42.4 with the minimum increase being 35 and the maximum increase being 45.

Table 13 shows the total number of training trials required by each participant across both non-arbitrary and arbitrary trials for each relational frame.

Table 13

Results of the relationship between verbal ability and performances in relational responding is presented in Study 1

P	Average Verbal Score *	Coord.		Distinc.		Coord. Distinc. Mixed		Comp.		Opp.		Hier.		Total	
		NA	Arb	NA	Arb	NA	Arb	NA	Arb	NA	Arb	NA	Arb	NA	Arb
1	111	0	0	0	0	0	0	70	0	20	0	20	0	110	0
2	92	0	0	0	0	0	20	220	0	20	0	20	0	260	20
3	94	0	0	0	0	0	10	260	0	80	40	0	0	340	50
4	85	0	0	60	10	0	0	0	0	60	10	10	0	130	20
5	88.7	40	0	60	0	0	10	0	10	50	10	30	20	180	50

* Average score of K-BIT and PPVT

All five participants completed relational responding testing/training beginning at non-arbitrary co-ordination and continuing until all participants were tested and trained on the relational frame of hierarchy. Table 13 displays the number of training trials each participant required to proceed through the protocol in Study 1. For the purpose of comparison an average verbal score was calculated based on the two standardised verbal assessments: the K-BIT and the PPVT. Overall across all stages Participant 1 who had the highest average verbal score required the least amount of training (110 training trials). Across all other participants (Ps 2-5) no clear relationship can be seen between participant's level of verbal ability and performance on relational responding. It should be noted that Participant 1 who had the highest level of verbal ability was the only participant who did not require training on arbitrary relations.

Examining the amount of training required for each individual relational frame a pattern can be seen between participant's verbal ability and the number of training trials required. Participant 5, who had the second lowest level of verbal ability, was the only participant in Study 1 who required training (40 training trials) across both non-arbitrary and arbitrary co-ordination trials. All other participants passed through all stages of the co-ordination relations with no training.

Participant 4, who had the lowest level of verbal ability, required the most amount of training for the relational frame of distinction (60 non-arbitrary and 10 arbitrary training trials). Participant 5, who had the second lowest level of verbal ability, required the second highest number of training trials (60 training trials) pass non-arbitrary distinction. All other participants passed through all stages of the distinction relations with no training.

Participants 2, 3 and 5 required training to proceed through arbitrary co-ordination and distinction mixed trial testing while Participant 1 who had the highest level of verbal ability did not require any training on this frame. Participant 5, who had the second lowest level of verbal ability required 10 training trials to proceed through arbitrary mixed trials. Participant 2 who had the third lowest level of verbal ability required 20 training trials to proceed through arbitrary mixed trials. Participant 3 who had the second highest level of verbal ability required 10 training trials to pass arbitrary co-ordination and distinction mixed trials.

Participant 1, 2, 3 and 5 required training to proceed through arbitrary comparison trials. Participant 4 who had the lowest level of verbal ability did not require any training in this stage. Participant 3 who had the second highest level of

verbal ability required the most amount of training with 260 training trials required to pass non-arbitrary comparison trials. Participant 2 who had the third lowest level of verbal ability required 210 training trials to proceed through non-arbitrary comparison testing. Participant 1 who had the highest level of verbal ability required 70 training trials to proceed through non-arbitrary comparison. Participant 5 who had the second lowest level of verbal ability required to least amount of training requiring 10 training trials to proceed through non-arbitrary comparison.

All participants (Ps 1-5) required training to pass non-arbitrary opposition relations. Participant 3 who had the second highest level of verbal ability required 80 training trials to proceed through non-arbitrary opposition relations. Participant 4 who had the lowest level of verbal ability required the second highest number of training trials to proceed through non-arbitrary opposition relations (60 non-arbitrary and 10 arbitrary training trials). Participant 5 who had the second lowest level of verbal ability required the third highest number of training trials (50 non-arbitrary and 10 arbitrary training trials) to precede through non-arbitrary opposition relations. Participant 1, who had the highest level of verbal ability, and participant 2, who had the third highest level of verbal ability, required the least amount of training trials on oppositional relations (20 training trials). Participant 3, who had the second highest level of verbal ability, required to most amount of training to proceed through arbitrary opposition relations.

All participants (Ps1-5), with the exception of Participant 3 who had the second highest level of verbal ability, required training to proceed through non-arbitrary hierarchy relations. Participant 5 who had the second lowest level of verbal ability required the most amount of training to proceed through non-arbitrary

hierarchy relations (30 training trials) and was the only participant who required training on arbitrary hierarchy relations (20 training trials). Participant 4 who had the lowest level of verbal ability required 10 training trials to pass non-arbitrary hierarchy relations. Participant 1 and 3 required 20 training trials to pass non-arbitrary hierarchy relations.

Discussion

Study 1 involved the participation of five children with GDD, four with ASD and one with Down's syndrome. All were exposed to the same experimental stages beginning with assessment of verbal ability and then proceeding through the relational frames of co-ordination, distinction, comparison, opposition and finally hierarchy. All five children demonstrated different verbal abilities in addition to different competencies in relational responding. Overall the results of Study 1 provide support for an RFT based intervention for the development of relational responding skills in children with developmental disabilities in addition to providing empirical evidence to support a possible developmental sequence in the emergence of such skills. The current study also provided evidence in support of the relationship between relational responding and verbal ability. One important issue raised by the findings from Study 1 is the possibility that the results obtained arose, at least in part due to the sequence of training and testing to which participants were exposed. In other words, if the experimental stages were reversed would similar patterns of responding be obtained? This issue was addressed in Study 2.

-Chapter 3-

Study 2

One issue raised by the results in Study 1 was the possibility that the results obtained arose, at least in part due to the sequence of training and testing to which participants were exposed. Study 2 was designed to investigate if the sequence of testing and training has an impact on participant's acquisition of the relational frames. In other words, if the experimental stages were manipulated would this have an impact on participants relational responding? This is an issue of extreme empirical importance as while it is fairly well established which relational frames are essential to the development of language and higher cognition (Rehfeldt & Barnes-Holmes, 2009), there is little or no empirical evidence to suggest the sequence in which these might emerge or should be trained for optimal effects (Dunne, 2011). The aim therefore of Study 2 was to manipulate the training sequence utilised in Study 1 and examine the effect on the acquisition of relational responding. Study 2 was identical in format to Study 1 except the sequence of stages was manipulated. Specifically the children were exposed to relational responding testing and training in the following sequence: co-ordination; distinction; opposition; comparison and hierarchy. Study 2 was also an attempt to build upon the evidence in Study 1 supporting an RFT based intervention for the development of relational responding skills in children with developmental disabilities in addition to providing further evidence in support of the relationship between relational responding and verbal ability.

Method

Participants

A total of four children (Ps1-4) participated in Study 2. All had been independently diagnosed with ASD (these were not the same participants as in Study 1). All participants were male and were aged between 3 years, 7 months and 4 years, 7 months. All participants attended full-time at the same early intervention centre for children with Developmental Disabilities in Wicklow, Ireland.

Ethical Approval

As participants in Study 2 were of the same population as participants in Study 1, individuals with GDD, the same ethical considerations were considered.

Setting

All aspects of the setting in Study 2 were identical to Study 1.

Materials

All of the materials employed in Study 2 were identical to those used in Study 1 with the exception of training opposition relations. In training opposition relations in Study 2 a novel set of stimuli (empty and full) were tested.

Programmed Consequences

Programmed Consequences used in Study 2 were the same as those used in Study 1.

Inter-observer Agreement

The procedure for collecting and calculation inter-observer agreement (IOA) was identical to Study 1 with a second independent observer with training in behaviour analysis employed for 30% of trials. Agreement across sessions ranged from 90% to 100%, with a mean overall agreement of 96%.

Experimental Sequence

As in Study 1, the current study contained an array of standardised measures, as well as an extensive series of training and testing in relational responding. However the sequence used in Study 2 differed slightly to that used in Study 1. In Study 2 opposition was trained before comparison therefore the sequence of training was as follows: co-ordination, distinction, opposition, comparison, hierarchy and perspective-taking.

Procedure

As in Study 1 the current study comprised of 8 stages, some with a number of phases.

Stage 1: Baseline of standardised measures of verbal ability. As in Study 1 all participants completed the three standardised measures in the same sequence, with the VB-MAPP first, followed by the PPVT and finally the K-BIT.

Stage 2: Co-ordination relations. As in Study 1 there were three main phases in the presentation of the relational responding co-ordination protocol. That is, Phase 1 targeted non-arbitrary co-ordination relations firstly

with identical stimuli and then with non identical non-arbitrary stimuli belonging to the same category and Phase 2 targeted arbitrary co-ordination relations.

Stage 3: Distinction relations. As in Study 1, testing and training of non-arbitrary and arbitrary trials making up the relational frame of distinction involved four phases: Phase 1 targeted non-arbitrary distinction relations firstly with identical stimuli and then non identical non-arbitrary stimuli belonging to the same category; Phase 2 targeted arbitrary distinction relations; Phase 3 targeted non-arbitrary same/different responding and Phase 4 targeted combinatorial entailed same/different relations.

Stage 4: Comparison relations. As in Study 1, testing and training the relational frame of comparison involved three phases: Phase 1 targeted yes/no responding, Phase 2 targeted non-arbitrary relations and Phase 3 targeted arbitrary relations.

Stage 5: Opposition relations. As in Study 1, testing and training of non-arbitrary and arbitrary trials making up the relational frame of opposition involved two phases: Phase 1 targeting non-arbitrary relations and Phase 2 targeting arbitrary relations. Study 2 differed from Study 1 in the opposition protocol as once participants in Study 2 reached criteria on the first stimuli set for non-arbitrary opposition they were then tested on a novel stimuli set (full and empty). Participants were presented with two actual glasses one which was full with water and one which was empty. Participants were asked to select the appropriate stimulus when asked "Show me the full one"/ "Show me the empty one". This was done for a single block of 10 trials with 5 trials

for each dimension mixed across the block. Mastery criterion was 90% correct responding. If this criterion was not reached participants proceeded immediately to training using the same stimuli. If this criterion was reached, participants proceeded immediately to the further testing.

Participants were then asked "Show me the opposite of full"/ "Show me the opposite of empty". This was also done for a single block of 10 trials with 5 trials for each dimension mixed across the block. Mastery criterion was 90% correct responding. If this criterion was not reached participants proceeded immediately to training using the same stimuli. If this criterion was reached, participants proceeded immediately to the further testing.

Stage 6: Hierarchy relations. As in Study 1 participants were first exposed to Phase 1 targeting non-arbitrary relations followed by Phase 2 targeting arbitrary relations.

Stage 7: Post-intervention standardised measures of verbal ability. As in Study 1, all participants were re-administered with the same three standardised measures used during baseline in the same sequence, with the VB-MAPP first, followed by the PPVT and finally the K-BIT.

Results

The primary aim of Study 2 was to examine the emergence of relational responding in four participants with ASD. The data on participants' acquisition of each relational frame forms the bulk of the current results section. A secondary aim of Study 2 was to examine the relationship between verbal ability and relational responding. The data relating to this aim will be presented at the end of the results section.

Stage 2: Co-ordination Relations

Table 14 shows performances on the conditional discrimination tests, as well as the number of training trials required for each participant to reach criterion on the conditional discrimination

Table 14

Number of correct test responses and number of required training trials in non-arbitrary and arbitrary co-ordination relations

P	Phase 1: Non-Arbitrary							Phase 2: Arbitrary					
	Identical Test (20)	A-B Test (10)	B-C Test (10)	B-A Test (30)	C-B Test (30)	C-A Test (30)	A-C Test (30)	A-B Test (10)	B-C Test (10)	B-A Test (30)	C-B Test (30)	C-A Test (30)	A-C Test (30)
1	20	30	30	30	30	30	30	30	30	30	30	30	30
2	20	30	30	30	30	30	30	30	30	30	30	30	30
3	20	30	30	30	30	30	30	30	30	30	30	30	30
4	20	30	30	30	30	30	30	30	30	30	30	30	30

- Indicates not required

All four participants passed all components of non-arbitrary and arbitrary testing of the relational frame of co-ordination with perfect performances.

Stage 3: Distinction Relations

Table 15 shows performances on the conditional discrimination tests, as well as the number of training trials required for each participant to reach criterion on the conditional discrimination training.

Table 15

Number of correct test responses and number of required training trials in non-arbitrary and arbitrary distinction relations

P	Phase 1: Non-Arbitrary									Phase 2: Arbitrary					
	Non Identical (20)	A-B Test (10)	A-B Teaching (10)	A-B Retest (10)	B-C Test (10)	B-A Test (30)	C-B Test (30)	C-A Test (30)	A-C Test (30)	A-B Test (10)	B-C Test (10)	B-A Test (30)	C-B Test (30)	C-A Test (30)	A-C Test (30)
1	20	30	-	-	30	30	30	30	30	30	30	30	30	30	30
2	20	30	-	-	30	30	30	30	30	30	30	30	30	30	30
3	20	0	10	30	29	29	29	30	30	30	30	30	30	30	30
4	20	30	-	-	30	30	30	30	30	30	30	30	30	30	30

- Indicates not required

All participants passed the non-arbitrary test of identical stimuli with perfect performances. Similarly Participants 1, 2 and 4 passed the A-B test while Participant 3 emitted 0 correct responses. However after 10 training trials he reached criteria and passed a second exposure to A-B trials. All four participants passed A-B, B-C, B-A, C-B, C-A and A-C test trials. All participants passed all types of arbitrary distinction trials with perfect performances (A-B, B-C, B-A, C-B, C-A and A-C).

Table 16 shows performances on the non-arbitrary and arbitrary coordination and distinction mixed conditional discrimination tests, as well as the number of training trials required for each participant to reach criterion on the conditional discrimination training.

Table 16

Number of correct test responses and number of required training trials in non-arbitrary and arbitrary co-ordination and distinction mixed trials

Phase 3: Non-Arbitrary		Phase 4: Arbitrary						
P	Test (10)	Test (12)	ID Same Test (12)	ID Diff Test (12)	S/D Test (12)	Teach ID S/D mix (10)	Teach "Are they S/D?" (10)	Retest (12)
1	20	0	12	12	0	-	10	12
2	20	12	-	-	-	-	-	-
3	20	0	12	12	0	-	10	12
4	20	12	-	-	-	-	-	-

- Indicates not required

All four participants passed the first non-arbitrary test of non-arbitrary same/different mixed trials with perfect performances. Participant 2 and 4 also passed arbitrary testing of same/different relations while Participant 1 and 3 emitted 0 correct responses. Both participants required training on deriving same/different arbitrary relations. However 10 training trials were sufficient for participants to reach criteria and pass a second exposure.

Stage 4: Opposition Relations

Table 17 shows performances on the conditional discrimination tests, as well as the number of training trials required for each participant to reach criterion on the conditional discrimination training.

Table 17

Number of correct test responses and number of required training trials in non-arbitrary and arbitrary opposition relation

P	Dimension set	Phase 1: Non-Arbitrary					Phase 2: Arbitrary	
		Dimension (10)	Opposites (10)	Training (10)	Retest (10)	Novel test (10)	Dimension (10)	Opposites (10)
1	Happy/Sad	10	0	10	10	10	10	10
2	Happy/Sad	10	0	10	10	10	10	10
3	Happy/Sad	10	0	10	10	10	10	10
4	Happy/Sad	10	0	10	10	10	10	10

- Indicates not required

All four participants passed the first component of Phase 1 of testing which involved the abstraction of non-arbitrary dimensions. All participants then required training on the component of the abstraction of non-arbitrary opposites. However 10 training trials were sufficient for participants to reach criteria and pass a novel stimulus set. All participants passed abstraction arbitrary dimensions and arbitrary opposition with perfect performances.

Stage 5: Comparison Relations

Table 18 shows performances on the conditional discrimination tests, as well as the number of training trials required for each participant to reach criterion on the conditional discrimination training.

Table 18

Number of correct test responses and number of required training trials in non-arbitrary and arbitrary comparison relations

Phase 1: Non-Arbitrary						Phase 2: Arbitrary		
P	Yes/No (10)	Big/ small (20)	Bigger/smaller/biggest/ smallest (20)	Is this one bigger/ smaller (20)	CE (24)	Bigger/smaller/biggest/ smallest (16)	Is this one bigger/ smaller (16)	CE (24)
1	10	20	40	20	24	16	16	24
2	10	20	40	20	24	16	16	24
3	10	20	40	20	24	16	16	24
4	10	20	40	20	24	16	16	24

- Indicates not required

All four participants passed all stages of both non-arbitrary and arbitrary comparison testing with perfect performances.

Stage 6: Hierarchy Relations

Table 19 shows participant's performances on non-arbitrary and arbitrary hierarchal relations testing, as well as the number of training trials required for each participant to reach criterion on the conditional discrimination training.

Table 19

Number of correct test responses and number of required training trials in non-arbitrary and arbitrary hierarchy relations

Phase 1: Non-Arbitrary					Phase 2: Arbitrary	
P	Test (10)	Teach (10)	Retest (10)	CE (10)	Test (10)	CE (10)
1	2	10	10	10	10	10
2	4	10	10	10	10	10
3	8	10	10	10	10	10
4	10	-	-	10	10	10

- Indicates not required

One participant (P4) passed all components of both non-arbitrary and arbitrary hierarchy. Three participants (Ps 1, 2 and 3) required training on the non-arbitrary hierarchal relations however 10 training trials were sufficient for participants to reach criterion and pass the re-test using the same stimuli set. All participants then passed non-arbitrary combinatorial entailment in addition to arbitrary and arbitrary combinatorial entailment trials.

Relationship between Verbal Ability and Relational Responding

There were two components involved in examining the relationship between verbal ability and relational responding. Firstly, participant's verbal ability was measured pre- and post-relational responding testing/ training. Secondly, the predictive influence of prior verbal scores on performance throughout the sequence of relational responding testing/training was examined. The results of this analysis will be presented in the remaining text.

Table 20 shows the overall scores of verbal ability per participant on the PPVT-IV, the K-BIT and the VB-MAPP were compared at pre- and post-relational testing/training.

Table 20

Results of overall scores on the standardised verbal assessments at pre- and post-relational testing/training in Study 1

P	K-BIT (160)			PPVT-IV (160)			VB-MAPP (170)		
	Pre	Post	Diff.	Pre	Post	Diff.	Pre	Post	Diff.
1	97	93	-4	104	99	-5	159	161	+2
2	98	118	+20	99	108	+9	163	165.5	+2.5
3	90	109	+19	103	118	+15	103	148	+45
4	73	66	-7	80	97	+17	107	144	+37

Results from baseline of standardised measures of verbal ability shows that on the K-BIT three participants (Ps1, 2 and 3) were categorised as average (scoring between 90-100) and one participant (P4) was categorised as well below average (scoring between 70-79) at pre relational testing/training. No participant scored above the mean average score across the assessment (100). On post intervention measures of verbal ability two of the four participants (Ps 1 and 4) showed a decrease in the overall score from pre-to post-relational testing/training. The mean decrease in scores was 5.5 with the children's scores decreasing between 4 and 7 points. Two participants (Ps 2 and 3) showed an increase in score from pre-to post-

relational testing/training. The mean increase across participants was 39, the children's scores decreased between 19 and 20 points.

Results from baseline of standardised measures of verbal ability showed that on the PPVT two participants (Ps 1 and 3) were classified as high average (scoring between 100-115), one participant (P2) was classified as low average (scoring between 85-100) and one participant (P4) was classified as moderately low (scoring between 100-115) at pre relational testing/training. No participant reached the mean average score on the PPVT (100). On post intervention measures of verbal ability three of the four participants (Ps 2, 3 and 4) showed an increase in the overall score from pre-to post relational testing/ training. The mean increase in scores was 16 with participant's scores increasing between 9 and 17 points. One participant (P1) showed a decrease in the overall score from pre-to post relational testing/training with this participants score decreasing by 5 points.

Results from baseline of standardised measures of verbal ability shows that on the VB-MAPP assessment two participants (P1 and P2) were classified in Level 3 (the highest possible level) on the VB-MAP and two participants (P3 and P4) were classified as Level 2 on the VB-MAPP at pre-intervention. The maximum score on the VB-MAPP assessment is 170. No participant scored the maximum score on the VB-MAPP assessment. On post intervention measures all participants all participants showed a considerable increase in the overall score from pre-to post relational testing/training. The mean increase in scores was 21.6 with the minimum increase being 2 and the maximum increase being 37.

Table 21 shows the total number of training trials required by each participant across both non-arbitrary and arbitrary trials for each relational frame is presented.

Table 21

Results of the relationship between verbal ability and performances in relational responding is presented in Study 2

P	Average Verbal Score *	Coord.		Distinc.		Coord. Distinc. Mixed		Comp.		Opp.		Hier.		Total	
		NA	Arb	NA	Arb	NA	Arb	NA	Arb	NA	Arb	NA	Arb	NA	Arb
P1	100.5	0	0	0	0	0	10	0	0	10	0	10	0	20	10
P2	98.5	0	0	0	0	0	0	0	0	10	0	10	0	20	0
P3	96.5	0	0	10	0	0	10	0	0	10	0	10	0	30	10
P4	76.5	0	0	0	0	0	0	0	0	10	0	10	0	20	10

* Average score of K-BIT and PPVT

All four participants completed relational responding training beginning at non-arbitrary co-ordination and continuing until all participants were tested and trained on the relational frame of hierarchy. Table 27 displays the number of training trials each participant needed to proceed through the protocol in Study 2. For the purpose of comparison an average verbal score was calculated based on the two standardised verbal assessments: the K-BIT and the PPVT. A clear relationship between level of verbal ability and number of training trials to progress through the relational responding training is seen in Study 2. The two participants with the highest

verbal score (Ps 1 and 2) required the least training trials with a total of 60 training trials across both participants. The two participants with the lowest level of verbal ability (Ps 3 and 4) required the most training trials with a total of a total of 120 training trials between them. Participant 3, who had the second lowest level of verbal ability, required the most training trials to proceed through the protocol.

Examining the amount of training required for each individual frame a further pattern can be seen between participant's verbal ability and the number of training trials required. No participants needed training on the relational frame of co-ordination. Participant 3 had the second lowest level of verbal ability required 10 training trials on non-arbitrary distinction relations in addition to 10 training trials to pass non-arbitrary co-ordination and distinction mixed trials. All participants (Ps1-4) progressed through comparison testing with no training. All participants (Ps1-4) required 10 training trials to pass non-arbitrary opposition and hierarchy testing.

-Chapter 4-

General Discussion

The current research was comprised of two studies which attempted to investigate the optimal sequence for establishing derived relational responding in nine children with GDD, eight diagnosed with ASD and one diagnosed with Down's syndrome. Four children with ASD and one child with Down's syndrome participated in Study 1. The findings from Study 1 demonstrated that participants required varying levels of training across the relational frames. Overall, it was found that an RFT based intervention utilising training in non-arbitrary relations followed by arbitrary relations across multiple exemplars was found to be successful in establishing or facilitating the relational frames of co-ordination, distinction, comparison, opposition and hierarchy across all participants. A number of interesting patterns of responding were evident across this study which will be briefly outlined.

An interesting trend in the acquisition of the relational frame of co-ordination was seen in Study 1 where one participant (P5) demonstrated competence to criteria on testing non-arbitrary co-ordination relations with identical stimuli however required training on non-arbitrary co-ordination relations with non identical stimuli from the same category. A possible explanation for this is that the stimuli which were non identical from the same category still required the participant to respond to non-arbitrary relations however there was a slight arbitrariness. This was a step towards responding to arbitrary co-ordination relations. The benefits of introducing this stage of testing and training the relational frame of co-ordination is evident in the fact that this participant then demonstrated competence to criteria on arbitrary relations. It seems reasonable to assume that this participant would have had difficulty with arbitrary relations if they had not made the transition to non-arbitrary

identical stimuli to non-arbitrary non identical stimuli. It is possible that introducing the non-arbitrary testing with non identical stimuli from the same category facilitated the transition to arbitrary responding.

In testing and training the relational frame of distinction a similar trend was seen where one participant (P4) demonstrated competence to criterion on testing non-arbitrary distinction relations using identical stimuli however required training on non-arbitrary distinction relations using non identical stimuli from the same category. Ten training trials were sufficient for this participant to reach criteria on A-B trials and pass testing with stimuli with a more similar comparison and a novel stimuli test. This participant then required training on B-C trials as responding did not generalise. A greater amount of training was required on B-C trials with 40 training trials on the first stimuli set and a further 10 training trials on the second stimuli set which involved a more similar comparison. Participant 4 then passed B-1, C-B, C-A and A-C trials. However this training did not generalise to arbitrary relations with 10 training trials required for this participant to reach criteria. It is clear that unlike Participant 5's performance in co-ordination relations the training this participants received in non-arbitrary non identical stimuli from the same category was not sufficient to facilitate responding to arbitrary distinction relations. It appears that this participant had greater deficits in the relational frame of distinction. Perhaps an additional step of testing and training non-arbitrary non identical stimuli with greater arbitrariness may have been beneficial in assisting this participant in transitioning to arbitrary responding. It may be interesting to note that Participant 4 was the only participant in the current study diagnosed with Down's syndrome while all other participants had a diagnosis of ASD. This is interesting as the lack of ability to generalise would generally be more widely referenced to

children with ASD however it is clear from the findings that Participant 5 demonstrated generalisation from non-arbitrary to arbitrary stimuli while Participant 4 lacked this generalisation.

In the acquisition of the relational frame of distinction Participant 5 demonstrated a unique performance with this participant requiring training on non-arbitrary identical stimuli. This participant was the only participant who required training on identical stimuli throughout both Study 1 and 2. In addition, this participant required further training on non-arbitrary non identical stimuli from the same category where training was required on both A-B and B-C trial types. However this then generalised to B-A, C-B, C-A and A-C trial types. Furthermore the training in non-arbitrary relations using non identical stimuli from the same category seemed to facilitate responding to arbitrary relations in this participant who demonstrated competence to criterion on arbitrary distinction trials. This finding is similar to the finding from this participant's acquisition of the relational frame of co-ordination. Again, this is interesting when compared to Participant 4's lack of generalisation from non-arbitrary to arbitrary stimuli.

In Study 1, participant's demonstrated flexibility in responding according to non-arbitrary co-ordination and distinction mixed trials however four participants (Ps 2-5) required training on arbitrary mixed trials. It is possible that arbitrary trials involve greater complexity than non-arbitrary trials hence less flexibility between frames was found. The performance of Participant 2 differentiated him from the other participants in the current study as he demonstrated competence to criterion on arbitrary testing of the relational frame of co-ordination and distinction however required training on identifying the same and different arbitrary stimuli when trials

were mixed. It is possible that this participant lacked flexibility in responding in relation to arbitrary stimuli. This participant also required training on deriving the same or different relation which an additional three participants also required (Ps 3, 4 and 5). However following explicit training all participants reached criteria. It is possible that greater exposure to trials produced greater flexibility in responding.

Results found that three participants (Ps 1-3) in Study 1 required a significant level of training in non-arbitrary comparison relations despite having passed co-ordination and distinction relations on the first exposure. This may suggest that there is greater complexity involved in comparison relations. All participants, with the exception of Participant 2, passed arbitrary comparison relations on the first exposure again providing evidence that training in non-arbitrary relations facilitated responding to arbitrary relations. Participant 2 required a minimal level of training to reach criterion on the derivation of arbitrary comparison relations. Interestingly, the two participants (Ps 4 and 5) who received the most training on non-arbitrary co-ordination and distinction trials demonstrated better performances on non-arbitrary comparison trials. Participant 4 passed through comparison relations on the first exposure and Participant 5 required a significantly less number of training trials than the other participants. As such, this finding may suggest that training in the earlier relational frames of co-ordination and distinction facilitated responding to comparison relations.

All participants in Study 1 required training on non-arbitrary opposition relations. It may be interesting to note that the three participants (Ps 1-3) who required the most training on non-arbitrary opposition relations also required the most training on arbitrary opposition relations. It may be possible that the

Researcher was establishing the relational frame of opposition in these participants while the Researcher may have been facilitating responding according to the relational frame of opposition in the other instances (P4 and 5). It may be interesting to point out that three of the five participants in Study 1 required training on arbitrary opposition relations. The two participants (Ps1 and 2) who did not require any training on opposition relations were the only two participants who did not receive any training on arbitrary trials in previous frames. It may be possible that these participants already had a number of relational skills in their repertoires prior to the commencement of this study. Furthermore, all participants in Study 1, with the exception of Participant 3, required training on non-arbitrary hierarchy relations. It appears from the findings of Study 1 that hierarchy relations contained greater complexity than facilitated in earlier frames. This training then generalised to arbitrary relations for all participants except one. This may suggest that the training these participants received then facilitated responding to arbitrary relations.

The performance of Participant 3 across comparison, opposition and hierarchy relations may be worth highlighting. Participant 3 required the most training on non-arbitrary comparison relations and non-arbitrary and arbitrary opposition relations despite demonstrating competence to criterion on the earlier frames of co-ordination and distinction. It is possible that comparison and opposition relations contained greater complexity than earlier relations. Interestingly, Participant 3 was then the only participant to pass both non-arbitrary and arbitrary hierarchy relations. It appears that the training this participant received on earlier relations facilitated responding to hierarchy relations.

Across relational responding testing and training in Study 1 the performance of Participant 1 differentiated him from the other participants in the current study. Participant 1 was the only participant throughout the training sequence who didn't require explicit training in arbitrary relations. This participant did require training in non-arbitrary comparison, opposition and hierarchal relations. It may be possible that the training this participant received in non-arbitrary relations generalised to arbitrary responding across the relational frames. This pattern was also seen across the performances of other participants in Study 1 in relational responding with training in non-arbitrary relations sufficient to facilitate responding according to arbitrary relations. While there is no direct evidence suggesting that the participants who failed non-arbitrary relational responding would have also failed arbitrary responding it seems reasonable to assume that this is the case. It appears that in many cases the participants already had many relational responding skills in their repertoires however they simply needed reinforcement for attending to the correct contextual cue and responding accordingly. It is possible that for many participants reinforcement for correct responding was sufficient to produce correct responding following only one training trial.

Four participants with ASD participated in Study 2. The findings from Study 2 demonstrated that participants required varying levels of training however results demonstrated that overall an RFT based intervention utilising training in non-arbitrary relations followed by arbitrary relations across multiple exemplars was found to be successful in establishing or facilitating the relational frames of coordination, distinction, comparison, opposition and hierarchy. As in Study 1 a number of interesting patterns of responding were seen across this experiment which will be briefly outlined.

The performance of Participant 3 in distinction relations differentiated him from the participants in Study 2. As seen with some participants in Study 1, this participant required training on non-arbitrary distinction relations with non-arbitrary stimuli belonging to the same category despite having passed non-arbitrary responding using identical stimuli. However a minimal number of training trials (10) were sufficient for this participant to reach criteria and pass arbitrary trials. It is possible that these skills were already in the participant's repertoire however following a long history of reinforcement of responding to the contextual cue of "Same" the participant simply required reinforcement for responding to the contextual cue of "Different".

Similarly to Study 1, the performance of participants in co-ordination and distinction mixed trials may be of interest with two participants (Ps 1 and 3) requiring explicit training on deriving the same/different arbitrary relations. However a minimal number of training trials (10) were required for participants to reach criteria. It is possible that the sound performance of participants evident in Study 2 in co-ordination and distinction relations may suggest that participants already had well established repertoires of co-ordination and distinction responding prior to participating in this study. It is possible that Participant 1 and 3 simply required the facilitation of flexibility in responding to arbitrary relations. However all other participants demonstrated a high level of flexibility in responding to co-ordination and distinction mixed trials.

A strong pattern of performance was seen across all participants on the relational frame of opposition with all participants requiring training in deriving non-arbitrary opposites however 10 training trials was sufficient for these participants to

reach criteria. The training these participants received in non-arbitrary opposites then generalised to arbitrary opposites with all participants passing arbitrary testing on the first exposure. It is possible that participants simply lacked exposure to the contextual cue of "Opposite" however once explicit training was received they were capable of responding correctly across both non-arbitrary and arbitrary stimuli. Study 2 differed from Study 1 in that a novel stimulus set was introduced following participants reaching criteria on the first set of stimuli. All participants passed this novel test on the first exposure.

Significantly, all participants passed both non-arbitrary and arbitrary comparison relations on the first exposure suggesting that earlier training may have facilitated the emergence of these relations in participants. It is reasonable to assume that the training in opposition relations in some way facilitated responding to comparison relations as where this step was lacking in Study 1 participants demonstrated a much inferior performance. All participants required training on non-arbitrary hierarchy relations however 10 training trials were sufficient for participants to reach criteria and generalise to arbitrary relations. Like opposition relations, it is possible that the participants had hierarchy relations in their repertoires however they simply needed reinforcement for responding to the correct contextual cues. This finding may also suggest that hierarchy relations contain greater complexity not facilitated in earlier frames.

As in Study 1, an overall pattern of responding was seen whereby training in non-arbitrary responding seemed to facilitate arbitrary responding. Again, it is likely that on many occasions participants simply needed reinforcement for responding to the correct contextual cue and exposure to non-arbitrary trials provided this. In

utilising reinforcement for correct responding to the contextual cues it was clear that participants quickly began responding correctly after a minimal number of training trials.

Examining the data across both Study 1 and 2 may allow a greater insight into the variables that impact relational responding. Across both studies there were a number of similarities in performances which will be summarised below. In the testing and training of the relational frames of co-ordination and distinction an interesting pattern can be seen across all participants. Firstly, perhaps worth noting across both studies is that only one participant required training on non-arbitrary co-ordination relations however three participants required training on non-arbitrary distinction relations. It is possible that participants demonstrated greater performance on co-ordination trials due to a history of reinforcement for responding to the contextual cue of "Same".

Furthermore, examining the current findings reveals that all participants, with the exception of one participant (P5), demonstrated competence to criterion in the testing of non-arbitrary co-ordination and distinction relations using identical stimuli while three participants required training in non-arbitrary non identical stimuli. It is possible that participants had a greater history of reinforcement for responding to identical stimuli compared to responding to non identical stimuli. Introducing responding to non-arbitrary non identical stimuli from the same category is a closer step towards arbitrary responding hence seemed to facilitate arbitrary responding in some participants. While it is difficult to prove that participants would not have responded correctly to arbitrary trials it seems reasonable to assume that introducing

non-arbitrary responding to non identical stimuli may have facilitated responding to arbitrary stimuli.

The performance of Participant 4 in distinction relations in Study 1 may be worth highlighting again as this participant was the only participant across both co-ordination and distinction trials in both studies in which training in non-arbitrary relational responding did not facilitate responding to arbitrary stimuli. It seemed, for this participant a lack of generalisation existed. Interestingly, this participant was the only participant with Down's syndrome who participated in the current studies. This is interesting as the lack of ability to generalise would generally be more widely referenced to children with ASD however the generalisation from non-arbitrary to arbitrary responding to co-ordination and distinction relations was seen for all participants with ASD in the current studies.

Across both Study 1 and 2 the performance of participants in arbitrary co-ordination and distinction mixed trials is of interest. While participants were all capable of responding to arbitrary co-ordination and distinction trials separately many participants had difficulty responding to arbitrary co-ordination and distinction mixed trials with six participants requiring training. One participant required training in identifying the same/different stimuli while six participants required training in deriving the same/different relation. It appears that arbitrary mixed trials contained greater complexity and required greater flexibility than non-arbitrary trials.

An interesting trend is seen in the testing of oppositional relations with all participants across both Study 1 and 2 failing baseline measures of non-arbitrary opposition. However following training on non-arbitrary trials six participants then passed arbitrary trials. It is possible that these participants simply lacked a history of

reinforcement for responding to "opposite" and a minimal number of training trials was sufficient to facilitate the emergence of oppositional responding. It is also reasonable to assume that oppositional relations contain greater complexity which is not facilitated in earlier frames. Study 2 differed from Study 1 in that a novel stimuli set was introduced following participants reaching criteria on the first set of stimuli. All participants passed this novel test on the first exposure. What is interesting however is the performance of participants in the following relational frame, comparison, which may have been impacted by the use of multiple exemplar training in Study 2 as opposed to the single stimuli set used in Study 1.

In testing and training the relational frame of comparison across both studies a significant pattern is seen. Three participants in Study 1 required a significant level of training in non-arbitrary comparison relations. However in Study 2, following the sequence being manipulated, all participants passed non-arbitrary comparison relations on the first exposure. It seems probable that training oppositional relations prior to comparison relations may have facilitated responding to comparison relations. In addition, the use of multiple exemplars in training oppositional relations in Study 2 may have facilitated greater flexibility in responding to later frames. In testing and training the relational frame of hierarchy across both studies seven participants required training on non-arbitrary hierarchal relations. This training then generalised to arbitrary relations in all but one participant. Again, like previous frames it is possible that participants simply lacked a history of reinforcement for responding to hierarchy relations.

Across both Study 1 and 2 a trend can be seen whereby training in non-arbitrary relations seemed to facilitate responding to arbitrary relations. For example,

in Study 1 Participant 1 required training in non-arbitrary comparison, opposition and hierarchy following which the participant demonstrated performance to criteria on arbitrary trials. It is possible that in many cases participants had the ability to respond relationally in their repertoires however they simple required reinforcement for responding to the correct contextual cue. Additionally across both studies it appeared that participants required a higher level of training on non-arbitrary trials than arbitrary trials.

Examining the relationship between verbal ability and relational responding across both studies appears to suggest that a relationship exists. Firstly, the impact of relational responding training on verbal ability was examined through examining verbal ability pre- and post-relational responding testing/training using the K-BIT, the PPVT-IV and the VB-MAPP. In Study 1 varying patterns of verbal scores were seen. Participant 1 showed a decrease in scores on the K-BIT and an increase in scores on the PPVT-IV and the VB-MAPP. Only two participants (Ps 2 and 4) demonstrated increased verbal scores on post assessment. One participant (P3) demonstrated a decrease in scores on the K-BIT and the PPVT-V and an increase in scores on the VB-MAPP. One participant (P5) showed an increase in scores on the K-BIT and the VB-MAPP in addition to a decrease in scores on the PPVT-IV. It may be interesting to note that one of the two participants (P2) to demonstrate an increase in verbal scores on all post assessments received the second highest number of relational responding training trials. This may suggest that a greater amount of training in relational responding resulted in an increase in verbal ability. In Study 2, again a variable level of performances on post relational responding testing/training of verbal ability was also found. One participant (P1) showed a decrease in scores on the K-BIT and the PPVT-IV and an increase in scores on the VB-MAPP. Two

participants (Ps 2 and 3) showed an increase in scores on the K-BIT, the PPVT-IV and the VB-MAPP. One participant (P4) showed a decrease in scores on the K-BIT and an increase in scores on the PPVT-IV and the VB-MAPP. It may be interesting to note that one of the two participants (P3) to show an increase in all verbal assessments in Study 2 received the highest number of relational responding training trials. This again provides further evidence that training in relational responding improves verbal ability.

Secondly, examining the relationship between verbal ability and performances in relational responding testing and training in Study 1 shows that Participant 1, with the highest average verbal score, required the least amount of training in relational responding. Across all other participants (Ps 2-5) no clear relationship can be seen. However, on removing the relational frame of comparison from analysis, a relationship can be seen between level of verbal ability and the amount of relational responding training needed. It may be beneficial to remove this relational frame from analysis as the sequence of training did not appear to be effective in facilitating the emergence of this frame. Therefore including the relational frame of comparison in data analysis may distort data. Across all other relations Participant 5 who had the second lowest level of verbal ability required the most amount of training (220 training trials). Participant 4 who had the lowest level of verbal ability required the second highest number of training trials (150 training trials). Participant 1, who had the highest level of verbal ability, required the least amount of training (40 training trials). Examining the relationship between verbal ability and performance on relational responding testing and training a clear relationship between level of verbal ability and number of training trials required in Study 2 can be seen. The two participants with the highest verbal score (Ps 1 and 2)

required the least amount of training with a total of 60 training trials across both participants. The two participants with the lowest level of verbal ability (Ps 3 and 4) required the most amount of training trials with a total of a total of 120 training trials between them. Participant 3, who had the second lowest level of verbal ability, required the most amount of training trials to proceed through the protocol.

Specific Implications of Findings

Training relational frames. The current studies attempted to systematically target deficits in participant's relational responding repertoires. The concordance between the two studies suggests that participants demonstrated varying levels of deficits across the core relational frames of co-ordination, distinction, comparison, opposition and hierarchy. Where deficits in skills existed an RFT based intervention was found to be successful in remediating deficits. This finding was consistent with previous research which has found success utilising an RFT based protocol to establish co-ordination (Dunne et al., 2011; O'Connor et al., 2009), distinction (Dunne et al.), opposition (Dunne et al.), comparison (Barnes-Holmes et al., 2009; Dunne et al.) and hierarchy (Dunne, 2011) in children with developmental disabilities. Findings from the current study also support previous interventions used in teaching arbitrary applicable relational responding such as utilising feedback and targeting non-arbitrary trials first (Vitale et al., 2008).

A pattern of responding was seen in Study 1 and 2 whereby training in non-arbitrary relations appeared to facilitate arbitrary responding. In the case of co-ordination and distinction it appeared that creating a gradual transition from non-arbitrary to arbitrary stimuli through introducing non-arbitrary non identical trials facilitated the transition to arbitrary responding. This finding supported previous

research which found that training in non-arbitrary relations facilitated responding according to arbitrary relations in children with deficits (Barnes- Holmes et al., 2004; Barnes- Holmes et al., 2004; Cassidy et al., 2011; Gorham et al., 2009). However in contrast to this trend, in some cases the training participants received on non-arbitrary trials did not facilitate responding to arbitrary trials. For example, in Study 1 Participant 4 required training on non-arbitrary A-B and B-C trial types following which training was required on arbitrary A-B trials. It may be possible that the contextual cue was not as firmly established in these participants and a longer history of reinforcement for correct responding to the specific cue was necessary. Perhaps these participants would have benefited from additional exposure to non-arbitrary trials.

It may be important at this point to highlight that in certain cases the current research facilitated the emergence of derived relational responding while in other cases the research established derived relational responding. Examining the data from the acquisition of relational responding it is possible that where minimal training was required Researcher was simply facilitating the emergence of relational responding. In these cases the skills were already in the participants repertoires. Consider for example Participant 1 who in Study 1 required minimal training in non-arbitrary relations and passed all testing in arbitrary relations. It is most likely that this participant already had a high level of relational skills in his repertoire and the current study was simply facilitating responding to the appropriate contextual cues. However in other cases participant's demonstrated limited relational skills therefore it may be possible that in these cases the researchers were establishing relational responding. Previous research has found evidence of facilitating relational responding through an RFT based protocol (Barnes-Holmes, Barnes-Holmes, Roche

& Smeets, 2001a; Barnes-Holmes, Barnes-Holmes, Roche & Smeets, 2001b; Healy, Barnes-Holmes, & Smeets, 2000).

Sequence of training. Barnes-Holmes et al. (2001) and Dunne (2011) questioned the optimal sequence of training relational responding in children with developmental delays. The current research was primarily concerned with systematically identifying the most effective training sequence for teaching relational responding to children who have deficits. While a body of research exists examining the development of each relational frame there is little or no empirical evidence to suggest the sequence in which they might emerge or should be training for optimal effects (Dunne). Essentially, this research was interested in investigating if certain forms of derived relations are pivotal for the establishment or facilitation of others.

Rehfeldt and Barnes-Holmes (2009) suggested a possible training sequence for establishing the earliest relational operants of co-ordination, opposition, distinction, comparison and hierarchy. Whilst this sequence is based on empirical evidence of the development of the separate relational frames it has yet to be empirically validated. The current studies presented two alternative sequences of training relational responding. In Study 1 participants were exposed to relational responding testing/ training in the following order: co-ordination; distinction; comparison; opposition and hierarchy. In Study 2 the location of comparison and opposition was systematically manipulated and participants were exposed to relational responding testing/ training in the following sequence: co-ordination; distinction; opposition; comparison and hierarchy.

Across both studies evidence exists supporting the previously suggested existence of a developmental sequence in relational responding. Examining the

findings for the relational frame of co-ordination in the current studies it appeared that many participants (n=8) already had this frame in their repertoire supporting the already established finding that this is the earliest relational frame that children acquire. Findings from the current series of studies also support the suggestion that distinction relations emerge thereafter with the current studies finding that many participants who demonstrated competence to criterion on co-ordination relations also demonstrated the existence of distinction relations in their repertoires (n=6). The suggestion that opposition relations emerge following co-ordination was supported in the current research with all participants requiring training on non-arbitrary opposition relations suggesting that this skills contained greater complexity than co-ordination and distinction relations. Of significance in the current studies is that in Study 2 training opposition relations directly after co-ordination and distinction relations appeared to facilitate a smooth acquisition of this relational frame compared to training it after comparison with participants requiring a significant less amount of training than participants in Study 1. In addition, all participants in Study 2 received training on non-arbitrary opposition relations which generalised to arbitrary relations however in Study 1 some participants also required training in arbitrary relations.

The current studies provide empirical support for the suggestion that comparison relations follow oppositional relations. Across both studies a significant difference in performance was seen when opposition was trained prior to comparison. Examining the performance of participants in Study 1 reveals that all participants, with the exception of one participant, required significant training in comparison relations with an average of 140 training trials required per participant. The performance of participants in Study 2 revealed that all participants progressed

through comparison testing on the first exposure with no training necessary. It is probable that the training participants received in opposition relations greatly facilitated responding to comparison relations. The use of multiple exemplars in the testing and training of oppositional relations in Study 2, as opposed to a single stimuli set in Study 1, may have added to this effect. In addition, the recognition that hierarchal relations contain greater complexity than later relations was supported in the current studies with all participants requiring training on non-arbitrary hierarchy relations.

While not a feature of the current studies it may be interesting to note that following participants progressing through the relational frames from co-ordination to hierarchy the Researcher presented a baseline measure of perspective-taking, the next stage in relational responding, to participants. The researcher presented the participants with a standard perspective-taking protocol utilised in previous studies (e.g. Dunne, 2011) with participants with developmental disabilities and found that participants exhibited significant deficits across all levels of relational responding. What was interesting however is that in Study 1, Participant 5 who was the only participant to receive training on non-arbitrary trials across each relational frame had the highest level of correct responses on simple perspective-taking relations. Additionally, Participant 3 who had the second highest score on simple perspective-taking relations was the only participant who did not receive any training in arbitrary relations. In Study 2, the participant who received the highest number of training trials in earlier protocols had the highest number of correct responses in simple relations. It is clear from these results that some participants demonstrated basic competencies in perspective taking at baseline testing. It may be possible that training in the earlier relational frames in some way facilitated responding to simple

perspective-taking relations. However this is purely speculative and further empirical investigations in the area of perspective-taking are required examining its development.

Examining the data across Study 1 and 2 it appears that the training sequence utilised in Study 2 was a more effective sequence than that used in Study 1. This is particularly significant in training comparison relations where a significant difference was seen in participant's performances when the training sequence was altered from the sequence used in Study 1. It is possible that training oppositional relations facilitated responding to comparison relations. This finding supports the recommendation made by Rehfeldt and Barnes-Holmes (2009) who suggested training opposition relations prior to comparison relations.

While the evidence suggested thus far appears to suggest a developmental sequence in the emergence of relational responding the particular link between frames has been questioned. More specifically, in developing a sequence of training relational responding it has been questioned if there is a link between the development of frames and if some frames provide prerequisite skills for the acquisition of later frames. It was predicted that the establishment of each relational frame would provide the skills necessary for the establishment of the next relational frame due to the existence of common features (Hayes et al., 2001). The current research studies provide evidence to this effect as it appeared that training in certain frames appeared to facilitate the emergence of later frames. This is particularly evident in the case of Study 2 in which training in opposition relations appeared to provide the prerequisite skills necessary for responding to comparison relations. However while certain frames may provide the prerequisites necessary for later

frames there does not appear to be a definite developmental pattern and just because a participant has one frame we cannot ascertain that they will have a later or earlier frame.

This brings about an additional empirical question of what facilitates the development of each relational frame. Typical language interactions between verbally fluent adults involve the derivation of multiple relations. There is no evidence to suggest that frames develop in isolation and it seems more probable to assume that frames emerge in convergence with each other. Being able to respond relationally is one behaviour however being able to move rapidly between the relational frames in a fluent manner is another behaviour. It has been suggested that a core behaviour behind how frames link together is flexibility.

Flexibility. A variable which may affect the transition across relational frames is flexibility. Barends and Hayes (2007) outlined that when applying relational frames it is important to establish flexible forms of contextual control. This can be achieved through combining different types of relational responding within a relational frame. For example in testing the relational frame of hierarchy participants may be asked specific questions that are related to the relational frame of distinction. Barends and Hayes outlined that remaining too rigid in our training of relational frames may prevent the behaviour of flexibility which is necessary for mature verbal and intellectual functioning. In establishing relational flexibility we should ensure that skills from one relational frame generalise to other frames and there is a transition across frames. The current research provided a brief synopsis of participant's flexibility between the relational frames when co-ordination and distinction mixed trials were examined. It was clear, that despite participant's

demonstrating competence to criteria in each of these repertoires separately many struggled during coordination and distinction mixed trials. It is possible that participant's reduced performances in mixed trials may be accountable to a lack of flexibility in responding. However this is purely a preliminary suggestion and a more systematic study incorporating flexibility in responding during the training of relational frames would provide a greater insight into the relationship between the acquisition of relational frames and flexibility.

General Implications of Findings

Verbal ability. A significant question that exists in the empirical investigation of relational frame theory is if a relationship exists between the ability to derive novel untrained relations and verbal ability. This relationship has been supported by many researchers (Devany et al., 1986; Dunne et al., 2011; Lipkens et al., 1993; Luciano et al., 2007). The current series of studies allowed for an analysis of the relationship between derived relational responding and verbal ability through first investigating the impact of relational responding testing and training on verbal ability and secondly investigating the predictive influence of prior verbal scores on participant's performance throughout relational responding testing and training.

Overall, all participants across both Study 1 and 2 showed an increase in scores on the VB-MAPP on post assessment however varying levels of scores were seen on the K-BIT and the PPVT-IV. In interpreting results of pre- and post-relational responding testing/training scores it is impossible to attribute an increase in scores to the relational responding training alone as there are a number of additional variables which may have contributed to the increase in scores such as the individual's day to day experience in the natural environment and their individualised

educational goals. The findings from pre- and post-verbal assessments supported previous research which found an increase in verbal scores following relational responding training (Cassidy et al., 2011).

Examining the number of training trials required by participants across relational frames appears to suggest that there is a relationship between participant's prior level of verbal ability and competency in relational responding. Essentially, it appears that there is a relationship between the participant's verbal ability and their performance on relational responding testing and training. That is, participants at the lower level of verbal ability required a higher number of training trials than participants at the higher level of verbal ability. The relationship between participant's prior level of verbal ability and performance on relational responding testing and training has been supported by previous research (Dunne et al., 2011; O'Hora et al., 2005). Taken together these results appear to suggest that a relationship exists between derived relational responding and verbal ability. This finding provides support for RFTs prediction that relational responding would correlate with verbal ability due to relational responding being a core process of language.

Educational implications. The results of the current research may have significant educational implications on a wider conceptual framework but also more specifically for EIBI language intervention programmes. Primarily, the current studies provide preliminary empirical evidence of an effective evidence based sequence of training derived relational responding in children with developmental delays. This training sequence was clearly

effective in developing derived relational responding in children with developmental delays. However this training sequence also had practical benefits in that all the children appeared to enjoy the training and the training of the core relational frames from co-ordination to hierarchy was completed in a number of months. Secondly, this research provides further evidence to support previous findings of the impact of training derived relational responding on verbal ability.

The results of the current studies have potential implications for the design of verbal behaviour programmes for instructing basic language. The variations in the methods utilised across both studies provided a significant insight into the variables that impacted the participant's acquisition of the relational frames. Although it is impossible to generalise across children from any given population it is reasonable to assume that the findings of the current studies, particularly in training relational responding, may provide a significant contribution to EIBI programmes targeting language remediation. While it cannot be overlooked that a possibility exists that current intervention programmes are indirectly targeting the development of the core relational frames further emphasis on the development of derived relational responding within EIBI programmes would undoubtedly have a significant benefit on the field of EIBI. These concerns have been raised by previous researchers who have criticised the limitations of the widely used verbal behaviour approach to language development (Chomsky, 1959; Lerman et al., 2005; Luciano et al., 2009; Moore, 2009; Redfeldt, 2011). It has been suggested that training in derived relational responding is required to

establish generalization skills in children with developmental delays, who characteristically lack these skills.

A major challenge facing behaviour analysts working with students with GDD, more specifically ASD, is the lack of emergence of generative behaviours. The utilisation of training based on RFT to establish generative behaviours would be an extreme benefit in EIBI programmes. The current study not only highlights the importance of training relational responding, through providing evidence of its relationship to verbal ability, but also provides an empirically validated sequence of training the earliest relational operants of co-ordination, distinction, opposition, comparison and hierarchy which may be implemented to establish these skills in children with delays.

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Appendix A

Parental Information Sheet

Information about research being conducted at St Catherine's Association Ltd. Newcastle, Greystones, Co. Wicklow, Ireland.

Your child is being invited to take part in a research study. Before you decide if your child will take part, it is important for you to understand what the research is about. This information sheet will tell you what the research is about and what your child would be asked to do if you agree to take part.

If you would like your child to take part, I will ask you to sign a Consent Form. If there is anything that you are not clear about, I will be happy to explain it to you or give you further information.

Please take as much time as you need to read it. You should only agree to take part in this research when you feel that you understand what is being asked of your child, and when you have had enough time to think about your decision.

Please note that this research procedure should not be considered to be a treatment of any description.

Details about Researchers

The current research will be conducted by Grainne Kent, BSc (Hons) Psych., who is a doctoral student at the Department of Psychology, National University of Ireland, Maynooth, Co Kildare.

Grainne has been a trainee ABA tutor at St Catherine's association LTD in a school for children with diagnosed autism and intellectual disabilities for the past year, and can be contacted via telephone:

0876179465 , or email: grainnekent@stcatherines.ie. The research will be supervised by Dr. Yvonne

Barnes Holmes B.Sc, Ph.D, CPsychol, CSci, AFBPsS. Dr Barnes Holmes is course manager on the

Doctorate in Psychological Science at the Department of Psychology, NUI Maynooth, and can be

contacted via telephone: 017086080 or email: Yvonne.barnes-holmes@nuim.ie.

What is the purpose of the research?

The ability to understand stimuli in complex ways, such as understanding the concept of the same/different, more/less, before/after and I/You, is thought to be very important in human language. The

current research will look at the best teaching sequences for establishing such relations in childhood. For example, should more/less relations be taught prior to before/after relations, or vice versa?

This research project aims to establish the optimal training sequence in the emergence or facilitation of these relations.

What will the research involve if my child participates?

Firstly, the investigator will conduct assessments of your child's verbal ability using The Peabody Picture Vocabulary Test- Fourth Edition (PPVT™-4) and the Kaufman Brief Intelligence Test (K-BIT). Assessments will also be conducted to determine your child's ability to relate, for example, same/ different stimuli, based on published tests of relational responding (Rehfeldt and Barnes-Holmes, 2009).

An example of this testing is: Imagine your child is presented with four identical cards. It may be odd that these cards are all identical but this is important as otherwise the children may respond in terms of colour or size. Let's call these cards A, B, C, and D. On one trial, for example, the researcher says this card (A) is the same as this card (B) and this card (C) is the same as this card (D). The researcher then points to card A and says "Give me the one that is the same".

This is an example of assessing the relational frame of co-ordination. If participants are unable to do this task training will begin which will involve the same procedure as testing however feedback (positive reinforcement) will be given to children on their performance. Following this training sequence it is hoped that children will be able to relate stimuli through sameness and differentness. All other relational frames (more/less stimuli, opposite, hierarchy, or I/You relations) will be tested and trained in the same way within the timeframe of the research project.

Please note that both relational assessments and training will involve the use of material which are based on the curriculum and currently in the child's IEP goals. Positive reinforcement will be used throughout the teaching programme and frequent short breaks will be provided.

Please note the researcher may require access to your child's previous assessments in particular the **the Verbal Behavior Milestones Assessment and Placement Program (VB MAPP)** which is carried out in your child's school on an annual basis and/or the Wechsler Pre-school & Primary Scale

of Intelligence, Third UK Edition (WPPSI-III UK) and the Bayley Scales of Infant Development Third Edition (BSID-III) . In the event that the researcher does require such results you will be contacted to provide consent. In the event that you are unhappy to grant consent for these results to be accessed that is absolutely fine and there is no obligation to provide access to these results.

When will the research be conducted?

Research will be conducted during the child's typical school-day for 20 minutes 3 or 4 times per week. These sessions will be scheduled in consultation with the Classroom Teacher to avoid any missed instructional periods. The timeframe of the research will be approximately 18 months and the projects will take place during the school year across 2012/2014. The research is expected to commence in November 2012.

How much time will it take to complete the research?

It is difficult to predict the total amount of time it will take one individual to complete all assessments and training as it is largely subject to individual ability and performance. However it is anticipated that it will take an average of 35 hours for participants to complete all assessments and training. This time frame will run across an 18 month time period. Participants will not be involved in testing for any longer than 20 minute sessions four times a week.

Where will the research be conducted?

The research will be conducted within a quiet classroom on the school premises with only the child and researcher present most times. The classroom will have a glass door and will be clearly visible to other staff and students. It is common practice within the setting to work on a 1:1 staff student ratio. An additional researcher may be present on certain occasions to ensure accuracy of data collection.

What if I do not want my child to participate?

If you don't want your child to participate that is absolutely fine and there is no obligation or penalty of any kind for not participating.

What if I say yes but my child doesn't want to participate?

Where possible, we will attempt to gain consent from your child each time a session is commenced. We will monitor your child throughout to ensure that participation is voluntary and your child is not distressed in any way. If your child appears distressed by the research procedures, the session will be terminated. There are no foreseeable risks or side effects attached to taking part in this study.

Confidentiality

All information that is collected about your child during the course of the research will be kept strictly confidential and only the primary researcher and her supervisor will have access to the data. The information collected in this research study will be stored in a way that protects your child's identity. No participant will be identified in any resulting research publication and false names will be used where necessary. All data collected during assessments and training will be recorded using a paper and pen. During assessment and training periods these hard copy files will be kept in a locked filing cabinet in the managing director's office. On completion of all testing and assessments data will be transferred from pen and paper into a secure computer system (which will be password protected and encrypted) at which point pseudo names will be applied. Details of each participant and the link between the pseudo names and participant identity will be kept in a separate computer until all data is inputted. Once all data is inputted into the data files this link will be deleted from the computer system and will be stored under lock and key in the managing director's office. The paper files will be destroyed using a shredding machine. On completion of all training the same system will occur. Following the elapse of 5 years computer files will be deleted and the link between participants and pseudo named data will be removed from a locked cabinet in the managing director's office and destroyed. Raw data will be kept for 5 years so abide by current research guidelines after which it will be wiped from the researcher's computer and destroyed.

What will I be told about the outcome of assessments/training and overall research project?

Individual results from the PPVT-IV and the K-BIT will not be made available to either the school or parents as doing so may result in clinical decisions being made based upon them. It is not the intention of this research project to guide any clinical or teaching decision. Should a parent request access to the test results, they will be asked to make a formal written request and access will be provided (in accordance with current Freedom of Information legislation) with formal written advice from the researcher and supervisor that the test scores should not be used to guide clinical or other

important decisions because the researcher is insufficiently experienced to interpret test results for this purpose.

I would like to remind you that you are free to refuse consent for your child to take part in this study without any disadvantage.

You are entitled to change your mind about your child's participation in this study at any time during the course of the study without disadvantage or penalty to your child.

If you feel a need to make a complaint at any point during or after the study is conducted, the researcher will be at hand to note and address this issue.

All procedures will be conducted in accord with current ethical standards and guidelines of the Psychological Society of Ireland.

Please note if there are plans for your child to have a formal IQ assessment within the next 6 months it would be advised to exclude them from the current study in order to prevent possible practice effects. Please be aware that if an unscheduled IQ assessment arises within 6 months of your child's assessments being conducted as part of this research project your child's performance may be impacted by practice effects.

If during your participation in this study you feel the information and guidelines that you were given have been neglected or disregarded in any way, or if you are unhappy about the process, please contact the Chairperson of the Department of Psychology Ethics Committee: Dr Bryan T Roche. Email: Bryan.T.Roche@nuim.ie

You may in addition contact the school director Stephen Bradley on 0876179465 or email Stephenbradley@stcatherines.ie.

Please be assured that your concerns will be dealt with in a sensitive manner.

You will be given a copy of the Participant Information Sheet and a signed Consent Form to keep for your own records.

Thank you very much for taking the time to read this information sheet.

Appendix B

Parental Consent Form

Title of project: Exploring the most advantageous course in development of repertoires of relational responding as a learning sequence in children with developmental/ intellectual disabilities.

Researcher Details: Grainne Kent, BSc (Hons) Psych., doctoral student at the Department of Psychology, National University of Ireland, Maynooth, Co Kildare. Research Supervisor: Dr. Yvonne Barnes Holmes, Department of Psychology, NUI Maynooth. The research will be conducted in accordance with current ethical guidelines from the Psychological Society of Ireland, and with the consent of the School Principal.

Please Initial Box

1. I confirm that I have read the parental information sheet for the above study and have had the opportunity to ask questions.
2. I am satisfied that I understand the information provided and have had enough time to consider the information.
3. I understand that my child's participation is voluntary and that I am free to withdraw my child from the study at any time, without giving reason, without penalty for me or my child.
4. I understand that this research will be conducted during school hours.
5. I understand that all personal details about my child obtained during the research will be kept anonymous and confidential and will not be shared with a third part prior to my consent.
6. I understand that data in relation to my child's performance will be treated confidentially and be stored safely through the application of pseudo names and the use of protected data files (see Information Sheet).
7. I understand that raw data will be retained for a period of 5 years by the researcher after which it will be destroyed.
8. I understand that this research is not a treatment or intervention.
9. I understand that there are no anticipated risks to my child; the student researcher Grainne Kent is responsible for adhering to ethical guidelines for the Psychological Society of Ireland and the Behaviour Analysis Certification Board.
10. I have been provided with an information sheet related to the research project.
11. I agree to allow my child to take part in the above study.
12. My child will undergo a number of assessments outlined in the accompanying Information Sheet
13. Individual results from the PPVT-IV and the K-BIT will not be made available to either the school or parents as doing so may result in clinical decisions being made based upon them. It is not the intention of this research

project to guide any clinical or teaching decision. Should a parent request access to the test results, they will be asked to make a formal written request and access will be provided (in accordance with current Freedom of Information legislation) with formal written advice from the researcher and supervisor that the test scores should not be used to guide clinical or other important decisions because the researcher is insufficiently experienced to interpret test results for this purpose.

I have read and understand the information provided above and in the Information Sheet and I agree voluntarily to my child's participation in the research.

Please ensure all boxes above are ticked.

Name of Parent

Date

Signature

Name of Person taking consent

Date

Signature

Appendix C

Continued Consent Form

Title of project: Exploring the most advantageous course in development of repertoires of relational responding as a learning sequence in children with developmental/ intellectual disabilities.

Researcher Details

Name: Grainne Kent

Contact number: 0876179465

Email: GRAINNE.KENT@NUIM.IE

Supervisors Details

Name: Dr Yvonne Barnes Holmes

Contact Number- 017086080

Email- Yvonne.barnes-holmes@nuim.ie

We would like to thank you for your cooperation with the current piece of research for which you have provided consent for your child to part-take in. At this point in the research programme, which we are approximately half way through we would like to make sure you are still comfortable with your child's continued participation. If you have any concerns please do not hesitate to contact the researcher using the above details. The researcher is always willing to answer questions you may have or address any issues which may have arisen since the research has commenced. Given your child's progress through the first half of the research procedure we estimate that your child will participate in a further **X (approx)** sessions. This is an estimation of the number of future sessions as it is difficult to predict the rate at which any child will learn. Please note that the research procedure will not carry on past the 31st of January 2014.

At this stage we would like to offer the chance to negotiate your child's participation in the study. Please sign below if wish to **WITHDRAW** your child from the study and return this form immediately. If you wish to allow your child to continue you do not need to do anything further.

Please only sign below if you wish to **WITHDRAW** your child from the study.

Signed:

_____ Participant/Parent

_____ Participant/Parent

_____ Researcher

_____ Date

Appendix D

Consent for researcher to use my child's recorded data from previous assessments

Title of project: Exploring the most advantageous course in development of repertoires of relational responding as a learning sequence in children with developmental/ intellectual disabilities.

Researcher Details: Grainne Kent, BSc (Hons) Psych., doctoral student at the Department of Psychology, National University of Ireland, Maynooth, Co Kildare. Research Supervisor: Dr. Yvonne Barnes Holmes, Department of Psychology, NUI Maynooth. The research will be conducted in accordance with current ethical guidelines from the Psychological Society of Ireland, and with the consent of the School Principal.

Should the researcher, Grainne Kent, wish to view and or use any recorded data from previous assessments [e.g., the **Verbal Behavior Milestones Assessment and Placement Program (VB MAPP)** assessment tool and/or the Wechsler Pre-school & Primary Scale of Intelligence, Third UK Edition (WPPSI-III UK) and/or the Bayley Scales of Infant Development Third Edition (BSID-III)] conducted with my child at NAME OF SCHOOL, I am hereby providing consent for the researcher to access these data for research purposes in the following circumstances only:

The researcher will request access to such data formally by written application to the School Director

The researcher will treat the data confidentially, at all times protect my child's identity, and protect any data used in the manner outlined in the Information Sheet.

I understand that I may opt *not* to allow the researcher access to previous assessment data for my child without any penalty to me or my child

I have read and understood the above information in addition to the Informed Consent Sheet and the Information Sheet provided.

Parent/Caregiver Signature: _____

Appendix E

APA Guidelines

Please find a copy of the American Psychological Associations Guidelines on test users qualifications here: <http://www.apa.org/science/programs/testing/qualifications.pdf>.

The following points may be relevant:







“The APA’s purpose in developing these guidelines is to inform test users as well as individuals involved with training programs, regulatory and credentialing bodies, and the public about the qualifications that the APA considers important for the optimal use of tests. These guidelines describe two types of test user qualifications: (a) generic qualifications that serve as a basis for most of the typical uses of tests and (b) specific qualifications for the optimal use of tests in particular settings or for specific purposes. They are aspirational because they identify qualifications for the optimal use of tests in a competent and responsible manner. These guidelines describe qualifications that apply to a variety of testing settings and for multiple purposes; therefore, it is unlikely that a single test user possesses all the qualifications described here. The qualifications should also be considered in relation to the context, setting, and purpose of test use.” (p.8)

“Various activities included in the testing process may be appropriately conducted by different people working collaboratively. Each participant should possess the knowledge, skills, and abilities relevant to his or her role. For example, different individuals may be responsible for deciding what constructs, conditions, or characteristics need to be assessed; selecting the appropriate tests; administering and scoring tests; and interpreting and communicating the results. Moreover, some testing activities may involve tasks that require limited professional knowledge (e.g., administering or scoring some tests, communicating simple test results). In such circumstances, test use should be directed by a qualified test user. It is this test user to whom these guidelines apply. Persons whose psychological test use is confined to research will find that the degree to which these guidelines apply to their work depends on their research focus and the research setting. The sections that address knowledge and skills in relation to psychometrics, statistics, test administration, and scoring are applicable to research that uses psychological tests.” (p.9)

Appendix F

Table A1
















Non-arbitrary Co-ordination/ Distinction Phase 1 Materials

Stimulus Class/Set	A	B	Comparison
1			
2			

Appendix G

Table A2










Non-arbitrary Co-ordination/ Distinction Phase 2 Materials

Stimulus Class/Set	A	B	C
1 (A1- B1-C1)			
2 (A2- B2-C2)			
3 (A3- B3-C3)			
4 (A4- B4-C4)			
5 (A5- B5-C5)			

Appendix H

Table A3













Arbitrary Co-ordination/Distinction Materials

Stimulus Class/Set	A	B	C
1 (A1- B1-C1)			
2 (A2- B2-C2)			
3 (A3- B3-C3)			

Appendix I

Table A4







Sample Comparison Materials

Relation Type	A	B	C
Non-arbitrary Set 1			
Set 2			
Set 3			
Arbitrary			

Appendix J

Table A5









Sample Opposition Materials

Relation Type	A	B
Non-arbitrary Set 1		
Non-arbitrary Set 2		
Arbitrary		

Appendix K

Table A6

Sample Hierarchy Materials

Relation Type	A	B	C	D
Non-arbitrary Set 1				
Non-arbitrary Set 2				
Arbitrary	