Chapter 1

Behavioural Methodologies to Teach Relational Responding to Preschool Children with Diagnosed Autism

Experimental behaviour analysis and related laboratory based research has laid the groundwork for Applied Behaviour Analysis (ABA). Skinner (1938/1966), developing on the work of key figures such as Watson (1913) and Pavlov (1927), provided accounts of classical and operant conditioning. His work on non-human subjects has since been translated to the field of ABA for its use in human populations. ABA began to be used across a variety of settings in the mid 1900's with preschool children (Baer, 1962) and children with autism (DeMyer & Ferster, 1962). The use of ABA has since expanded to a much wider variety of populations and settings including Organisational Behaviour Management (OBM; Alvero, Bucklin & Austin, 2001; O'Hara, Johnson & Beehr, 1985), dementia patients (Dwyer-Moore & Dixon, 2007; Trahan, Kahng, Fisher & Hausman, 2011) and people with intellectual disabilities (Carr & Durand, 1985; Grey & Hastings, 2005). The area most recognised for successful application is with individuals with autism, with ABA being one of the most predominantly used treatments for autism (Larsson, 2012; Odom, Boyd & Hume, 2010).

Applied Behaviour Analysis has been shown to be efficacious in treating the symptoms of autism, proving more effective than all other possible autism treatments (see Larsson, 2013, for a full review of Early Intensive Behavioural Intervention, EIBI). Studies indicate that the earlier an individual begins a behavioural intervention the better the outcome and a minimum of 20 hours of therapy up to a maximum of 40 hours per week is recommended (Eikeseth, Smith, Jahr & Eldevik, 2007; Lovaas, 1987) across a range of 18 months to 5 years (Larsson, 2012). Importantly, ABA interventions have been found to reduce problem behaviours and increase other more appropriate behaviours for the individual, such as communication, language and social skills (Rogers, 1998; Volkmar, Cook, Pomeroy, Realmuto & Tanguay, 1999). Brosnan and Healy (2011) reviewed 18 studies in which ABA was used to reduce aggressive behaviours and found that in all of the studies the intervention was effective. Randomised control trials indicate that children who receive behavioural interventions from a young age show fewer symptoms of autism, fewer problem behaviours and general improved development (Rogers & Vismara, 2008), Additionally, these children show greater improvements in areas such as language, social behaviours and self-management skills in comparison to peers in who receive treatment as usual (Remington et al., 2007). Significant increases in Intelligence Quotient (IQ) and positive adaptive behaviours have also been noted in children receiving EIBI (Reichow, 2012). Furthermore, EIBI is cost effective, ultimately, in that the overall cost that would be spent across the individual’s lifetime might otherwise be much greater because it enhances the possibility of achieving a more independent life as an adult (Motiwala, Gupta, Lilly, Ungar & Coyte, 2006).

One main area targeted in all behavioural interventions is communication and language (Sundberg & Michael, 2001) given that autism spectrum disorder (ASD) is characterised by an impairment in verbal and non-verbal communication (Diagnostic and Statistical Manual of Mental Disorders: DSM; American Psychiatric Association, 2013). Some people with autism may not learn how to communicate vocally (Rhea, 2008) with up to half of individuals diagnosed with autism unable to emit speech (Charlop & Haymes, 1994) and those who do learn to produce speech may still find it difficult (Rhea, 2008). Augmentative communication is often used by people with communication difficulties such as the Picture Exchange Communication System (PECS; Frost & Bondy, 2002), functional communication training, visuals for choice making and various computerised devices (Mirenda, 2001) such as Grace App, PECS IV+ and Proloquo2Go.

Behavioural Accounts of Language

Skinner’s research and theory on verbal behaviour has been hugely influential in behaviour analysis particularly since his book *Verbal Behaviour* (1957). He addressed several key issues including the basic verbal operants and how they are effected by reinforcement and punishment, stimulus control and motivating operations similar to all other operant behaviours (Morris, Smith & Altus, 2005). Skinner (1957) theorised that language, or verbal behaviour, is an operant behaviour which is learned via the same behavioural principles which strengthen or reduce all other behaviours, for example reinforcement, punishment and extinction. However, verbal behaviour is mediated by the behaviour of a ‘listener’ with a relevant history of reinforcement. He outlined how verbal behaviour does not necessarily have to be vocal and the function of the behaviour, rather than the topography, determines if it is verbal behaviour. Pointing, sign language and written language are all verbal behaviour according to Skinner’s definition. Skinner’s functional account of verbal behaviour proposed verbal operants which include mands, tacts, echoics, intraverbals which are categorised by their function (Vargas, 2013) and brought about through operant processes mediated by the social community.

Skinner’s account of verbal behaviour is used in application such as ABA intervention programs for children with autism to teach language and communication skills (Sundberg & Michael, 2001). By understanding that verbal behaviour is functional, the environment and relevant contingencies can be arranged to teach the necessary verbal operants (McLaughlin, 2010). For example, mands are taught by manipulating establishing operations to contrive motivation for the student to emit a mand while the student could also be taught separately to tact the same object. This contrasts with other accounts of language which presume once a student can label an object he will also be able to ask for it (Sundberg & Michael, 2001). Similarly, intraverbals may be taught separately if they fail to emerge; for example, a student may be able to tact “bed” when he sees one, mand for “bed” when he is tired but yet be unable to say “bed” as an intraverbal response when asked, “What do you sleep in?”. Sophisticated speakers may be able to readily transfer from one verbal operant to another for example from a tact to a mand (Skinner, 1957) but this can be quite complex for an individual with ASD and related language deficits. A great deal of research exists examining mand, tact, echoic and intraverbal training to individuals with developmental disabilities or delays (Sautter & LeBlanc, 2006). Each of the verbal operants can be taught separately to form the foundation for more complex language skills (Sundberg & Michael, 2001). A particular emphasis has been placed on research in mand training and functional communication training and the effects on the reduction of problem behaviour (Hagopian, Fisher, Sullivan, Acquisto & LeBlanc, 1998; Sautter & LeBlanc, 2006).

Despite Skinner’s large contribution and the ABA language programmes derived from his work (1938, 1957), the subsequent behavioural research on phenomena such as Stimulus Equivalence (SE; Sidman, 1971; Sidman & Tailby, 1982) and Derived Relational Responding (DRR) and Relational Frame Theory (RFT; Hayes, Roche & Barnes-Holmes, 2001) are thought to provide a more complete account of complex language features such as generativity, metaphor, emergence of grammar and so forth (Hayes et al, 2001) Skinner's account of generativity largely used analogy (e.g., if an individual had previously manded for *bread* and received bread he could then mand for *jam* even if he had never done this before if he already knew how to tact *jam*) and a proposed recombination of known verbal operants (Skinner, 1957; Murphy, Barnes-Holmes & Barnes-Holmes, 2005).

Sidman indicated that SE was composed of three features, namely reflexivity, symmetry and transitivity. For example, reflexivity is demonstrated when an individual is shown a stimulus A and can then select A from an array when asked (identity matching). Symmetry occurs when an individual can reverse a taught rule such that when taught that A = B the individual derives (untaught, emergent) that B = A. Transitivity is shown when an individual can combine symmetry relations, for example when taught that A = B and B = C the individual will understand that A = C, and C=A, without direct training or reinforcement.

RFT which follows on from SE, provides a post-Skinnerian account of language and cognition that explains the generativity of language and the manner in which novel verbal behaviour is produced based on DRR (Hayes et al., 2001). While SE provides a description of stimulus equivalence, RFT gives an insight into how stimulus equivalence (as well as other types of relational framing) occurs and provides a more complete explanation on how this happens (Gross & Fox, 2009). RFT also built upon SE by including more stimulus relations than just stimulus equivalence. By including a greater number of stimulus relations, RFT can provide a more complete account of language than SE. Examples of other relations included in the RFT account of language and cognition are distinction (different relations e.g. dogs are different to cats), opposition (opposite relations e.g. cold is opposite to hot), comparison (one event is related in accordance with a different event e.g. bigger than, smaller than) hierarchical (hierarchy of relations in which X is a part of or a member of a class e.g. Apples are fruit, apples are sweet), temporal (relating to time e.g. before/after, first/last), spatial (how items are arranged e.g. under and over, in and out) and deictic (perspective taking e.g. 'If I were you and you were me, how would you feel?'; Hayes et al., 2001). The relational frames of co-ordination and distinction (same/different) are thought to be one of the more basic frames involved in language and cognition but they are also some of the most essential frames (Ming & Stewart, 2017). Exposure to multiple exemplars of all relational frames allows for the emergence of the operant responding class of derived relational responding (Barnes-Holmes, Barnes-Holmes & Cullinan, 2000).

An important feature described as 'arbitrarily applicable relational responding' is a key aspect of language and cognition in RFT terminology. This may be best described in relation to human language, for example, a social community may assign a word to refer to an object, for example the word *tree* to refer to the object *tree*, but this is an arbitrary relation because the word does not physically resemble the object. While non-humans are capable of engaging in relational responding, it is non-arbitrary as it is based on formal dimensions of the stimuli (e.g. one stimulus is physically same as, or bigger than, the other stimulus). In contrast, humans have the ability to relate stimuli based on arbitrary properties which are not physically apparent and quite complex. An example of this could be the understanding that a fifty-cent coin is worth less than a one euro coin even though the former is physically bigger than the latter (Hayes et al., 2001). The RFT account uses terminology to describe the processes involved in relational responding. Terminology used includes mutual entailment, combinatorial entailment and transformation of functions which can be described as follows:

Mutual entailment involves responding to one stimulus in respect to another stimulus such that if A is related to B then B is related to A. If we are taught that A is bigger than B, this relation entails that B is smaller than A and language-able humans readily derive this bi-directionality, which is seen also in symmetry relations involved in SE (i.e., if A=B then B=A). It is thought that bidirectional relations are relevant to language, for example, example, a parent gives a child a toy car and teaches the word “car”, via mutual entailment the child will be able to select the toy car if the parent says “Where’s the car?” (Hayes et al., 2001).

Combinatorial entailment is similar to transitivity in stimulus equivalence except it encompasses non-equivalence relations thus, if A is related to B and B is related to C, then the mutually-entailed AB/BC relations combine to the effect that A is related to C in the same context. For example, if I’m told that John is smarter than Claire and Claire is smarter than Billy, I may derive that John is smarter than Billy (AC) and Billy is less smart than John (CA). With combinatorial entailment, it is not always possible to derive the exact relation between various stimuli. The transformation of stimulus function described in RFT is understood to mean that if a stimulus in a relational network has a particular psychological function, then the psychological functions of the other stimuli in the network may change in relation to the first stimulus. For example, if John has a fear of dogs and he is told that wolves are similar to dogs, the psychological function of fear may be transformed in relation to wolves, so that John now fears wolves in the absence of experience of wolves, due to the relation of sameness between dogs and wolves (Hayes et al., 2001).

The application of RFT in educational settings is becoming more widespread as practitioners are being provided with more information on how to put theory into practice with populations such as children with autism. Pre-requisites to derived relational responding such as joint attention and social referencing, basic relational frames (e.g. co-ordination, distinction, opposition), establishing mand and tact repertoires using derived relational responding and more complex relational responding such as analogies can all be taught based on RFT literature (see Rehfeldt & Barnes-Holmes, 2009). The applications of RFT are hugely significant for teaching children with autism given that language deficits are a significant issue with this population (Charlop & Haymes, 1994). By incorporating derived relational responding into teaching methods, practitioners can program for maximum effects and exponential learning.

Combining RFT and ABA in applications may provide practitioners with an even more powerful teaching technology than ABA alone, with important implications for teaching children with autism and related deficits in language and indeed cognition, or cognitive behaviour (see suggested synthesis, Cullinan, Barnes-Holmes & Barnes-Holmes, 2001). In particular, planning programmes to reinforce derived relational responding including pre-requisites to derived relational responding (relational framing; see Rehfeldt & Barnes-Holmes, 2009) could be very advantageous for children with ASD who frequently have language repertoires characterised by ‘rigid’ rather than ‘flexible’ responding, for example, generalisation of learning from one context to another may be problematic for a child with ASD. Using other terms, the child may not derive coordination relations between teaching contexts, thus the learning functions taught in one context may fail to emerge in other contexts without direct training, which of course has time-related resource implications in terms of learning and indeed teaching.

Studies have shown correlations between relational responding abilities and linguistic and cognitive abilities. Training in relational responding can aid educational performance as linguistic and cognitive abilities are important in this area. Furthermore, certain relational frames can help to form the foundation for more complex relational responding for example the frame of co-ordination is imperative for acquiring vocabulary which in turn is important for language development. Additionally, frames such as comparison form the basis for spatial and hierarchical frames while skills in the frame of opposition are useful for deictic relations (Dymond & Roche, 2013). RFT procedures have great potential in educational settings and have been used to teach academic goals such as fraction-decimal equivalence (Leader & Barnes-Holmes, 2001), derived manding (Murphy, Barnes-Holmes & Barnes-Holmes, 2005), more-than and less-than which is necessary for mathematic skills (Murphy & Barnes-Holmes, 2010) and temporal relations which are important for understanding time and schedules (Dymond & Roche, 2013).

Promoting the Emergence of Advanced Knowledge

A relatively new tool being introduced into behavioural and educational application using a combination of RFT and ABA is Promoting the Emergence of Advanced Knowledge (PEAK-ABA). PEAK is an assessment and curricular tool comprised of four modules as follows; Direct Training (DT), Generalisation (G), Equivalence (E) and Transformation of Functions (TF). PEAK is designed to facilitate assessing an individual's repertoire quickly and efficiently to identify gaps in learning. The PEAK assessment can be carried out to identify the child's skills and the PEAK score can then be shaded in the triangular visual associated with each module with a higher score indicating a greater amount of skills in the child's repertoire. For example, each module contains 184 targets and a child who has 40 of these targets in his repertoire has a PEAK score of 40 for that module (see Dixon, 2013 for further detail on PEAK scoring). The tutor can then select a programme in the corresponding PEAK manual to teach the learning target that is absent from the individual's repertoire, and the PEAK curriculum manual provides details on how to teach each skill (Dixon, 2013).

The PEAK DT module involves directly teaching certain skills absent from an individual's repertoire. This module is contingency-based and is similar to traditional ABA methods of teaching. Learners are provided with direct positive reinforcement contingent on correct answers which is most appropriate for early learners. The direct training module is composed of 184 programmes and it addresses prerequisite skills, vocal skills, reading, writing, basic maths and more complex verbal skills (Dixon, Whiting, Rowsey & Belisly, 2014).

The PEAK G module aims to teach generalised responding across 180 targets including both stimulus and response generalisation. This module focuses on using multiple exemplar training when training e.g. several pictures of a cat for a tacting target to ensure that the participant learns to pick the salient features that identify a cat such as long hair, four legs, two pointed ears, a long tail, whiskers and so on. The teacher can then use novel testing stimuli to examine if responses generalise to new stimuli. This train-test method in the PEAK-G module involves discrete trial training and positive reinforcement for the training trials (Dixon, 2014).

The PEAK- E module is designed to assess an individual's ability to engage in equivalence responding and, also, provides a guide on how to teach this type of responding. This module incorporates reflexivity, symmetry and equivalence. An example of a target from the equivalence module is '4A Symmetry- Picture to text' in which student receives training on selecting text when given a picture of the text (when given a picture of a house the student will pick the written word 'house' from an array) and can then select a picture when given the text (select a picture of a house from the array when given the written word 'house'). Targets become increasingly complex e.g. when taught that a specific combination of money (A) is enough to buy an item and then taught that a different combination of money (B) is the same as the first combination (A) the student will choose the second combination of money (B) to buy the item (Dixon, 2015).

The final, and most recently published module, is the PEAK-T module which provides an assessment for relational abilities and guidelines for teaching complex relational skills. This module includes targets on relations such as opposition, temporal, spatial, comparison and deictic. An example of a target from this module includes perspective taking (deictic relational frame) in which a student is shown a piece of paper with images on both sides and the student will be able to say who sees what image using "You" and "I" phrases (Belisle, Dixon, Stanley, Munoz, & Daar, 2016).

Given that PEAK is new in the field there are other assessment tools available which are widely used. Two of the most popular packages used in ABA for children with autism are the Verbal Behaviour Milestones Assessment and Placement Program (VB-MAPP; Sundberg & Sundberg, 2011) and Assessment of Basic Language and Learning Skills (ABLLS; Partington, Bailey & Pritchard, 2010). The VB-MAPP is an assessment for children with autism and language delays. It is also used to guide an individual's curriculum by dividing skills into different age ranges (across three levels) up to four years of age. Targets are set according to skills shown by typically-developing children in each of the age ranges. The VB-MAPP also includes a transition assessment, a barriers assessment, task analysis, skills tracking component and IEP (Individualised Education Plan) goals (Sundberg, 2008). The ABLLS is also an assessment tool and curriculum guide used for children with developmental disabilities. It includes 544 skills from 25 skill areas including language, motor skills and social skills. It is used for pinpointing deficits, guiding IEPs and identifying future goals. Although both the VB-MAPP and ABLLS are widely used in ABA there has been little research done on their psychometric properties.

One published study (Barnes, Mellor, & Rehfeldt, 2014) which examined the reliability of the VB-MAPP indicated that two school psychologists could implement the assessment having read the manual, with an average score of 57% based on a checklist designed for the study. Following Behavioural Skills Training (BST) the average score increased to 92%. This study included Levels one and two of the VB-MAPP assessment only. A second study examined the reliability of the intraverbal section of the VB-MAPP and found 93% agreement in IOA for correct intraverbal responses (Sundberg & Sundberg, 2011). However, the main of this study was not to examine the reliability of the intraverbal section but rather to examine if typically developing children and children with autism learned intraverbals in the same way. Regarding the ABLLS, one published pilot study which included typically developing children has shown the ABLLS to have internal consistency and test-retest reliability (Partington, Bailey, & Partington, 2016). The authors highlight that these are preliminary results and a larger participant sample is needed. This study followed up on some unpublished research which suggested that the ABLLS has good content validity and interrater reliability.

Although there has been some research on the reliability and validity of tools such as the VB-MAPP and ABLLS this research is limited, as previously outlined. There is a lack of evaluation of the psychometric properties of the VB-MAPP and the published data is not sufficient to consider this measure wholly reliable or valid (Gould, Dixon, Najdowksi, Smith, & Tarbox, 2011). Additionally, these tools do not have published data on normative samples which is important for assessing the validity of a curriculum and for comparing performances between individuals with disabilities and typically developing individuals (Dixon, 2014). Uncertainty surrounds the utility of these tools given the lack of research on them and practitioners have little evidence to suggest that these guides produce the best outcomes for children with developmental disabilities (Dixon et al, 2014). PEAK, however, is the only ABA curriculum which has empirically demonstrated reliability and validity (McKeel, Rowsey, Dixon, & Daar, 2014).

Given that ABA is a science set on evidence-based practice (Smith, 2013) it is particularly noteworthy that two prominent assessment and curricular tools do not have a great deal of evidence to support their use. As previously outlined, the benefits of early intensive behavioural intervention can produce hugely significant results for the child’s life. There is a critical age period in which intensive intervention will be most worthwhile and will produce the most positive outcomes for the individual (Fenske, Zalenski, Krantz &

McClannahan, 1985). This critical age spans from infancy to approximately four years old (Rogers, 1996; Fenske et al., 1985). It would be of great importance to use tools that are scientifically proven to work within this critical period in order to achieve the best possible outcome for these children (McKeel et al., 2014)

Research on PEAK, however, demonstrates that it may have some promising psychometric properties. Dixon et al. (2014) conducted research with children with autism or with other related disorders and found significant positive correlations between the participants' PEAK score and the Peabody Picture Vocabulary Test (PPVT) and Illinois Early Learning Standards Test. Both the PPVT and Illinois Early Learning Standards Test are tests which have been shown to be reliable and valid and correlate with tests of a similar nature. The correlation shown between PEAK and PPVT and Illinois Early Learning Standards Test is a good indication that PEAK is an appropriate tool for language assessment and training. Additionally, this positive correlation would also suggest that PEAK targets the material covered in educational settings.

In the same study by Dixon et al. (2014) both unskilled caregivers who were familiar with the child and a behaviour analyst who was not familiar with the child conducted the PEAK assessment on 25% of the participants at random. Dixon and colleagues indicated that there was high interobserver reliability of 85%. This result shows that PEAK can be used by both skilled and unskilled individuals regardless of their familiarity with the child while still producing a reliable result. The results of this study outline the potential use of PEAK over tools such as VB-MAPP and ABLLS.

Another advantage to using PEAK in comparison to the VB-MAPP is due to a ceiling effect shown by the latter (Dixon et al., 2014). Participants with autism, aged 5-21, were assessed using the PEAK direct training (PEAK DT) module and PEAK generalisation module (PEAK G) as well as the VB-MAPP. Scores on PEAK DT and PEAK G were combined to form PEAK Combined score. There was a strong positive correlation between PEAK Combined score and scores on the VB-MAPP. The scores on the VB-MAPP, however, increase towards a ceiling. Results analysis included examining the relationship between PEAK DT and PEAK G with the VB-MAPP separately. A strong relationship between PEAK DT and VB-MAPP was shown while there was a moderate relationship between PEAK G and VB-MAPP. A ceiling effect was also shown for each of these individual analyses specifically when there was a score of 60 in the PEAK DT module and a score of 31 in the PEAK G module. This suggests that when individuals show generalised verbal responding it may no longer be appropriate to use the VB-MAPP to assess them as they have excelled beyond this measure. PEAK is superior to VB-MAPP in this regard as it can assess individuals who show more complex verbal skills and can suggest additional targets for these children where VB-MAPP cannot.

Additional research on PEAK on normative samples has strengthened the notion of its utility over other behaviour analytic assessment and curricular packages. A recent study (Dixon, Belisle, Whiting & Rowsey, 2014) compared the scores on PEAK DT of a normative sample of individuals (aged 1-21 years) with those of a sample of individuals with autism or intellectual disabilities (aged 5-22 years). This research is advantageous in that the normative data provide a comparison for other populations which can help with providing clinical diagnoses and guiding treatment. Normative samples have also been used for comparison for the Wechsler intelligence tests (Goldstein et al., 2008), ABLLS (Partington, Bailey & Pritchard, 2010) and subsections of VB-MAPP (Sundberg & Sundberg, 2011). The PEAK study found that in the normative sample there was a strong positive correlation between PEAK DT scores and age. A ceiling effect was produced at approximately the age of eight in which most participants were capable of all items in the module. In contrast, no significant relationship was found between PEAK score and age in the sample with autism or intellectual disabilities and neither was the ceiling effect demonstrated with this sample. These comparative results suggest that typically developing individuals and individuals with autism learn directly trained skills in different ways and while typically developing children gradually increase their skills as they grow older, children with autism do not acquire these skills in such a linear fashion. The results of this study are beneficial as they suggest that PEAK DT could be used for individuals with autism across a large age span depending on their language and cognitive functioning while it could also be used for typically developing children up until age eight approximately.

Further research on PEAK has indicated that there is a strong, positive correlation between IQ scores, using various IQ measures, (which are often used as a benchmark to examine any relationship between these scores and scores on any new tools that are being developed) and PEAK scores. This provides an indication that PEAK is indeed measuring intelligence (Dixon, Whiting, Rowsey & Belisle, 2014). This provides further support for the validity of PEAK as an assessment tool. The importance of this particular piece of research is that using PEAK in schools could potentially produce an increase in individual's IQ scores. Normative measures of IQ are often used to compare skills of typically developing children to those of children with autism and can be used to identify areas in which an individual may need supplementary or more focused training (Sternberg, Grigorenko & Bundy, 2001). Educational psychologists report that they frequently use IQ measures, such as the Weschsler Intelligence Scale for Children-III, and perceive them to have educational utility (Pfeiffer, Reddy, Kletzel, Schmelzer & Boyer, 2000). Given the strong correlation between IQ and PEAK scores it is reasonable to suggest that targets outlined in PEAK, once met by an individual, could produce corresponding increases in IQ scores.

Relational Responding and Intelligence Quotient

Intelligence Quotient (IQ) scores, in general, tend to remain stable throughout life. Relatively recent research, however, suggests otherwise. Studies have indicated a positive correlation with skills in derived relational responding and IQ scores (O'Hora, Pelaez & Barnes-Holmes, 2005). Other research, (O'Toole, Barnes-Holmes, Murphy, O'Connor & Barnes-Holmes, 2009) indicated a positive correlation between relational responding skills on an IRAP (Implicit Relational Assessment Procedure), which requires fluency in responding, and IQ scores. Following on from these studies, Cassidy, Roche and Hayes (2011) examined if training relational responding would produce a subsequent increase in IQ scores. Cassidy et al. (2011) conducted research with both typically developing and educationally disadvantaged participants. The results indicated that the typically-developing children exposed to multiple exemplar training in stimulus equivalence, 'same', 'opposite', 'more than' and 'less than' relational frames showed significant increases in full scale IQ (as measured by Wechsler Intelligence Scale for Children). This was in contrast to controls that received stimulus equivalence training only who did not show any improvement in IQ following their brief training.

A second study by Cassidy et al. (2011) included children with educational difficulties which indicated that an improved multiple exemplar training intervention produced significant increases in IQ for these participants. In addition to this a Relational Abilities Index (RAI) was administered pre- and post- relational frame training. The RAI was used to assess the fluency of the relational frames trained (same, more than, less than and opposite) to ensure that an improvement in relating abilities was due to the intervention. The result indicated a significant increase in relational performance with relational ability and fluency of relating abilities correlating with the increase in IQ. The results of these two studies by Cassidy and colleagues indicate that teaching relational frames and how to relate them rapidly could produce a rise in IQ for both typically-developing and developmentally challenged individuals.

Increasing the complexity of relational responding could produce further gains in cognitive ability. One such example of complex relational responding is that required for analogies which are at the core of human language and cognition. Analogies have been viewed by cognitive psychologists as a key element of intelligent behaviour (Sternberg, 1985). An RFT based behavioural account of analogies refers to them as equivalence-equivalence relations which involve relating relational networks (for the remainder of this paper the author will use the terms ‘analogy’ and ‘equivalence-equivalence relations’ interchangeably). They first require the individual to examine the relation between the first pair in the analogy, then derive a relation between the second pair and finally derive a relation which between both pairs. Take the example apple: orange :: dog : cat which requires the relation between apple and orange to be derived (equivalence as they are both from the same category- fruit) and then to derive the relation between dog and cat (also equivalence as they are both from the same category - animals). Finally, an analogy requires a derivation of the relation between the relations i.e. apple is equivalent to orange just as dog is equivalent to cat. This analogy identifies equivalence relations within and between relations (Barnes, Hegarty & Smeets, 1997). Training to discriminate and tact the type of relation in each compound of an analogy (e.g. apple: orange is an equivalence relation) has been shown to aid in the development of analogical reasoning in adults (Miguel et al., under submission) but this has not been done with children. Analogies help to explain the generativity of language as humans are able to relate entire networks of relations to each other rather than having to relate specific relations (Stewart, Barnes-Holmes, Hayes & Lipkens, 2001). In this way, knowledge in one area can be transferred to other areas by examining the relation between each (Rehfeldt & Barnes-Holmes, 2009). Previous research has shown that nine-year-olds are capable of analogical reasoning while five-year-olds cannot do so without additional training (Carpentier, Smeets & Barnes-Holmes, 2002). Five-year-olds can however, understand equivalence relations but not equivalence-equivalence relations, as are in analogies. This links with findings indicating that stimulus equivalence is present before equivalence-equivalence which suggests that equivalence-equivalence is a more complex skill (Stewart & Barnes-Holmes, 2001).

Findings from O'Hora, Pelaez and Barnes-Holmes (2005) suggested that demonstration of good relational responding skills is a predictor of performance on tests such as vocabulary and arithmetic as these tests require more complex relational responding in comparison to other tests such as spelling. Following on from this study, O'Toole and Barnes-Holmes (2009) examined the relationship between relational responding and IQ scores in a population of college students using an IRAP to present relational tasks. The

IRAP is particularly advantageous in such research as it allows for data collection on the accuracy and speed of responding which, in turn, can provide an indication of fluency levels. Relational tasks were presented using the IRAP which examined the relational frames similar/different and before/after. Participants were required to respond to these frames with consistent and inconsistent rules e.g. in a consistent block they would be required to select “true” when presented with ‘spring is before summer’ while in an inconsistent block when presented with ‘spring is before summer’ the correct answer would be “false”. This study found that individuals who were capable of responding more quickly on the relational task had higher IQ scores as measured by the Kaufman Brief Intelligence Test. Furthermore, those who demonstrated greater relational flexibility also showed increased IQ scores based on correlational data. Shorter response latencies were produced for equivalence relations in comparison to before/after relations indicating that equivalence relations are the most basic of relational classes. These results indicate the significance of relational responding as a factor of intelligence.

The authors noted that in educational settings it may be worthwhile to teach flexible learning repertoires as well as fluency in order to improve intelligent behaviours. This could be particularly useful for children with autism who are so often characterised by their rigid thinking. Promoting flexible responding has been shown to help with the acquisition of new skills within this population (O’Connor, 2004). Teaching relational responding and flexibility in relational responding therefore appears to be a practical step in promoting intelligent behaviour.

Autism, attentional deficits and on-task behaviour

Over the last number of years there has been an increase in the number of individuals diagnosed with autism and other developmental disorders. Boyle et al. (2011) found that, in 2006-2008, over 10 million children between the ages of 3-17 had a developmental disability. This represents a 17% increase in comparison to the previous decade. In a review of autism literature, Matson and Kozlowski (2011) noted that the prevalence rate of autism is increasing and it is increasing rapidly over a relatively short number of years. Individuals with autism often engage in behaviours which are different to those of individuals without autism which can hinder their development. Such behaviours which characterise individuals with autism include stereotypy, challenging behaviours, echolalia, restlessness, resistance to help or instructions and slower response rates (Matson, Baglio, Smiroldo, Hamilton & Packlowskyj, 1996). Attention deficits and staying on-task have been noted also, as a characteristic of individuals with ASD, who can display deficits in joint attention, an inability to stay focused, difficulties in switching attention between tasks and retaining information (May, Rinehart & Wilding, 2013; Whalen & Schreibman, 2003). Individuals with autism may require assistance in managing their behaviours and can build a dependence on prompts provided by adults to help them remain on-task and finish activities (Bryan & Gast, 2000). Inattentiveness has been recognised a risk factor for a child's development and can subsequently lead to poor academic performance (Breslau et al., 2009).

Research indicates that faster presentation of questions or learning trials can increase students' on-task behaviour, attentiveness and correct responding. Slower paced presentation of work can result in reduced attention, misbehaviour and a reduced likelihood that the child will attend later in the teaching session (Carnine, 1976). Individuals that are presented with learning trials in quick succession, and subsequently produce fluent responding for a particular learning objective, will be more likely to retain this information and put it to use in a more natural setting (Binder, 1996). A fluency rate of responding refers to a high level of accuracy and speed. Individuals that produce fluent responding are more likely to remain on-task and distractions are less likely to interrupt their work (Binder, Haughton & Van Eyk, 1990). Additionally, students that are given the opportunity to respond to learning trials rapidly and without interruption engage in less problem behaviour while working. Binder (1996) noted in his study that problem behaviour appeared to be replaced by positive behaviour such as smiling.

Precision Teaching

One teaching approach which has acknowledged the importance of fluency in responding, as outlined above, is Precision Teaching (PT). The learner is generally required to graph their own data on a standard celeration chart which can then be compared to their pre-determined aim. PT can be used to teach a wide variety of educational goals provided that these goals are conducive to being counted and timed (Lindsley, 1992). This allows for the learner to aim for fluency (Binder, 1988) in responding for a specific goal (e.g. tacting 40 letters in one minute) which targets both speed and accuracy of responding. The fluent rate of responding catered for in PT allows for greater retention and generalisation of educational targets in comparison to more traditional teaching methods. PT techniques have been used to facilitate teaching a variety of skills for children with autism and learning disabilities such as teaching emotions (Almon-Morrie & Diakite, 2007), story-telling

(Schirmer, Almon-Morris, Fabrizio, Abrahamson, & Chevalier, 2007), reading (Selfridge & Kostewicz, 2011) and word recognition (Cavallini & Perini, 2009).

While the benefits of PT have been widely discussed in research literature it is not widely used in all educational settings. In many educational settings, the presentation of learning trials is often disjointed and discontinuous while the teacher prepares materials and moves through an educational programme. This is not conducive for a flow in behaviour and opportunities arise for students to engage in off-task behaviour and inattentiveness (Binder, 1996). While this may not always be particularly problematic in mainstream schools where typically- developing children can be given worksheets to work on at their own individual place, it is evident in other educational settings that use other teaching methods e.g. discrete trial training. It is in these settings that inattentiveness and off-task behaviour are more prominent and individuals have less opportunity to respond at a fluency rate (Binder, 1996).

The Teaching-IRAP

One method to increase on-task behaviour and attentiveness would be to present trials in quick succession. Computerised methods of presenting trials rapidly have been developed such as the Behaviour Tech (Orgel, 1984 in Binder, 1996) and Mighty Math (Maloney & Summers, 1982), neither of which proved to be particularly successful. A more recent computerised program is now available to present trials rapidly, the T-IRAP (Teaching-IRAP). This programme has been adapted from the Implicit Relations Assessment Procedure (IRAP) which examines implicit attitudes. The T-IRAP does not examine implicit attitudes but it is used to present trials rapidly (which encourages fluency of responding), with various stimuli, and records data automatically. This computerised programme presents two images or words on the screen (or a combination of images and words), the researcher can input any desired stimuli into the programme to be presented to the participant. The participant is provided with a written rule, for example, “Press D if the images are the same. Press K if the images are different”. If the stimuli are the same, the participant is required to press the “D” key on the keyboard and if the stimuli are different participants are required to press the “K” on the keyboard. Response times for each trial are recorded in milliseconds and accuracy scores for each trial block are calculated automatically. Trials are presented in trial blocks and the number of trials and trial blocks per session can be adjusted. Additionally, the T-IRAP can allow for the rule to be reversed in that participants can be required to provide the “wrong” answer, for example, when presented with two different stimuli the participant could be required to press “D” for the same which can be used to promote fluency and flexibility in responding. In this way, the T-IRAP links with PT and fluency measures as students are required to respond as quickly and as accurately as possible and this can be measured because, as previously mentioned, the T-IRAP records both speed of responding and accuracy responding.

The T-IRAP has been used in previous research to teach relational responding to children with autism (Kilroe, Murphy, Barnes-Holmes & Barnes-Holmes, 2014; Lyons & Murphy, under submission). Kilroe et al. (2014) demonstrated that the T-IRAP could be used to teach various relational frames to young children with autism. Relational frames of co-ordination, comparison, opposition and derived relational responding were taught using both non-arbitrary and arbitrary stimuli. Participants were taught relational responding using Table-Top teaching (TT) and the T-IRAP was introduced at staggered time intervals in the multiple baseline design. Kilroe and colleagues found that all four participants in the study demonstrated an increase in speed of responding and levels of accuracy when using the T-IRAP in comparison to TT which indicated that the T-IRAP produced more fluent responding. This research demonstrates the potential for the T-IRAP to be used as a supplementary teaching tool to teach a variety of relational frames using various stimuli while producing more accurate and faster responding.

Building upon the research by Kilroe et al., (2014), Lyons and Murphy (under submission) used an alternating treatments design to compare the effectiveness of the T-IRAP with TT in teaching relational responding and complex relational responding including double contingency reversals to children with autism. The double contingency reversals involved initially teaching particular relations and then reversing the contingency so that the participant was required to answer “incorrectly”. Following this, the contingency was reversed back to the original relational contingency. Children with autism often demonstrate rigid thinking and the type of flexible relational responding required in double contingency reversals could be difficult for them. Flexibility in thinking is thought to be a necessary component of intelligent behaviour and teaching how to relate flexibly could have a positive effect on IQ. This study examined the impact of teaching complex relational responding on IQ in children with diagnosed autism by measuring IQ using KBIT and PPVT-IV pre- and post- relational training.

Lyons and Murphy found, similar to Kilroe et al. (2014), that greater speed and accuracy was displayed by the participants when using the T-IRAP in comparison to TT. This is possibly due to the T-IRAP’s rapid presentation of stimuli allowing for more fluent and fluid responding. It is worth noting that TT teaching was organised for stimuli to be presented as fast as possible yet the T-IRAP remained a more efficient method. Results also indicated that, while there was not a statistically significant difference in the pre- and post-IQ scores, a visual analysis suggests some variation in IQ scores with a possible minor increase in IQ. The authors note that a possible reason for increased accuracy when using the T-IRAP is that the computer format may be more appealing to the participants and they have shown greater attentiveness when completing this work in comparison to TT teaching.

Using a T-IRAP could be advantageous in that it could be seen to be more appealing to children in comparison to TT teaching, as suggested by Lyons and Murphy (under submission). With the use of technology becoming more widespread in our daily lives it is natural that technology could become more prominent in educational settings. Research has suggested that computer based learning produces more on-task behaviour in comparison to book based learning (Williams, Wright, Callaghan & Coughlan, 2002). Williams and colleagues noted that a computer screen presents minimal information on the screen and this may reduce distractions that accompany traditional teaching. The participants in this study, children with autism, were also found to produce more appropriate behaviours and required fewer prompts than when in the book based learning condition. Research conducted by Heimann, Nelson, Tjus and Gillberg (1995) examined the use of a computer programme, Alpha, for facilitating language learning. Participants, children with autism and children with mixed handicaps, were recorded to have shown an increase in enjoyment when engaged with the teaching tool. The computer based program was thought to be more stimulating than their standard reading and writing activities. Participants indicated that they preferred computer instruction and they also learned more quickly with this method. The above research suggests that computer based presentation of tasks could encourage more on-task behaviour and better quality learning in addition to providing a more enjoyable learning experience for children. Given that children, particularly those with developmental difficulties, often emit challenging behaviours to escape from academic demands it would be advantageous to use teaching methods that they find more appealing to reduce the risk of such problematic behaviours.

The Current Research

The present study seeks to explore a number of research questions amongst a population of preschool children with autism. As outlined, Lyons and Murphy (under submission) examined the effects of teaching relational responding and double contingency reversals on the IQ scores of children with developmental delays. A significant effect was not found in this study but a visual analysis suggested a possible upward trend in IQ scores in comparing pre- and post- intervention. As this was one of the first studies to explore any correlation between relational responding training and IQ scores with this population, the current study seeks to examine the effect of relational training on measures of cognitive ability with a preschool population using the Bracken School Readiness Scales Third Edition, Vineland Adaptive Behaviour Scales and Reynold's Intellectual Assessment Scales: Odd Item Out subtest. Additionally, this research will examine if preschool children can learn analogies or the pre-requisites to analogies, such as the ability to tact equivalence relations and equivalence-equivalence relations using the T-IRAP. It has been shown that five-year-old children can demonstrate analogical relational responding when provided with additional training. This research will examine if these results hold true with preschool children with developmental delays such as autism.

This study will use the T-IRAP, as used by Kilroe et al. (2014) and Lyons and Murphy (under submission), to present the learning trials to the participants. By including this, the current study seeks to examine the suitability of the T-IRAP in teaching young children of preschool age and examining if extra supports (e.g. self-management supports, prompt levels) need to be provided for this population in comparison to previous research. Participants' on-task and off-task behaviour will be recorded using the Behavioural Observation of Students in Schools (BOSS; Shapiro, 2004) during their usual table-top work (as outline in their IEP) and while they are working on the T-IRAP. Previous research has suggested that computerised presentation of learning materials produces more on-task behaviour and students indicate a preference for computer based learning in comparison to their usual work. This study will seek to examine if these results extend to the T-IRAP and if there is a difference in on-task behaviour in comparison to table-top work.

The advantages of using computerised programmes and the T-IRAP have been outlined previously. In relation to this, this study will examine if the PEAK curriculum can be incorporated into the T-IRAP. Given that PEAK, particularly the direct training module, is emerging as a promising assessment and curricular tool it would be beneficial if this were available in a computerised format. PEAK aims to provide a quick assessment so that gaps in a learner's repertoire can be assessed efficiently and actions can be taken to teach missing skills. If some of the PEAK curriculum could be presented in a computerised format this enhance the value of PEAK as it would reduce the need to organise and collect relevant materials. Furthermore, if it is a possibility to present PEAK on a computer then PEAK could be directly taught using traditional table-top methods and learners could use the computerised version for maintenance and generalisation of skills learned and independent learning if appropriate.

In summary, this research will be comprised of a number of experiments including children with autism. The study will seek to examine a) Can PEAK DT targets be taught using a computerised teaching tool such as the T-IRAP to children with ASD?; b) Does the T-IRAP produce more on-task behaviour than table top work; c) Does teaching relational responding produce an impact on cognitive scores of participants with ASD?; d) Can self-management interventions be used in conjunction with the T-IRAP to produce more fluent responding with preschool children with ASD?; e) Can preschool children learn analogies or the pre-requisites to analogies using the T-IRAP and how does this compare to teaching analogies using table-top methods

Chapter 2

Introduction

RFT proposes that language and cognition are based upon relational frames which include co-ordination, distinction, opposition and so forth. The frame of co-ordination is thought to be one of the most basic relations required for language and that identifying same/different is hugely important in academia (Ming & Stewart, 2017). In addition to this, the frame of co-ordination can act as a pre-requisite for more complex relational framing as well as arbitrarily applicable relational responding and derived relational responding (Rehfeldt & Barnes-Holmes, 2009)

Research literature in RFT has suggested that training on relational responding has produced gains in IQ for both typically developing children and children with educational difficulties (Cassidy et al., 2011). Furthermore, O’Toole and Barnes-Holmes (2009) suggested that fluency and flexibility of relational responding correlates with IQ scores. Given the social significance of IQ scores this type of research could be very influential, particularly for those with developmental delays or intellectual disabilities in which IQ scores may be low.

Unlike other curricula for children with autism and other developmental delays, PEAK is based upon ABA and RFT and it takes into account various relational frames, derived relational responding and other elements of RFT. PEAK has also been shown to correlate with IQ measures (Dixon et al, 2014). Considering the impact of relational training, including PEAK, on language and cognition Study 1 sought to incorporate PEAK DT targets into a T-IRAP which can be used to present trials very rapidly. Participants were presented with two images on a computer screen as part of the T-IRAP, when the images were the same the participants were required to press the “D” key on the keyboard and when the images were different the participants were required to press the “K” key on the keyboard.

This study also sought to examine the impact of relational training of the frames of co-ordination/distinction, as derived from PEAK targets, on participants’ language and cognitive abilities as measured by various pre- and post-intervention assessments. An additional research question explored if there was a difference between on- and off- task behaviours displayed by participants when engaging with the PEAK/T-IRAP in comparison to their usual table-top work.

Study 1 used a multiple baseline design across four preschool participants who have diagnoses of ASD. This is the first study, to date, to present PEAK targets in a T-IRAP to children of this age and profile. Baseline data were collected to assess each participant’s ability to identify same and different. A PEAK/T-IRAP was implemented as the intervention in staggered intervals. The study concluded with a generalisation phase. Data were collected concerning on- and off-task behaviours throughout the intervention phase using the BOSS (Shapiro, 2004).

Method

Participants

Participants (*n* = 5, three male and two female) in this study were recruited from an early intervention ABA-based preschool in which the author is an instructor. All participants had formal diagnoses of autism prior to beginning the study made by an independent clinical psychologist in accordance with criteria in the *Diagnostic and Statistical Manual Fifth Edition* (DSM-V; American Psychiatric Association, 2013). Their diagnoses ranged from mild-moderate autism. The participants were aged between 3 and 4 years of age at the beginning of the study. Participants were selected based on their ability to sit at a desk and complete some table-top work (e.g. matching-to-sample, listener responding, tacting). This participation selection criteria were applied as the T-IRAP computer programme was presented at a desk in the intervention.

Michael was a four-year old boy. He had been attending the ABA preschool centre for 9 months. He communicated using vocal verbal behaviour with up to three word sentences e.g. “Open it please”. He exhibited some vocal and motor stereotypy. He also had some issues with his attending skills as he can attend to a given task for short periods only (up to one minute). Josh was a three-year old boy who had been attending the centre for approximately 14 months. He had a score of 16 on the VB-MAPP milestones assessment. He mainly communicated using PECS and could construct sentences using the sentence strip e.g. “I want play dough”. He also had some echoic skills. Daniel was a five-year old boy. He had been attending the centre for approximately two years. Daniel was non-vocal and had very limited skills in using PECS. He communicated mainly using a basic picture exchange for highly preferred items. He exhibited vocal and motor stereotypy frequently.

Emma was a three-year old girl who had been with the ABA service for 18 months. She exhibited some rigid behaviours such as a need to place items in a specific order, entering the classroom through a specific door and hanging her coat on a certain coat hook. She communicated using PECS and could competently construct sentences using the sentence strip e.g. "Can I have water play?". She produced frequent vocalisations but had no approximations of words or echoic skills. Her VB-MAPP milestones assessment had a score of 43.5. Sarah was a four-year old girl. She attended the service twice per week as she also attended a mainstream preschool. Sarah exhibited some rigid behaviours such as a need to complete routines in a certain way. She communicated using her speech and could use full sentences e.g. "Teacher, who are you working with today?". She had a VB-MAPP score of 159.

Settings/Materials

All the research sessions, including pre- and post- intervention assessments, were conducted in the child's classroom in the preschool during school hours. A total of four pre- and post- intervention assessments were used. These included the Vineland Adaptive Behaviour Scales (VABS), Bracken School Readiness Assessment-Third Edition (BSRA-3), Reynolds Intellectual Assessment Scales (RIAS) and Promoting the Emergence of Advanced Knowledge Direct Training Module (PEAK-DT). A T-IRAP was used in the intervention phase and the BOSS was used to record data on on- and off-task behaviour. See below for further detail for each of these materials.

Bracken School Readiness Assessment. The Bracken School Readiness Assessment (BSRA-3; Bracken, 2007) assesses a child's receptive language skills and concept knowledge as a measure of their readiness for school. It provides an overview of a child's general abilities.

Vineland Adaptive Behaviour Scales. The Vineland Adaptive Behaviour Scales (Sparrow, Cicchetti & Balla, 2005) assess an individual's communication, daily living skills, socialization and motor skills. It gives a general overview of an individual's global abilities. It is composed of a Teacher Rating Scale and a Survey Form, both of which were used in this current study.

Reynolds Intellectual Assessment Scales. The Reynolds Intellectual Assessment Scales measures verbal and non-verbal intelligence. It is divided into various subtests which include verbal and non-verbal memory, verbal and non-verbal intelligence index, guess what, verbal reasoning, odd item out and what's missing (Reynolds & Kamphaus, 2003). For this research. only the Odd Item Out subtest was used.

Promoting the Emergence of Advanced Knowledge. Promoting the Emergence of Advanced Knowledge Direct Training Module (PEAK-DT) is an assessment and curricular tool used to aid children in their language and cognitive development (Dixon, Belisle, Whiting & Rowsey, 2014). This is a relatively new resource used in behaviour analysis.

Teaching-IRAP. The T-IRAP is a computerised interactive teaching tool that was adapted for the current research from the IRAP (Implicit Relational Assessment Procedure; Barnes-Holmes et al, 2006; version 2.0.0). The T-IRAP was used to present trials and provide feedback for participant responding. Learning targets were selected from the PEAK Direct Module and stimuli entered into the T-IRAP were selected based on the PEAK-DT relational targets (e.g., matching a square to an identical square, identifying that a square and star are different). The T-IRAP records the number of correct responses and records response latencies in milliseconds (ms.) and these data were used as measures of accuracy and speed of responding, respectively

Behavioural Observation of Students in Schools. The Behavioural Observation of Students in Schools (BOSS; Shapiro, 2004) is a tool that assesses academic behaviour in a classroom setting. It specifically measures on- and off-task behaviour. A hard copy of the BOSS was used in this study.

Experimental Design

A pre-intervention assessment phase was conducted initially. This consisted of four assessments: PEAK DT, Reynold's Intellectual Assessment Scales, Vineland Adaptive Behaviour Scales and Bracken School Readiness Assessment- Third Edition. Baseline data were then collected for all participants using two probes for same (Matching) and different (Which One Doesn't Belong?) which were taken from the PEAK- DT module. A multiple baseline design was used to implement a PEAK/T-IRAP intervention across participants. Accuracy of responding was measured at baseline for the probes. Accuracy and speed of responding were measured on the T-IRAP when the intervention was put in place.

Measurement

The baselines for each participant included two probes (Matching and Which One Doesn't Belong). Accuracy data only were measured for each baseline probe by recording the number of correct responses and dividing this score by 10 (as there were 10 trials in each probe) and multiplying by 100. This was done manually by the researcher.

Duration/speed of responding data were not collected for the baseline table-top probes as the primary aim of the study was not to compare table-top sessions with the T-IRAP but rather to investigate if PEAK targets could be presented and taught to the participants on the T-IRAP. For the intervention phase, the PEAK/T-IRAP programme automatically recorded the number of correct/incorrect trials and speed of responding. This programme produced a Microsoft Excel sheet. The researcher then calculated the accuracy of responding to the PEAK/T-IRAP by adding the number of correct responses and dividing this score by 32 (total number of trials in a session) and multiplying this by 100 to obtain an accuracy percentage. The duration/speed of responding to the PEAK/T-IRAP was calculated by adding the response latency to each correct response on the PEAK/T-IRAP which was recorded and graphed in milliseconds. This produced a cumulative duration of responding score, or otherwise known as, speed of responding.

Ethical Considerations

A research ethics proposal was submitted and was approved on 25.9.2015. The primary issues addressed in the research ethics proposal were participants' voluntariness, consent from parents, participant confidentiality and special provisions made for the participants as they are considered a vulnerable population. The ethics proposal was also reviewed and accepted by the Managing Director of the preschool. The onsite BCBA (Board Certified Behaviour Analyst) in the preschool also agreed to oversee the research.

An informed consent form and an information sheet were sent home in each of the children's schoolbags for parents to read (See Appendices 1 and 2). The informed consent form and information sheet outlined the nature of the research, what the participant would be required to do and the frequency and duration of sessions. Both forms outlined that participation was entirely voluntary and that there would be no negative consequences for non-participation.

For the current study, the forms also explained that the data collected on the pre-intervention assessments (Vineland Adaptive Behaviour Scales, Reynolds Intellectual Assessment Scales and Bracken School Readiness Assessment) would not be made available to the parents unless by written request as the researcher is not sufficiently qualified to analyse and interpret the results of these assessments for clinical purposes. Parents were required to sign the informed consent form and tick the appropriate box if they did/did not want their child to participate. Additionally, a continued consent form (see Appendix 3) was sent home in each of the participant's schoolbags approximately halfway into the research sessions to ensure that parents still provided their consent as this study spanned over a number of months.

As some of the children who participated in this study were pre-verbal or had poor vocal verbal skills, the ethics proposal referenced acquiring each participants' assent before beginning each research session. Participants were asked before each session if they would like to work with the researcher that day. If the participant had speech or could communicate yes/no using PECS the researcher honoured the mand. If the participant declined or emitted negative behaviour the researcher did not begin the session. If the participant did so for three consecutive sessions the researcher considered terminating the rest of the research sessions. As some participants did not have speech or could not communicate yes/no the researcher paid particular attention for any signs of distress by the participant during the research sessions. This included signs such as excessive yawning, challenging behaviours, increased stereotypy, elopement from the research area or any other behaviours that would suggest that the participant was uncomfortable or distressed.

One potential risk that was associated with the use of the laptop computer was the possibility of the electronic devices inducing seizures. Although this was a minimal risk, parents were advised in the information sheet that children with a history of seizures should not participate in the study and that, if not already done so, they should alert the preschool to this medical condition. Should a parent wish to provide consent for a child with a medical history of a seizures the parent was referred to the research supervisor. This scenario did not arise in the process of obtaining consent.

All data collected during the research was stored under pseudonyms and pseudonyms have been used in this write-up to protect participant's anonymity. All computer based data have been stored under pseudonyms and have been password protected. A backup copy of computer based data has also been made and stored under a separate password. A key which links each participant to his/her pseudonym has been saved on a computer which is password protected. Following data collection this key will be destroyed. Confidentiality and data protection regulations were observed in accordance with current ethical standards dictated by the relevant professional bodies. The location and name of the educational setting which the participants attend is also kept confidential.

Interobserver Agreement

Interobserver Agreement (IOA) data was collected for RIAS and BSRA-3 pre- and post-intervention assessments. Trial-by-trial IOA was taken for the RIAS for 44% of the assessments with 100% agreement. Similarly, trial-by-trial IOA for the BSRA-3 was calculated for 33% of tests with 96% agreement. IOA was taken by the researcher or a trained observer for 20% of baseline probes with 99% agreement. Trial-by-trial IOA was calculated by dividing the number of agreements of all trials by the total number of trials and multiplying this by 100 to calculate a percentage. As the T-IRAP data was collected electronically IOA data was not necessary for this aspect.

Procedure

A multiple baseline design was implemented across four participants followed by a generalisation phase. Pre- and post-intervention assessments were also included See *Figure 1.* for a visual representation of the full procedure.

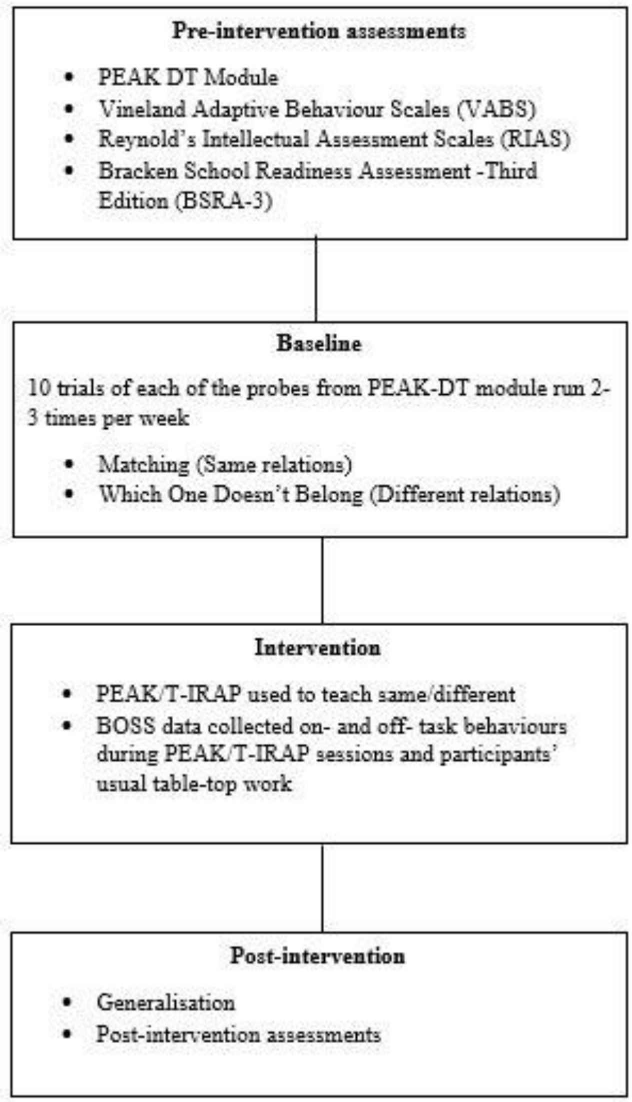


Figure 1. Visual representation of the procedure used in the current study

Pre-intervention assessments. Assessments were conducted in 20-30 minute sessions in the preschool at the participant's desk with no more than one session per day. These sessions tested the PEAK-DT module, the Bracken School Readiness Assessment and the Odd Item Out subtest of the Reynolds Intellectual Assessment Scales. As soon as a participant completed one assessment s/he moved straight to the next assessment within the same research session. There was approximately a six-month interval between pre- and post- assessments.

The Bracken School Readiness Assessment (Third Edition; BSRA-3) is broken into subscales: Colours, Shapes, Numbers, Sizes/Comparisons and Letters. The guidelines as outlined in the manual were followed. The researcher showed the participant the stimulus book and provided the relevant antecedent e.g. "Show me red" and then waited 5-10 seconds for the participant's response. If the participant did not respond, the researcher repeated the question. Positive reinforcement was provided for correct answers in the form of verbal praise and a preferred toy/edible. No corrections were provided for incorrect answers. The researcher recorded 1 on the data collection sheet if the participant answered correctly. A 0 was recorded if the participant answered incorrectly and NR (No Response) was recorded if the participant did not respond to the question. If the participant self-corrected before the presentation of the next item, the researcher recorded 1. If the participant reached three consecutive incorrect responses the test was stopped.

The subtest of the Reynold's Intellectual Assessment Scale: Odd One Out was conducted in a similar manner. Guidelines as outlined in the assessment manual were followed. The researcher showed the participant the stimulus book (e.g. five identical squares and one circle) and provided the antecedent "Point to the one that doesn't belong". All participants began with the first two sample items and then commenced with the test items. If the participant answered correctly on the first attempt of an item within 30 seconds the researcher recorded 2. If the participant was incorrect on the first attempt or exceeded the 30 second limit the researcher said "Try again. Point to the one that doesn't go with the others". If the participant responded correctly on a second attempt the researcher recorded

1. If the participant responded incorrectly or did not respond on the second attempt, the researcher recorded 0. The test was stopped if a participant received a score of 0 on two consecutive items.

For PEAK DT the researcher first ticked the items in the direct training module that were definite skills in the participant's repertoire. The researcher consulted with another tutor who was familiar with the participant while doing this. Any of the items in the module which the researcher and tutor were unsure of were directly tested in a 20-30 minute research session. The researcher followed the PEAK DT guidelines for each target that was tested.

The researcher completed the Survey Form of the Vineland Adaptive Behaviour Scales while each of the participants' key tutors in the preschool completed the Teacher Rating Form. The researcher consulted with the participant's parent if they were unsure of any of the answers. Both the researcher and key tutor of the participant followed the guidelines as outlined in the Vineland Adaptive Behaviour Scales manual. The forms included various statements e.g. 'Points to common objects in a book or magazine as they are named' and the response key included 2 = Usually, 1 = Sometimes or Partially and 0 = Never.

The researcher scored each of the assessments in accordance with the guidelines and scoring methods for each at the end of the pre-intervention assessment phase.

Baseline. When the pre-intervention assessments were complete for each participant the baseline measures began. The baseline was composed of two probes which were run by the participants' tutor twice per week.

Probe 1. The first probe was a matching probe (targeting ‘same’ relations) which was taken from the PEAK DT module. As the PEAK DT module outlines a number of ‘matching’ targets the researcher chose a target that was most relevant to the child’s IEP and skill set e.g. matching pictures, matching objects, matching size. The materials were presented on the desk in front of the participant and the verbal antecedent “Show me the same” was provided while giving the participant an object/picture to match to one of the stimuli on the table. Participants were required to place the matching object/picture on, above or below the target stimulus for a correct response to be recorded (correct responses were recorded using a ‘+’ symbol). An incorrect response was recorded if the participant placed the object/picture on, above or below a stimulus that did not match the sample (incorrect responses were recorded using a ‘-‘ symbol). Stimuli were evenly spaced on the desk to ensure placement of the sample was clear. Non responses were recorded as incorrect (‘-‘). These definitions for correct and incorrect responses were used when recording IOA. No positive reinforcement was provided contingent on correct responding nor were any corrections provided when an incorrect response was given.

Probe 2. The second probe was a target taken from the PEAK DT module named “Which one doesn’t belong?” (targeting ‘different’ relations). Three picture stimuli were placed on the table, two of which were identical and one that was different. Stimuli from the same category were used e.g. two identical pictures of oranges and one picture of grapes, two identical pictures of lions and one picture of a mouse. The verbal antecedent “Which one is different?” was provided and the participant was required to select the picture that was different from the other two. A correct response was recorded (‘+’) when the participant pointed to or touched the stimulus that was different to the other two. An incorrect response was recorded (‘-‘) if the participant pointed to or touched a stimulus that was the same as another in the array. Non responses were recorded as incorrect (‘-). These definitions of correct and incorrect responding were used when recording IOA data. No positive reinforcement was provided for correct responses and no correction was provided for an incorrect response or no response.

Participants completed 10 trials of each probe (20 trials in total) per session twice per week. All participants in the study were accustomed to thick schedules of reinforcement (e.g. FR2/FR3 schedule of reinforcement) during their usual work separate to the study. As there were no programmed consequences for these probes i.e. no positive reinforcement was provided for correct responses and no error correction procedure was in place for incorrect responses. It was important to be cognisant that participants may have become frustrated, bored or shown attentional difficulties should they have been required to respond to ten consecutive probe trials. If necessary, during the session some mastered trials were intermixed with the probe trials so that the participant could get some positive reinforcement from some source. These were interspersed after every three or four probe trials and took the form of mastered gross motor imitation (e.g. copying the researcher waving) or one step listener directions (e.g. ‘Stand up’) This was to ensure the participants continued to attend to the probes and remain on-task.

Intervention. A PEAK/T-IRAP intervention was used in this research which combined PEAK DT targets with a T-IRAP, specifically the targets “Matching” and “Which One Doesn’t Belong?” that are necessary for the relational frames of co-ordination and distinction.

Before beginning each PEAK/T-IRAP session the researcher paired with the participant for three to four minutes. This pairing involved the researcher engaging in some of the following with the participant- playing with some preferred toys, speaking to the participant, engaging in social games such as chasing, jumping on the trampoline with the participant or reading/writing with the participant.

Following the brief pairing session, the researcher explained that the participant would be doing some work on the computer and asked what the participant would like to work for. The researcher contrived an Establishing Operation (EO) by keeping some preferred items on deprivation. To contrive this EO, the researcher had a bag of toys, edibles and games which the participants did not have access to except for during the research sessions. The participant was encouraged to explore the items in the bag at the beginning of the session and s/he could engage with these items or choose an edible as part of a brief free operant preference assessment. The researcher then asked the participant to choose an item or edible based on this brief preference assessment. For example, if the participant spent some time exploring a Pop-Up Pirate game and also ate a chocolate button the researcher asked which one of these items s/he would like to work for. The participant used their communication method to mand for an item (PECS, vocal verbal or pointing). If the participant did not request any item or activity the researcher contrived an establishing operation for various items or activities until s/he manded for the item or activity, for example, demonstrating how the Pop-Up Pirate game works, demonstrating how to roll play-dough to make a snake and blowing big bubbles.

The researcher explained to the participant, in terms that were appropriate for each participants' level of understanding, that they would be doing an activity on the laptop and that they would see two pictures on the screen. The researcher explained that the participant would be required to press “D” or “K” to engage in the activity. Coloured stickers were placed on the “D” and “K” keys to make them salient. The researcher provided this general script before each session. Adaptations were made to cater for each participant’s level of understanding which included using fewer instructions (e.g. “same- press *here*, different – press *here*”) and phrases such as “First we’ll do some computer work and then we’ll get the trampoline”.

“So you would like to work for some jumping on the trampoline, great. We are going to do some matching on the computer now. You will see two pictures on the screen, some of them will be the same and some of them will be different. When you see two pictures that are the same you will press *here* (pointing to ‘D’ key) and when you see two pictures that are different you will press *here* (pointing to ‘K’ key). If you get it right, more pictures will come up. If you get it wrong, a red X will come up. But that’s okay, we can try again”.

Two stimuli were presented on the screen, one on top of the other (see *Figure 2.* and *Figure 3.* for a sample). In the left and right bottom corner of the screen the response options “Same” and “Different” respectively. The stimuli used in the T-IRAP were non-arbitrarily different and differences between stimuli were made salient.

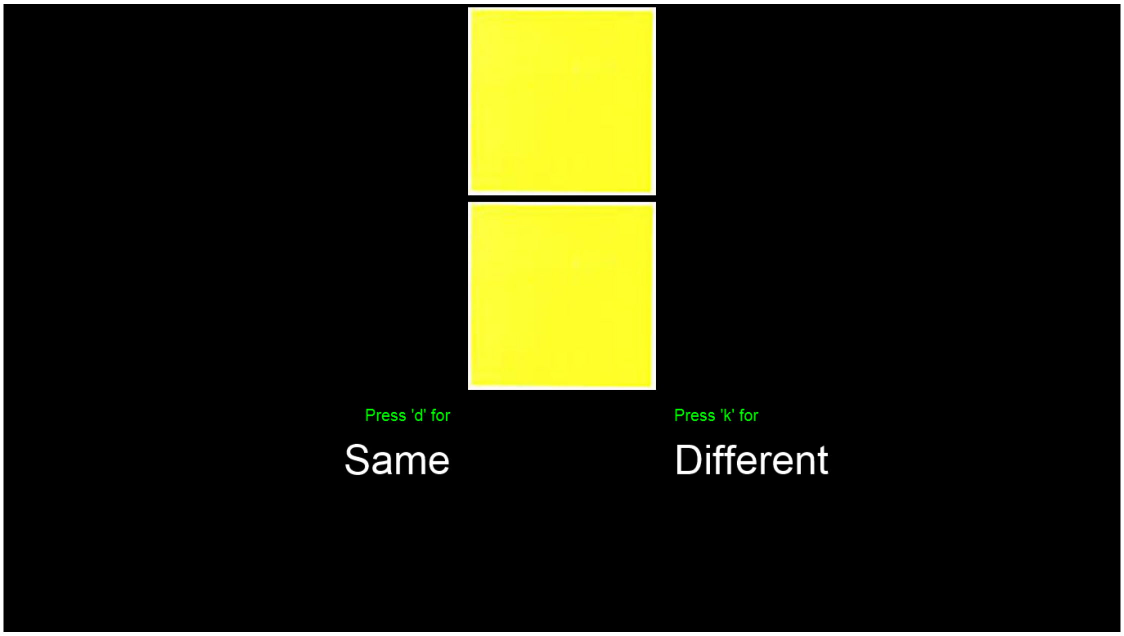


Figure 2. Sample of PEAK/T-IRAP of two similar stimuli

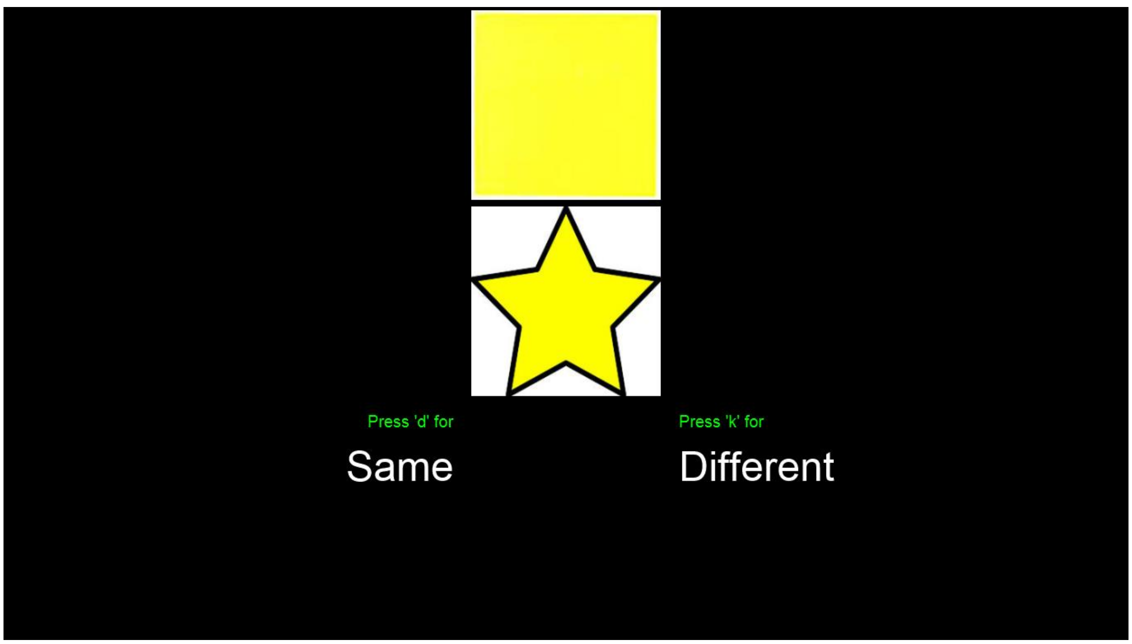


Figure 3. Sample of PEAK/T-IRAP of two different stimuli

When the two stimuli were presented on the screen the participant was required to press "D" if the stimuli were the same or "K" if the stimuli were different. If the participant answered correctly the next trial was presented. If the participant answered incorrectly, a red X appeared on the screen. The participant was required to select the correct option before the next trial appeared on the screen. If the participant did not select the correct response the researcher provided least to most prompting. There was a total of eight trials per block. Each session had a duration of 15-20 minutes. This allowed for approximately four blocks to be run per session including break times for the participants.

Most to least prompting was provided across sessions which included physical prompts, colour prompts and gestural prompts. Positive reinforcement (verbal praise) was provided contingent on correct responding throughout each trial block. The schedule of reinforcement was individualised for each participant. Some participants required thicker schedules of reinforcement than others. The participants schedule of reinforcement used in their normal teaching was used as a guideline. The item that the participant had manded for at the beginning of the session was delivered at the end of the trial block so as not to disrupt the trial block data collection. Throughout the session, the researcher noted if the participant was becoming frustrated or demonstrated any signs of distress. If this was noted the researcher offered the participant a break (this was done with consultation from the onsite BCBA to ensure that off-task or negative behaviours were not being reinforced).

Criterion for reducing the prompt was 90% accuracy in two sessions or 100% accuracy in one session. Criterion for changing a prompt or increasing a prompt was five variable data points (accuracy data). Criteria were adjusted slightly according to participant's own learning history.

Behavioural Observation of Students in Schools Data collection. Data were collected using the Behavioural Observation of Students in Schools (BOSS) during the participant's usual table-top work and in the T-IRAP sessions by the researcher or a trained observer. Table-top sessions included different targets that the participant was working as selected from their Individualised Education Plans, for example, matching-to-sample, tacting and listener responding. During BOSS data collection during table-top sessions the researcher attempted to schedule observations when the participant was engaging in a task which was similar to the T-IRAP task e.g. matching to sample, however, not all participants had matching-to-sample goals in their IEP and this was not always possible.

Observations were conducted for five minutes of the usual table-top teaching sessions and for the duration of the T-IRAP session. A five-minute observation for table-top session was selected based on the approximate duration of a T-IRAP session in order to match the observation times. The researcher also matched the number of observations between the T-IRAP and table-top sessions i.e. if the researcher collected BOSS data for three T-IRAP sessions then BOSS data were collected for three table-top sessions. The timer was paused, in both the T-IRAP and table-top sessions, when the participant received a break or a reinforcer (e.g. a toy or edible). The sessions were broken into 15 second intervals. Momentary time sampling was used to record Active Engaged Time (AET), Passive Engaged Time (PET) and Off Task behaviour (OT) at the beginning of each 15 second interval. These were defined as follows:

Active Engaged Time (AET) – Any time the student is actively attending to the assigned work

Passive Engaged Time (PET) – Any time the student is passively attending to assigned work

Off Task (OT) – Any time the student is not attending to the assigned work

Partial interval recording was used to record off-task behaviour including Off-Task Motor (OTM), Off-task Passive (OTP) and Off-task Verbal (OTV) which were defined as follows:

Off-Task Motor (OTM) - Any instance of motor activity not directly associated with assigned academic task

Off-Task Verbal (OTV) - Any audible verbalisations that are not permitted or related to assigned academic task

Off-Task Passive (OTP) - Any time a student is passively not attending to assigned academic activity for at least 3 consecutive seconds

Post-intervention. Once the intervention was complete the post-intervention phase began. This included generalization probes and post-intervention assessments.

Post-intervention assessments. Post-intervention assessments were the same as the pre-baseline assessments which included PEAK DT, RIAS, BSRA-3 and VABS. Post-intervention assessments were conducted in the same way as pre-baseline assessments.

Generalisation probes. Five generalisation probes were conducted following completion of the intervention. Stimuli for the probes included three objects, two of which were identical and a third which was not identical e.g. two identical red toy cars and a plastic fork. Participants were asked to identify the stimulus that was different. A plus was recorded if the participant touched or pointed to the correct stimulus. No reinforcement was provided for a correct response and no correction was provided for an incorrect response. Non responses were recorded as a minus.

Results

Assessment Results

Four pre- and post- intervention assessments were conducted which included PEAK DT module, Vineland Adaptive Behaviour Scales (VABS; Survey Form and Teacher Rating Form), Bracken School Readiness Assessment -Third Edition (BSRA-3) and Reynold's Intellectual Assessment Scales (RIAS; Odd Item Out subtest). As Daniel did not complete the intervention post-intervention assessments were not conducted with him.

The pre- and post- intervention scores of the Odd Item Out subtest are shown in Table 1. The scores from participants ranged from 0-30 in the pre-intervention assessment with a range of 0-38 in post intervention assessment. The maximum score on this scale is 102. Standardised mean raw scores from the Odd Item Out subtest indicate that children aged 3-8 have a score between 9-50. Emma and Sarah showed an increase in scores from pre- to post- intervention while Michael showed a decreased score and Josh's score remained the same.

Table 1

RIAS Odd Item Out Scores

	Pre-intervention	Post-intervention
Daniel	4	NA
Josh	0	0
Michael	6	0
Sarah	30	38
Emma	1	4

The scores of the PEAK DT module assessments are shown in Table 2. Scores ranged from 17-116 in pre-intervention assessment and scores of 26-118 in post-intervention assessment. A maximum possible score of 184 can be achieved on this test with this maximum score reflective of the skills of a typically developing eight-year-old. Josh, Sarah and Emma all showed increases in their PEAK DT scores from pre- to post-intervention assessments. Michael's PEAK DT score remained the same across assessments.

Table 2

PEAK DT Module Scores

	Pre-intervention	Post-intervention
Daniel	17	NA
Josh	23	26
Michael	30	30
Sarah	116	118
Emma	21	26

The scores of the BSRA-3 are depicted in Table 3. Participants scored between 4% and 75% in pre-intervention measures and scored between 5% and 84% in post-intervention assessment. Josh, Michael and Emma were all classified as 'very delayed' in the pre-intervention assessment while Sarah was classified as 'average'. Emma's score moved into the 'delayed' classification in the post-intervention assessment while the other participants' scores remained in the same classification but showed differences in mastery scores from pre- to post- intervention assessments. Sarah and Emma both showed increases in percent mastery scores while Michael's score decreased and Josh's score remained the same. Sarah's percent mastery score increased but her standard score and percentile rank decreased.

Table 3

Bracken School Readiness Assessment Scores

	Percent Mastery Pre/Post	Standard Score Pre/Post	Percentile Rank Pre/Post	Descriptive Classification Pre/Post
Daniel	4%/NA	52/NA	0.1/NA	Very delayed/NA
Josh	5%/5%	68/64	2/1	Very delayed/ Very delayed
Michael	15%/9%	59/42	0.3/<0.1	Very delayed/ Very delayed
Sarah	75%/81%	110/106	75/66	Average/Average
Emma	5%/15%	69/76	2/5	Very delayed/ Delayed

The Vineland Adaptive Behaviour Scales (VABS) are composed of a Survey Form and a Teacher Rating form which were completed by the researcher and the key tutor for each participant. Both these forms produce an overall Adaptive Behaviour Composite Standard Score with a corresponding percentile rank and adaptive level. Each of the VABS forms are comprised of four subdomains – communication, daily living skills, socialization and motor skills. For the purposes of brevity in this research the overall Adaptive Behaviour Composite Scores for the Survey Form and Teacher Rating Form are presented in Table 4. and Table 5. while the scores for the communication subdomain are presented in Table 6. and Table 7. as this is the subdomain most relevant to the research. Results of the other subdomains are available upon request from the researcher.

The Adaptive Behaviour Composite Scores for the Survey Form are shown in Table 4. Results from this assessment indicate that none of the participants showed changes in adaptive level in pre- and post- intervention assessments. Participants showed decreased standard scores in pre- and post- measures.

Table 4

Adaptive Behaviour Composite Scores for Survey Form (Vineland Adaptive Behaviour Scales)

	Standard Score Pre/Post	Percentile Rank Pre/Post	Adaptive Level Pre/Post
Daniel	46/NA	<0.1/NA	Low/NA
Josh	57/54	0.2/0.1	Low/Low
Michael	58/53	0.3/0.1	Low/Low
Sarah	94/89	34/23	Adequate/Ad
Emma	60/57	0.3/0.2	Low/Low

The Adaptive Behaviour Composite Scores from the Teacher Rating Form are shown in Table 5. Similarly, to the Survey Form results, participants did not show a change in adaptive level in pre- and post- intervention assessments and decreases in standard scores were observed.

Table 5

Adaptive Behaviour Composite Scores for Teacher Rating Form (Vineland Adaptive Behaviour Scales)

	Standard Score Pre/Post	Percentile Rank Pre/Post	Adaptive Level Pre/Post
Daniel	51/NA	<0.1/NA	Low/NA
Josh	58/55	0.3/0.1	Low/Low
Michael	49/52	<0.1/0.1	Low/Low
Sarah	94/92	34/30	Adequate/Ad
Emma	65/66	1/1	Low/Low

The scores for the communication subscale of the Survey Form are shown in Table 6. Participant's adaptive level did not change from pre- to post- intervention measures. Sarah's and Emma's standard scores remained the same across time while Josh and Michael both demonstrated decreased standard scores.

Table 6

Communication Subscale Scores for Survey Form (Vineland Adaptive Behaviour Scales)

	Standard Score Pre/Post	Percentile Rank Pre/Post	Adaptive Level Pre/Post
Daniel	42/NA	<0.1/NA	Low/NA
Josh	42/36	<0.1/<0.1	Low/ Low
Michael	65/45	1/<0.1	Low/ Low
Sarah	97/97	42/42	Ad/Ad
Emma	59/59	0.3/0.3	Low/ Low

The scores for the communication subscale for the Teacher Rating Form are shown in Table 7. All participants' scores remained in the same adaptive level from pre- to post-intervention assessments. Sarah's standard score increased between pre- and post- measures while Josh, Michael and Emma all showed decreased scores.

Table 7

Communication Subscale Scores for Teacher Rating Form (Vineland Adaptive Behaviour Scales)

	Standard Score Pre/Post	Percentile Rank Pre/Post	Adaptive Level Pre/Post
Daniel	49/NA	<0.1/NA	Low/NA
Josh	60/62	0.4/1	Low/ Low
Michael	58/51	0.3/<0.1	Low/ Low
Sarah	98/100	45/50	Ad/Ad
Emma	65/62	1/1	Low/ Low

PEAK/T-IRAP Training Results

Once pre-baseline with standardised assessments with five participants with autism spectrum disorder were complete, baseline probes were conducted with each participant to test for the ability to identify same/different as taken from the PEAK DT module, during which no programmed reinforcement was delivered. A multiple baseline design was used and an intervention was implemented to teach PEAK relational targets (‘Matching’ and ‘Which One Doesn’t Belong?’) via an adapted T-IRAP programme. PEAK/T-IRAP teaching was introduced in a staggered manner once stable baseline data were achieved for each participant (see Figure *5*). Across four participants the data for "Matching" or "Same" relations is recorded at high levels of accuracy whereas data for all four participants showed low levels of accurate responding for "Different" relations. It should be noted that for one participant, Daniel, baseline data for Same/Different relations remained very variable across a lengthy baseline period and Daniel's participation was then terminated because it was not possible to establish stable baseline responding (see *Figure 4*). Another point of note is that a delayed baseline phase was conducted with Sarah because she was previously unavailable for participation in the research project. During the initial baseline probe for "Different" relational responding, Sarah responded by selecting the two identical stimuli saying they were different from the remaining stimulus, thus she partly had the concept of "Different" but stimulus control was faulty (i.e., given a number of Same stimuli and one Different stimulus, it is more appropriate to select the one different stimulus when asked to different). It was decided that Sarah should commence the intervention phase after one baseline probe.

The probes for baseline Same/Different relations are shown using percentage correct of 10 trials as accuracy data. The thicker dashed line that is staggered through the tiers of the MBD graph indicates the gradual introduction of the PEAK/T-IRAP to teach Same/Different relational responding with four participants. Accuracy scores for the PEAK/T-IRAP training are reported as the percentage correct of trials per session. Four blocks containing eight trials each were run with each participant for a total of 32 trials per session. Accuracy data were calculated from the Microsoft Excel output document with the researcher manually counting the number of correct responses and dividing this by the total number of responses (32) to get a percentage correct score. Duration of each PEAK/T-IRAP session was calculated in seconds based on the participant’s time to respond to each trial, and duration data were used to indicate speed-of-responding for each participant. Duration data were calculated from the Microsoft Excel output document from which the researcher used the Excel 'Auto Sum' feature to add the individual response times to each trial which produced the overall duration of the session. *Figure 5.* shows both a primary and secondary y axis. Accuracy data are plotted on the primary y axis (left side of graph) while duration in seconds is scaled on the secondary y-axis (right side). It should be noted that no duration data were collected during table-top teaching in the baseline phase as the primary aim in the current research was to demonstrate that PEAK relational responding targets could be integrated with the computerised interactive T-IRAP teaching tool for application with children with ASD.

Baseline data for Same relations (Matching) are represented with circles on a solid line, and data for Different relations (Which One Doesn't Belong?) are shown with squares on a dashed line. PEAK/ T-IRAP training data are shown with accuracy depicted with diamond-shaped data points on a solid line and duration data are represented with triangles on a dashed line. Prompt levels (PL) are shown above each phase change which are scored according to PEAK recommendations with higher numbers indicating less intrusive prompts (PL #0= no response after multiple attempts at prompts; PL #2= multiple prompts or reduced stimulus array eventually produced a response; PL #4= 2 prompts at most produced the response with full stimulus array; PL #8= 1 single prompt of either verbal or visual nature; PL #10= independent accuracy on response with no prompt). Prompts used were individualised for each participant and these involved usual ABA tactics such as full physical prompt, gestural prompt, fleeting gestural prompt and similar. PEAK/T-IRAP accuracy data for the T-IRAP are plotted using a solid black line and diamond shaped data points, while duration data for the PEAK/T-IRAP responding are plotted using a dashed line and triangular data points.

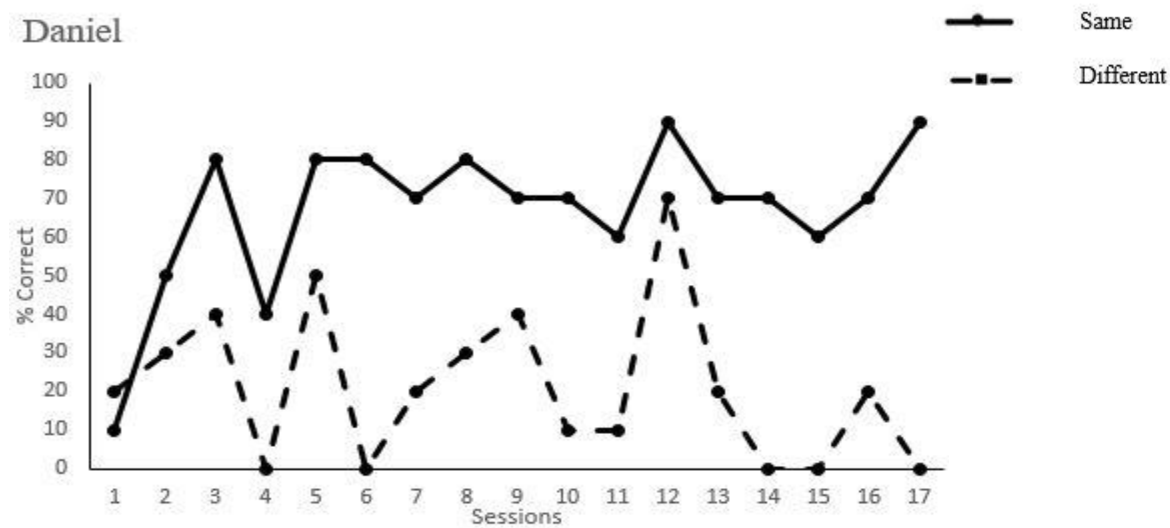
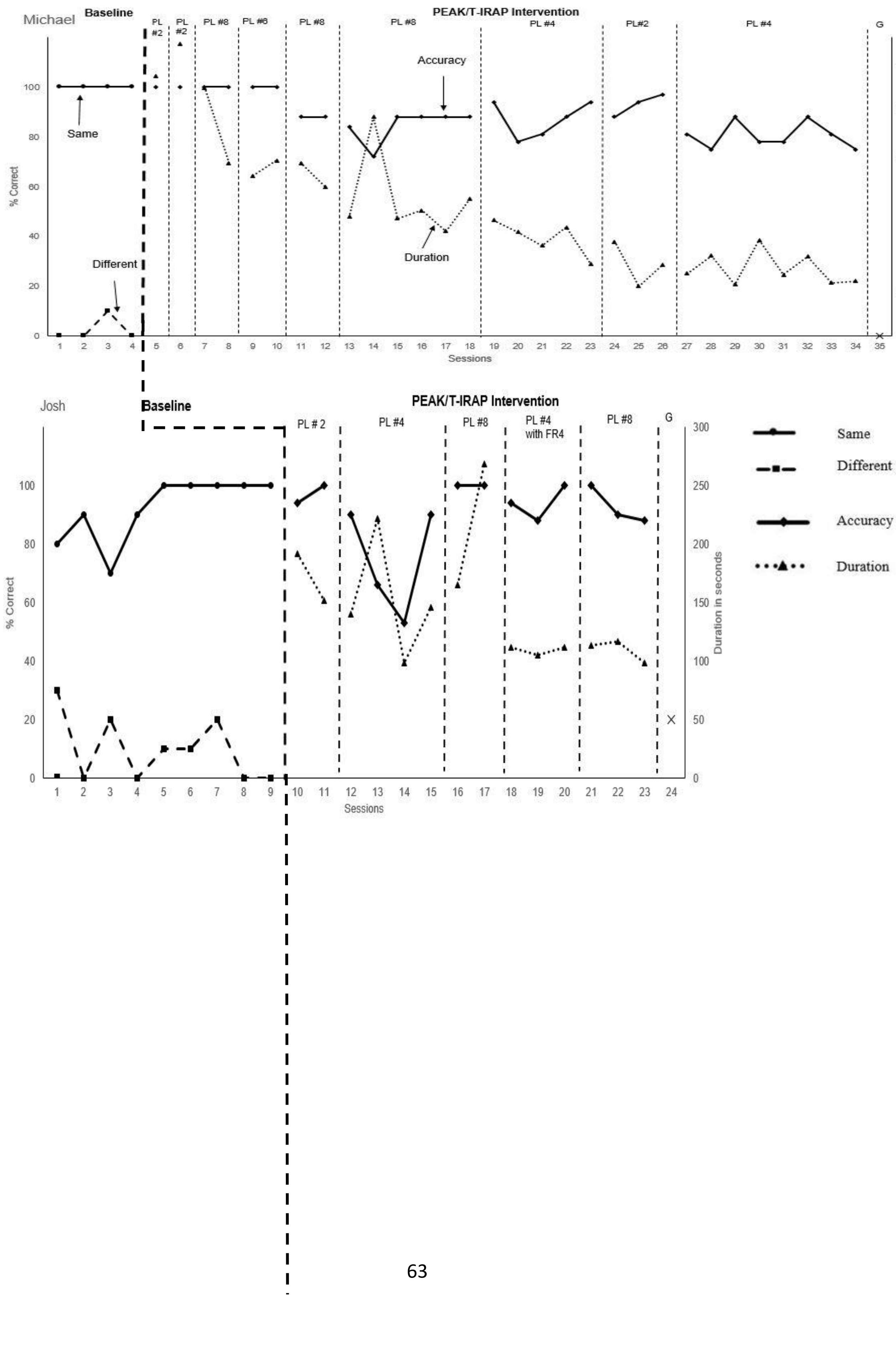


Figure 4. Baseline data for Daniel for Same (unbroken line) and Different (broken line) relational responding.


Michael
Baseline
PEAK/T-IRAP Intervention
PL #2
PL #2
PL #8
PL #6
PL #8
PL #8
PL #4
PL#2
PL #4
G
Accuracy
Same
Different
Duration
% Correct
Duration in seconds
Sessions
Josh
Baseline
PEAK/T-IRAP Intervention
PL # 2
PL #4
PL #8
PL #4 with FR4
PL #8
G
% Correct
Duration in seconds
Sessions
Same
Different
Accuracy
Duration

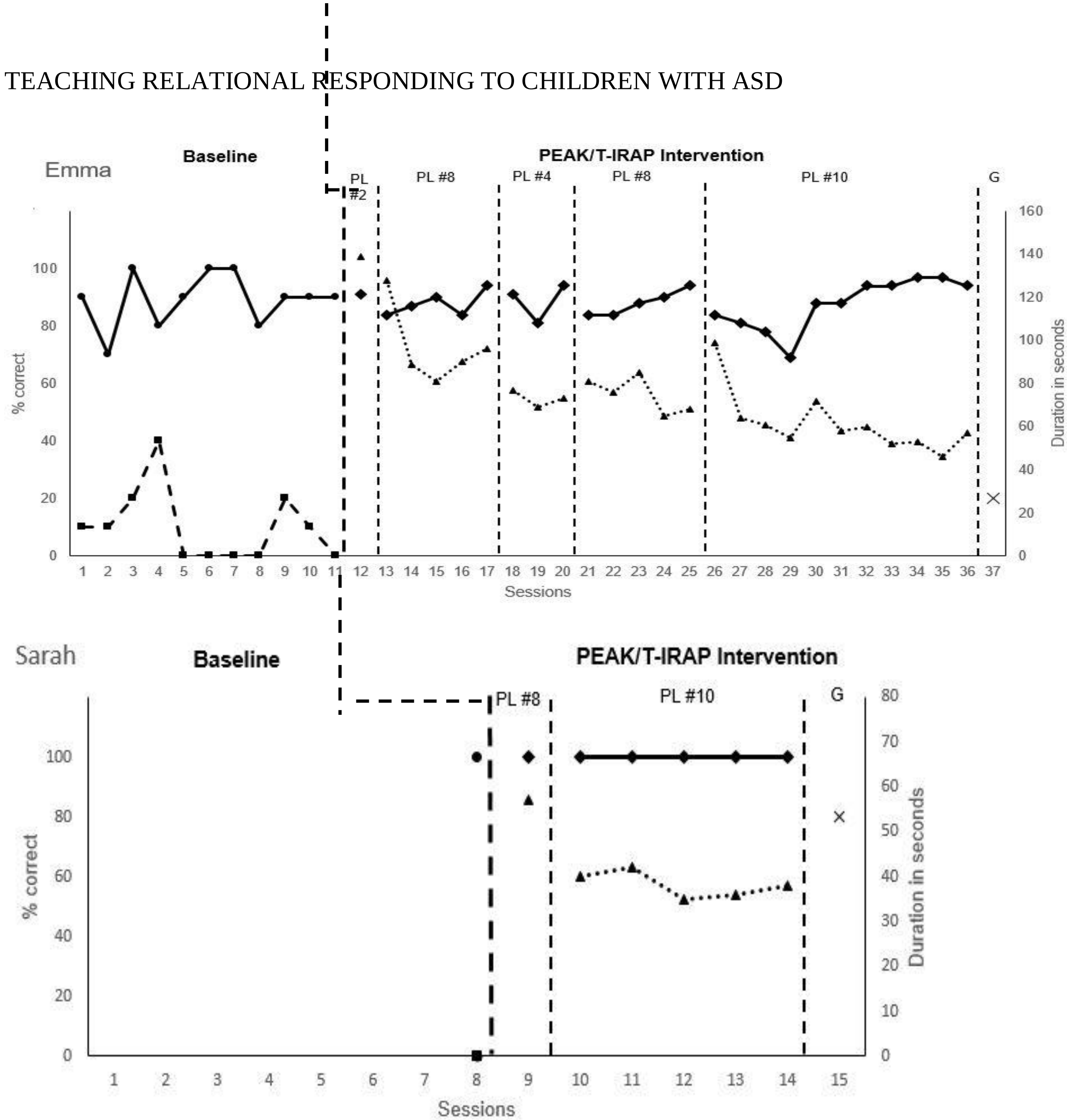


Figure 5. Multiple baseline design for four participants showing the use of the PEAK/T-IRAP intervention.

Behavioural Observation of Students in Schools Results

The data from the BOSS showed that participants engaged in more on-task behaviour and less off-task behaviour when interacting with the T-IRAP in comparison to their usual table-top work. Data from each of the participants are shown in the bar charts in *Figure 6, Figure 7, Figure 8 and Figure 9.* Momentary time sampling was used to collect data on active engaged time (AET), passive engaged time (PET) and off-task (OT) behaviours while partial interval recording was used to measure off-task motor (OTM), off-task verbal (OTV) and off-task passive (OTP) behaviours. Data were collected for 14% of PEAK/T-IRAP sessions (10 sessions) and for five minute intervals of participants' usual table-top work (12 sessions).

All participants showed more on-task behaviour during the T-IRAP sessions in comparison to their usual table-top work. Both Sarah and Emma demonstrated active engaged behaviours only during T-IRAP sessions with no off-task behaviours recorded. During their usual table-top work both of these participants demonstrated on-task and off-task behaviours. Sarah and Emma showed less active engaged behaviours during table-top work in comparison to the T-IRAP sessions. Michael and Josh demonstrated more off-task passive behaviours during their table-top work in comparison with the T-IRAP.

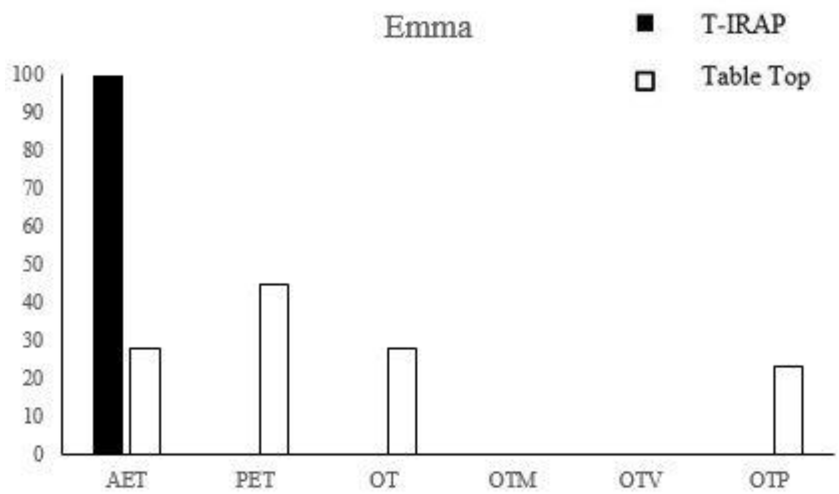


Figure 6. Behavioural Observation of Students in Schools (BOSS) data for Emma

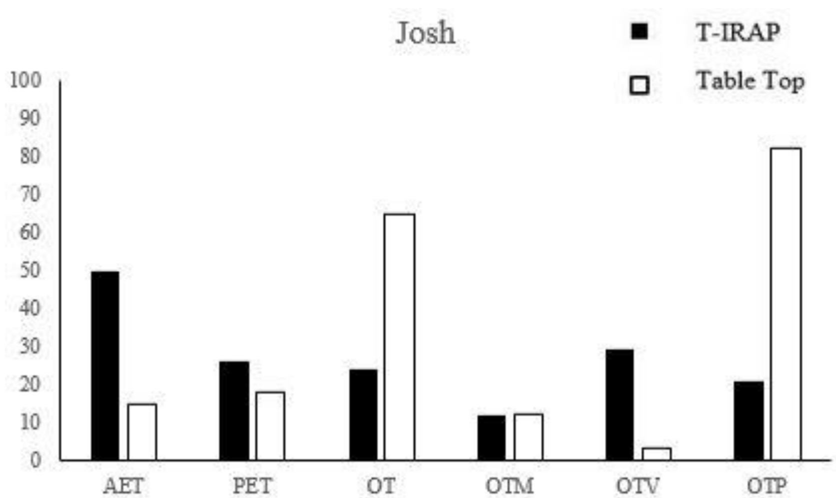


Figure 7. Behavioural Observation of Students in Schools (BOSS) data for Josh

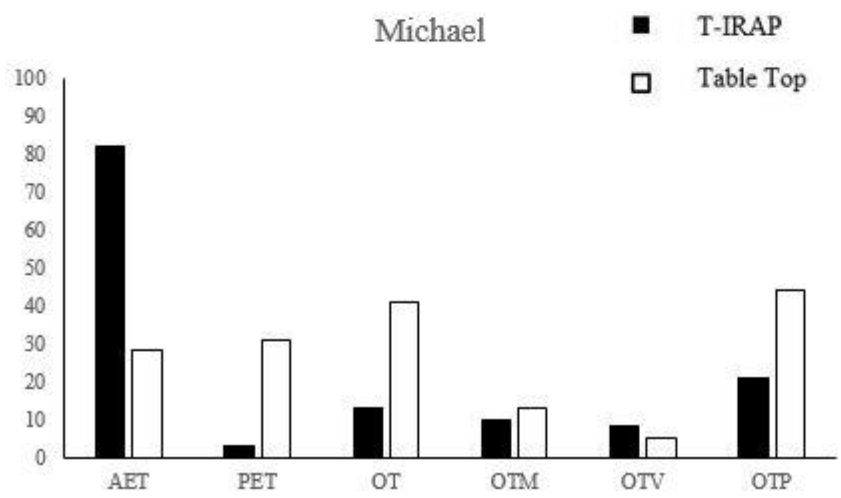


Figure 8. Behavioural Observation of Students in Schools (BOSS) data for Michael

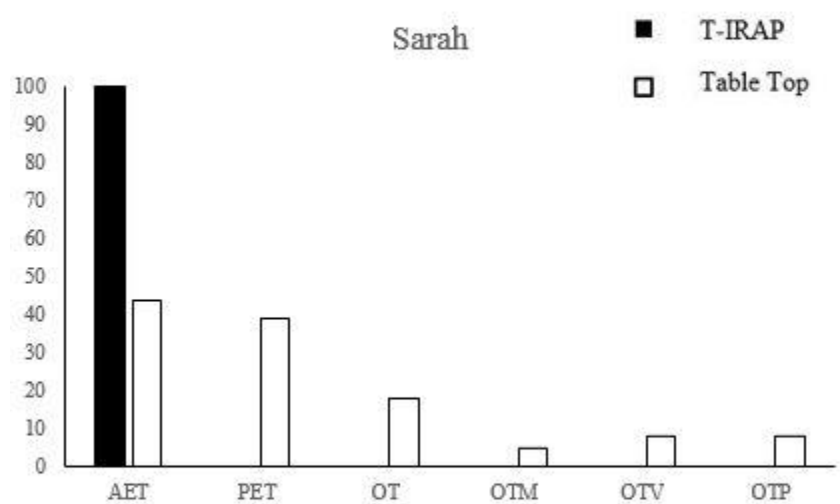


Figure 9. Behavioural Observation of Students in Schools (BOSS) data for Sarah

In summary, baseline results indicated that none of the participants could identify 'different' but all participants could identify 'same'. On implementation of PEAK/T-IRAP in a multiple baseline design it was found that two of the four participants could engage with the PEAK/T-IRAP independently while the remaining two participants could do so with prompts. One participant only could generalise the skill to novel 3D stimuli when tested in a generalisation probe at the end of the study. BOSS results indicated that all participants engaged in more on-task behaviour and less off-task behaviour when engaged with the T-IRAP in comparison to their usual table-top work. Pre- and post- measures of general and cognitive ability showed some fluctuation across participants. It was noted that Sarah and Emma showed the most increases in pre- to post- measures.

Discussion

The results above outline pre- and post-intervention assessments. Both Sarah and Emma showed increased scores in pre- and post- measures in the RIAS and BSRA-3. Sarah, Josh and Emma all demonstrated increased scores in PEAK DT module. Michael demonstrated a decrease in scores in the BSRA-3 and RIAS. This decrease in scores could possibly be attributed to attentional difficulties with Michael which emerged towards the end of the data collection period rather than as a result of the intervention. Participants also showed a decrease in scores in the Adaptive Behaviour Composite Score of the VABS. This is a standardised score based on the skills of a typically developing child of the same chronological age. As all participants in this study were diagnosed with autism they may not make the same gains as a typically developing child would in the same time frame. This would also account for the decrease in percentile ranking of Sarah's BSRA-3 score considering that her mastery score increased in the pre- and post- intervention assessments.

The results of this study show that two of the participants were capable of using the PEAK/T-IRAP independently. The remaining two participants could use the PEAK/T-IRAP with some prompts. Michael was the first participant to receive the intervention in the multiple baseline design. Despite a variety of different prompts used he was unable to use the PEAK/T-IRAP independently. Similarly, Josh displayed some behavioural issues during the study which were independent of the research and were emitted across the day in the preschool setting. These behaviours resulted in the termination of data collection prematurely. Both Sarah and Emma were competent in manipulating the PEAK/T-IRAP independently at the end of the study.

Emma and Sarah were the only two participants able to independently use the T-IRAP and were also the only two participants to show gains in PEAK DT module, BSRA-3 and RIAS. It is it not possible to ascertain if this was as a direct impact of the intervention as participants were receiving early intervention as usual during this study which may have also impacted these scores. However, it is worth noting that all four participants received treatment as usual during the study but only those that competently used the PEAK/T-IRAP showed gains in pre- and post-intervention assessments of general and cognitive ability.

Baseline data from Study 1 revealed that all participants could readily match stimuli that were the same but they could not identify a stimulus that was different from the others. This is a very interesting finding as it suggests that these participants could not derive “different” despite extensive training in finding “same” as part of their Individualised Education Plans. These IEPs are largely based on the VB-MAPP which includes several “matching” targets ranging from matching identical pictures to matching art activities. Even with a heavy weight placed on ‘matching’ stimuli within a child’s academic work these participants were unable to identify ‘different’. Identifying stimuli that are the same or different is thought to be a very important aspect of cognition and intelligence (Ming & Stewart, 2017) and has also been shown to have a positive impact on student’s learning (Marzano, Pickering & Pollock, 2001) which causes additional concern for a lack of instruction on how to teach same/different.

The PEAK curriculum does outline some targets which involve both same and different, for example, Which One Doesn’t Belong and Match Pictures. Study 1 successfully incorporated such targets into a T-IRAP and presented this to low- and high-functioning preschool children with ASD. Results of the pre- and post- intervention assessments indicated that some participants showed gains in the RIAS, BSRA-3 and PEAK-DT scores. Some participants showed a decrease in scores in pre- and post-measures. The participants that produced the most gains were Sarah and Emma who were the two participants capable of engaging with the T-IRAP independently. This result reflects previous research which suggests that more fluent responding to relational responding targets produces gains in IQ (Cassidy et al., 2011) and is also reflective of previous research which found some individual gains in IQ assessments following relational training (Lyons & Murphy, under submission). It is important to note that the participants in the current research were all receiving early intervention behavioural services in accordance with their autism diagnosis and gains made in the pre- and post-intervention assessments may have been impacted by their intensive education. The research by Cassidy and colleagues suggested IQ gains were made following training in various relational frames which also correlated with the fluency of relational abilities. Their research did also suggest that participants that received only stimulus equivalence training did not produce IQ gains, however, the results of Study 1 could tentatively suggest that teaching the relational frames of co-ordination/distinction to a fluency level could potentially produce gains in cognitive and general ability assessments. This possibility should be explored in further detail particularly with other young, preschool participants and with a larger sample. As it is thought that more complex relational responding develops with a child's age it could mean that teaching more basic relational frames to younger participants could produce increases in tests of cognitive ability if these frames are absent from the child's repertoire and could present a challenge for them.

The results from all participants in this study suggest that the PEAK/T-IRAP produces more on-task behaviour and less off-task behaviour as shown by the BOSS data in comparison to the participants' usual table-top work. Emma and Sarah displayed active engaged behaviour only during PEAK/T-IRAP sessions while the BOSS data from their table-top work indicated that they engaged in significantly less active engaged behaviour. Furthermore, both Michael and Josh engaged in significantly more off-task behaviours during their table-top work in comparison to the PEAK/T-IRAP sessions. Given the attentional difficulties associated with autism spectrum disorders it is significant that the PEAK/ T-IRAP results in more on-task behaviours in comparison to traditional table-top teaching methods. The presentation of trials on a laptop computer may have been more appealing for participants as it is different to their usual work. Due to the nature of the PEAK/T-IRAP, trials were presented at a rapid pace which also could have impacted on on-task behaviours versus table-top work which requires a tutor to gather and re-arrange materials allowing time for off-task behaviours to occur. Additionally, the PEAK/T-IRAP requires that the participant actively engages with the task by pressing the 'D' and 'K' keys while table-top work may not require the same level of active responding. This difference may have produced higher levels of active engaged behaviour during the T-IRAP sessions.

This study included a generalisation phase to determine if participants could generalise the skills learned to novel stimuli presented using table-top methods. One participant only, Sarah, was successful in generalising the skills from the PEAK/T-IRAP to this table-top condition. A possible explanation for this is that the generalisation probe was simply too different from what the intervention had been in that the participant was trained on the PEAK/T-IRAP but the generalisation probe required table-top responding. Also, a single exemplar was used in the PEAK/T-IRAP training sessions which may not have promoted the generalisation necessary to respond to novel stimuli in a different format. It is interesting to note that Sarah was the only participant to be able to generalise the skill and she was also the participant that produced the most fluent responding on the T-IRAP. This finding links in with fluency research that suggests that more fluent responding produces greater generalisation of skills and that knowledge can be more easily transferred to a more natural setting (Binder, 1996). As a follow-up to the generalisation result, the second study will use multiple exemplars during the intervention to seek to address the issue of generalisation.

Given the profiles of the participants in this research, it was not possible to administer a full-scale IQ test. Some of the participants had been diagnosed with moderate-severe autism and also had possible diagnoses of Global Developmental Delay and intellectual disabilities. For the purposes of comparison within Study 1, uniform tests of cognitive and general ability were required to accommodate the variety of children participating in this research. As it was thought there may be an issue with floor effects in assessments that had been used in similar research (Cassidy et al.; 2011; Lyons & Murphy, under submission) such as Peabody Picture Vocabulary Test (PPVT), Kaufman Brief Intelligence Test (K-BIT) and the Weschler Intelligence Scale for Children, different pre- and post- assessments were chosen for Study 1 to allow for the most appropriate tests to be administered with the current participants. One limitation of this is that the current research cannot be directly compared with previous research in the area but as this study is one of the first to teach same/different relations to participants of this profile using the T-IRAP it was necessary to make adjustments to the assessments and, additionally, provides some guidance for future research.

Study 1 was similar to research carried out by Kilroe and colleagues (2014) and Lyons and Murphy (under submission) although with older participants aged between seven and twelve years old. Findings from these studies suggested that the T-IRAP could be used to present various relational frames to these participants including non-arbitrary and arbitrary stimuli. Study 1 used non-arbitrary stimuli only and, as outlined, some of the participants found this difficult. For this reason, arbitrary stimuli were not introduced and this suggests that abilities to respond to more complex relations develops with age given that the current participants were much younger than those in the previous research. As EIBI has been proven to be an effective treatment for children with autism (Larsson, 2013) it is important to investigate the relational responding capabilities of young children to ascertain any deficits in relational responding and how these can be overcome. With enough research in this area, a protocol could be designed to assess and teach relational responding skills within EIBI particularly as there is no behaviour analytic curriculum for teaching even basic relational frames such as co-ordination (Ming & Stewart, 2017).

Chapter 3

Introduction

Four children took part in Study 1 which aimed to teach same/different relational responding using a PEAK/T-IRAP. The effects of this PEAK/T-IRAP training intervention on cognitive and general ability tests were also examined at an individual level. Findings of Study 1 indicated that two of the four participants could engage with the PEAK/T-IRAP independently. Results also showed that only one participant could successfully generalise the skills learned from the PEAK/T-IRAP. Findings showed that participants who were capable of using the PEAK/T-IRAP independently showed some increases in the tests of cognitive and general ability. Additionally, the results of Study 1 showed that all participants demonstrated more on-task behaviour and less off-task behaviour during the PEAK/T-IRAP sessions in comparison to their usual Table-Top work.

Study 2 sought to address two issues noted in Study 1 which included a) a lack of independent responding to the PEAK/T-IRAP with two of the participants and b) poor generalisation of skills noted in the generalisation phase. Study 2 attempted to overcome these issues by including a self-management intervention to promote independent responding when using the PEAK/T-IRAP and introducing multiple exemplars to the PEAK/T-IRAP to examine any effects on generalisation skills. Furthermore, data were collected using the BOSS on on-task and off-task behaviour to examine if the results of Study 1 were replicable.

Self-management interventions are used across a wide range of behaviours including play skills, academic behaviour, task engagement and increasing independence (Callahan & Rademacher, 1999; Hume & Odom, 2007; Wilkonson, 2008). These types of interventions usually involve a number of aspects such as monitoring and assessing one's own behaviours, recording these behaviours and self-reinforcing if the behaviours have reached their target (Lee, Simpson & Shrogen, 2007). Self-management interventions often aim to increase the independence of the student. These interventions have shown to be particularly useful for students with ASD who may become prompt dependent on various tasks (Hume, Plavnick & Odom, 2012). The current study uses a basic self-management intervention adapted for the use of preschool children with autism using a T-IRAP in which the participants graph their own score on a line graph with guidance from the researcher. This intervention is also based loosely on Precision Teaching (PT) literature. In PT students are required to set aims (e.g. number of correct responses and number of errors to be reached by a certain date) and record these on a standard celeration chart. Following each training session, the student can then graph their scores from the session on the chart and track their progress across sessions. For this research, a line graph intervention was used in which participants were required to graph their daily aim for their PEAK/T-IRAP score (accuracy and duration) and then graph their score following the session. A basic line graph rather than a standard celeration chart, as is traditionally associated with PT, was used in this study owing to the profiles of the participants in this study who may have been overwhelmed by a standard celeration chart.

A delayed multiple baseline design across three participants was used in this study to examine the effects of a self-management intervention on speed and accuracy of responding when using a multiple exemplar PEAK/T-IRAP. As two of the four participants in Study 1 were unable to respond to the PEAK/T-IRAP independently it was hypothesised that a self-management intervention would promote independent responding for the participants in Study 2 as this type of intervention was visual in nature and would allow participants to visually track their aims and scores. This type of intervention encouraged the participants to compete with themselves in terms of achieving more accurate and faster responding across sessions. To assess the impact of the self-management intervention, the results examined the accuracy and speed of participants' responding as well as the prompt levels provided before and after implementation of the self-management intervention.

The self-management intervention was introduced at staggered intervals which involved the participants marking their own PEAK/T-IRAP aims and results on a line graph. Following completion of the intervention the research tested for generalisation of the skill using two generalisation probes.

Method

Participants

Participants (*n* =3) were recruited from an early intervention ABA-based preschool in which the author is an instructor. Participants were selected based on their ability to sit at a desk and attend to materials presented to them. Additionally, all participants were required to have the ability to hold a marker (pincer grip was not necessary) as this was required in the intervention stages. All participants were male with a formal diagnosis of autism by an independent clinical psychologist in accordance with criteria in the *Diagnostic and Statistical Manual Fifth Edition* (DSM-V; American Psychiatric Association, 2013). All participants had moderate to severe autism diagnoses. Participants were aged between four and five years of age at the beginning of the study.

Matt is a five-year-old boy who has been attending the preschool full-time for two years. He uses vocal verbal speech to communicate and he can form full sentences. His most recent VB-MAPP assessment produced a score of 127 on the milestones assessment. Matt emits some tantrum behaviour which predominantly has an escape function. Oscar is a four-year-old boy who has been receiving early intervention at the current ABA preschool for 7 months. He uses vocal verbal speech to communicate but he often produces unintelligible speech and poor approximations. He has a score of 98.5 on the VB-MAPP milestones assessment. Oscar emits a variety of challenging behaviours including tantrums, property destruction and verbal protesting and these problem behaviours (PBs) are thought to have escape and access to tangible functions. Adam is a four-year-old boy who has been attending the preschool for six months. He can communicate using vocal verbal however, much of his speech is non-functional and includes echolalia. His VB-MAPP milestones assessment score is 45.5.

Settings/Materials

Research sessions were conducted in the same way as in Study 1. Materials included a T-IRAP (see Study 1 for a more detailed description) and two hard copies of a line graph (one each for speed and accuracy) were used for the self-management intervention.

Experimental Design

A delayed multiple baseline design across three participants was used, and a self-management intervention was introduced at staggered intervals. Accuracy and speed of responding on the T-IRAP were recorded during both baseline and intervention stages.

Ethical Considerations

Ethical considerations for Study 2 were similar to that of Study 1. Please see Study 1 ethical considerations for further details. As pre- and post- intervention assessments were not used in Study 2 these were not included in the information sheet or consent form (See Appendices 4 and 5 for these forms)

Interobserver Agreement

Interobserver Agreement (IOA) data was collected for the Behavioural Observation of Students in Schools (BOSS) for 28% of all BOSS sessions. Each item of each 15 second interval in the BOSS was counted as one trial for trial-by-trial IOA to be calculated. Trial-by-trial IOA was calculated by dividing the number or trials with agreement by the total number of trials and multiplying by 100 to obtain a percentage. Agreement was 96%. As the T-IRAP is a computerised tool all data were collected electronically and therefore IOA data were not collected.

Procedure

Baseline. Due to constraints on the participants' availability it was not possible to conduct a concurrent MBD, thus a delayed multiple baseline design was commenced with Matt. As participants became available, staggered baseline data were collected with Oscar and Adam. The researcher explained to the participant how to use the T-IRAP in language that was at the participant's level of comprehension. The participant was shown the laptop computer and shown the keys "D" and "K" which had coloured stickers on them to make them salient. The researcher explained in terms the participant could understand, and by showing two images presented on the screen, that the participant would be required to press the "D" key if the images were the same (identical) and the "K" key if the images were different.

The PEAK/T-IRAP presented four blocks of trials with each block containing eight trials. The participant was provided with a brief break between each block. Based on their current learning repertoires, participants were provided with most-to-least prompting throughout the sessions including full physical prompts and gestural prompts. Prompts were faded as rapidly as possible. If the participant answered a trial correctly (e.g., pressed the appropriate key on the keyboard) the next trial was presented on the T-IRAP (initially the researcher also delivered positive reinforcement on variable ratio schedule). If the participant answered incorrectly a red "X" was presented on the screen and the participant had to select the correct answer before moving to the next trial (initially the researcher provided corrective feedback). As is customary in ABA training procedures, reinforcement was tailored to each individual participant and frequent short breaks were provided.

Intervention. A self-management intervention was introduced in staggered intervals across the three participants. As part of the self-management intervention participants were required to graph their own aims (e.g. an accuracy score of 80% and a speed score of 180 milliseconds) and the speed and accuracy data on each session of the T-IRAP. Participants received help and instruction at a level appropriate to their learning needs from the researcher. The researcher presented the participant with two separate line graph charts, one for speed (duration of trials blocks per session) and one for accuracy (percentage of correct responses per trial-block). Participants were shown their baseline data on the graphs, and new targets for speed and accuracy were set taking account of their baseline responding. Participants were encouraged by the researcher to mark the level of the new targets (raised in the case of the accuracy chart; lowered in the case of the speed chart) and the researcher said "Let's try for this target here, and then you can have (preferred item)" and the researcher specified the reinforcement that would be delivered contingent upon the participant achieving each target. A picture of the reinforcer was attached to each chart.

Participants were guided through the PEAK/T-IRAP with the necessary prompts. Similar to baseline, positive reinforcement (verbal praise) was provided on a variable schedule (VR3). At the end of the session the researcher calculated the participant's accuracy and duration scores. The researcher then encouraged the participant to graph their score on the accuracy and speed charts (e.g. 88% accuracy and duration of 155 seconds).

Participants held the marker and were shown where to place a mark on the chart. Differential reinforcement was provided contingent on meeting the criteria, with greater reinforcement provided if the participant met both speed and accuracy criterion and lesser reinforcement for meeting one criterion. If the participant did not reach either criterion a lesser preferred item was provided as reinforcement.

Criterion for reducing the prompt was 90% accuracy in two sessions or 100% accuracy in one session. Criterion for changing a prompt or increasing a prompt was five variable data points (accuracy data). Criteria were adjusted slightly according to participant's own learning history.

Behavioural Observation of Students in Schools data collection. Data collection for the Behavioural Observations of Students in Schools (BOSS) was collected in the same way as Study 1 using momentary time sampling to record Active Engaged Time (AET), Passive Engaged Time (PET) and Off-task behaviours (OT) every 15 seconds. Partial interval recording was used to measure Off-task Passive (OTP), Off-task Verbal (OTV) and Off-task Motor (OTM) in 15 second intervals. See Study 1 Method section for greater detail.

Results

A delayed multiple baseline design was used in the current study to examine the effects of a self-management intervention on participant's speed and accuracy of responding on the PEAK/T-IRAP which used multiple exemplars. A baseline of prompts was taken and once stable responding was achieved for accuracy data a self-management intervention was put in place. The results of the delayed multiple baseline are shown in *Figure 10.* Accuracy data are shown for each participant with a solid (undashed) line with diamond data points. Duration data are depicted on the graph with a broken (dashed) line with triangle data points. Accuracy and duration data for the PEAK/T-IRAP were calculated using the same methods as outlined in Study 1. Additionally, two generalisation probes were conducted one of which includes a PEAK/T-IRAP (G1) and a table-top based probe (G2). Generalisation data for the PEAK/T-IRAP is graphed using the same accuracy and duration data points as during the training while the table-top generalisation data is graphed with an X data point. The introduction of the self-management intervention is shown by the use of a thick dashed line.

Prompt levels (PL) used in baseline and the intervention phase were individualised as is customary in ABA and changes in prompt levels are shown with a thin dashed phase change line. Prompt levels are scored according to PEAK recommendations with higher numbers indicating less intrusive prompts (PL #0= no response after multiple attempts at prompts; PL #2= multiple prompts or reduced stimulus array eventually produced a response; PL #4= 2 prompts at most produced the response with full stimulus array; PL #8= 1 single prompt of either verbal or visual nature; PL #10= independent accuracy on response with no prompt). Prompts used were individualised for each participant and these involved usual ABA tactics such as full physical prompt, gestural prompt, fading, colour prompt and similar. It should be noted that prompts were faded in each phase change but that these may not be entirely reflective on the graph owing to the PEAK recommendations of prompt categories, for example, PL #8 may include a gestural prompt and the next phase may also be labelled as PL #8 but the prompt provided is a fleeting gestural prompt. For the purposes of clarity within the delayed multiple baseline graph PEAK prompt levels have been used but more detailed information on prompts is available from the researcher. A break in the data collection period is depicted in Matt's graph using two black lines on the x-axis. This is owing to school holidays and following this, data collection resumed as normal.

The results of the multiple baseline design suggest that the self-management intervention was successful for Matt as he reached independent responding immediately after its implementation, accuracy scores remained high and the duration scores decreased. Both Oscar and Adam required a number of prompt phases before they began to reach independent responding. Oscar's data is shown to be quite variable, particularly the duration scores. Adam's accuracy data remained high following the implementation of the intervention while duration data was quite variable.

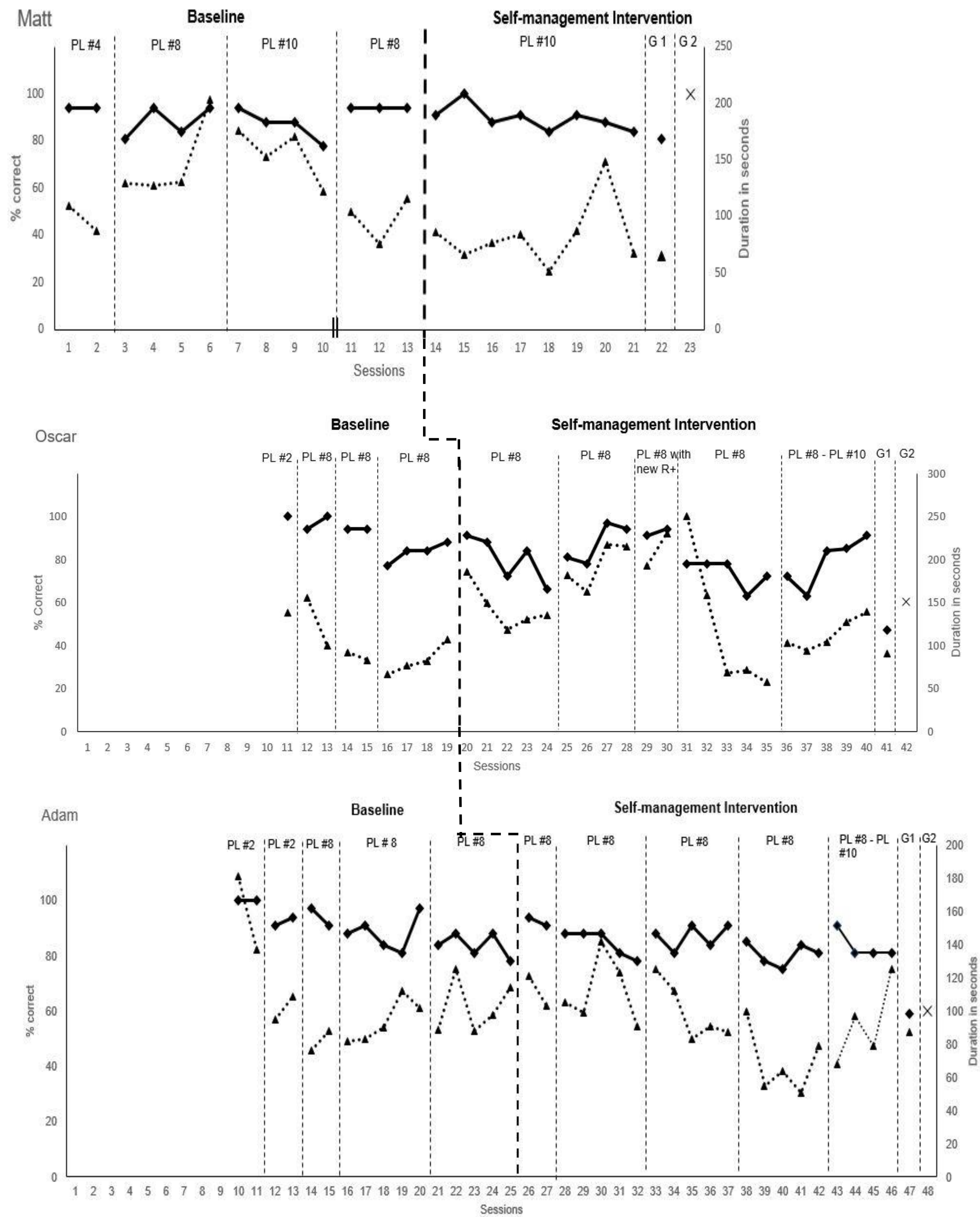


Figure 10. Delayed multiple baseline design with a self-management intervention.

Behavioural Observation of Students in Schools Results

BOSS (Behavioural Observation of Students in Schools) data were also collected in this study to examine if the participants' engagement with the T-IRAP in comparison to their usual table-top work. Data for the BOSS were collected in the same manner as Study 1 which used momentary time sampling to record Active Engaged Time (AET), Passive Engaged Time (PET) and Off-Task (OT) and partial interval recording to record Off-task Motor behaviours (OTM), Off-task Verbal behaviours (OTV) and Off-task Passive behaviours (OTP). Data were collected during the participants' use of the T-IRAP for 20% of T-IRAP sessions (18 sessions in total) and for five minute sessions of their usual table-top work (for 14 sessions in total). Results are shown below for each participant in *Figure 11*, *Figure 12* and *Figure 13.*

The results from the BOSS indicate that all participants demonstrated more on-task behaviour and less off-task behaviour during the PEAK/T-IRAP sessions in comparison to their usual table-top work. All participants showed more active engaged behaviours when interacting with the T-IRAP when compared with their table-top work. Matt, in particular, demonstrated very few intervals (4%) engaging in off-task behaviours and he was actively engaged for 100% of the intervals during the T-IRAP sessions. Oscar showed more intervals with off-task behaviours during his table-top session than the T-IRAP sessions. Similarly, Adam demonstrated off-task behaviours in 59% of the intervals recorded during table-top sessions in comparison to 10% of T-IRAP sessions. He also showed off-task passive behaviours in over half of the table-top intervals.

Supplementary Results

In addition to the BOSS, data were collected on the frequency of times per teaching session in which Oscar refused to complete his usual table-top work. Oscar had been demonstrating some challenging behaviours and on completion of a functional analysis (separate to this research and under the supervision of a BCBA) the functions of these behaviours were found to be escape and access to tangibles. Oscar vocalised phrases such as “No” and “Go away” when his usual table-top work was presented to him from 0-52 times per day. Across the course of this research, Oscar made similar vocalisations to the researcher when presented with the T-IRAP three times in total. On all of these occasions the researcher removed the T-IRAP and re-offered the T-IRAP later in the day in which Oscar then engaged with the research session.

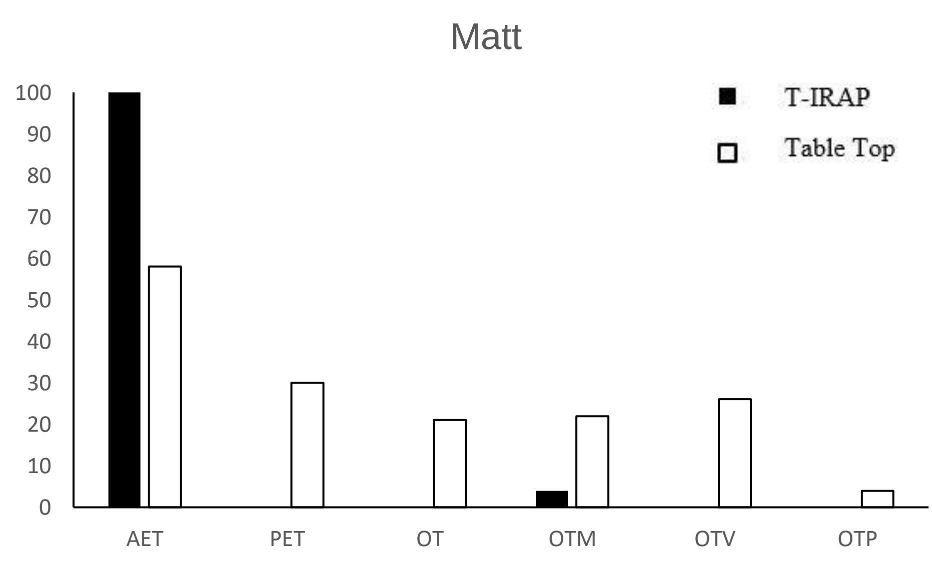


Figure 11. BOSS data for Matt

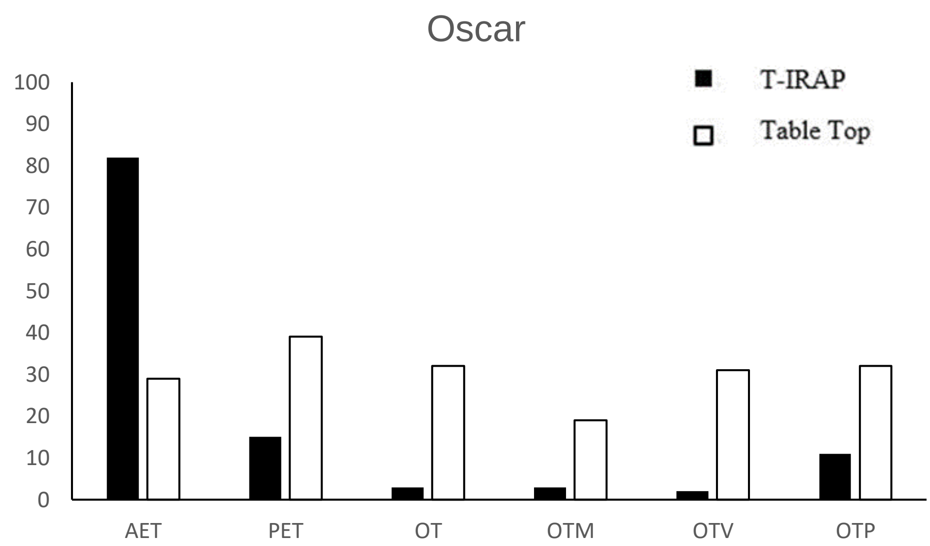


Figure 12. BOSS data for Oscar

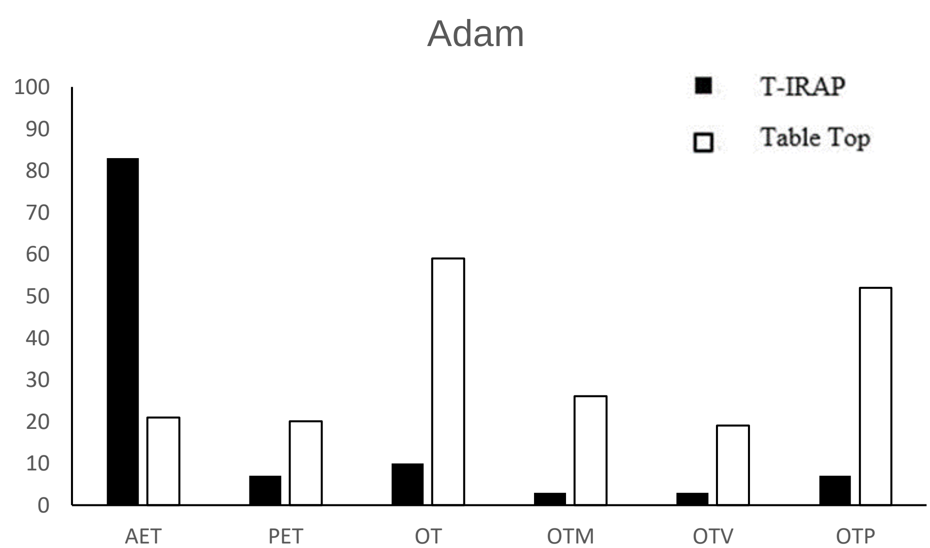


Figure 13. BOSS data for Adam.

In summary, the results of the multiple baseline design indicated that the line graph self-management intervention was successful for one participant only, Matt. On implementation of the intervention Matt required a reduced prompt level, accuracy scores remained high while duration scores showed a general decreasing trend. Both Oscar and

Adam required additional prompt phases before beginning to respond to the PEAK/T-IRAP independently. Generalisation probes on the PEAK/T-IRAP and table-top methods suggested that the participants could generalise the skill to novel stimuli to some extent with Matt producing the most favourable generalisation results. Results from the BOSS indicated that all participants demonstrated more on-task behaviour when engaged with the T-IRAP in comparison to their usual table-top work.

Discussion

Study 2 was designed as a follow-up to some of the findings and issues noted in Study 1. Study 2 attempted to address the issue of poor generalisation in Study 1 by including multiple exemplars in the PEAK/T-IRAP. Additionally, as some participants in Study 1 did not reach an independent responding phase, Study 2 included a self-management intervention to investigate if this would have an impact on the prompt levels used for each participant as well as their speed and accuracy of responding on the PEAK/T-IRAP. This self-management intervention linked in with precision teaching literature which incorporates selecting targets and allows for students to compete with themselves to achieve better scores (Lindsley, 1992). A delayed multiple baseline design across three participants was used to examine the effect of a self-management intervention on the speed and accuracy of responding on a multiple exemplar PEAK/T-IRAP with three participants with diagnosed ASD. The intervention was introduced in staggered intervals across participants as more participants became available for the study. In addition to this, data were collected using the BOSS to measure on- and off-task behaviours during participant's table-top work and the PEAK/T-IRAP sessions.

The results of the study suggest that the self-management intervention was successful for one participant, Matt. Once the intervention had been implemented, Matt was capable of responding independently to the PEAK/T-IRAP while his accuracy scores remained high and duration scores showed a generally decreasing trend. For both Oscar and Adam, the intervention did not appear to be effective in improving their accuracy and speed of responding on the PEAK/T-IRAP. Following the implementation of the intervention Oscar and Adam required further prompt phases before they began to respond to the PEAK/T-IRAP independently.

Results from the BOSS indicated that all the participants showed more on-task behaviours and less off-task behaviours when engaged with the PEAK/T-IRAP in comparison to their usual table-top work. All participants demonstrated greater active-engaged behaviours during the PEAK/T-IRAP which is an interesting finding given that active engaged behaviour is a behaviour that suggests that participants are more involved in their learning. Additionally, all participants showed greater off-task behaviours during their table-top work. Adam, in particular, demonstrated high instances of off-task behaviours with an emphasis on off-task passive behaviours during his table-top work with much lower instances of these behaviours during PEAK/T-IRAP sessions. The results from the BOSS in this study are very similar to those found in Study 1 with three different participants which provides additional support to the finding that the PEAK/T-IRAP produces improved on-task behaviour.

All three participants were capable of engaging with the self-management intervention itself and they marked their aims and scores on the graph with guidance from the researcher. One possible reason that the self-management intervention did not appear to be successful for Oscar and Adam was that there may have been a delay in access to the terminal reinforcer. Following the completion of the 32 trials on the PEAK/T-IRAP the researcher then had to calculate the participants' accuracy and duration scores before they marked their score on the line graph and then received the reinforcer contingent upon their scores. This process took approximately two minutes for the researcher to complete by which time the participants had become engaged with another activity or had left the desk area. This allowed for a time delay in access to the participants preferred item and may have weakened the contingency between accurate and speedy responding and receiving positive reinforcement. Additionally, during their usual academic work both Oscar and Adam receive frequent positive reinforcement while Matt can generally tolerate a longer delay and he may have had the ability to comprehend the self-management intervention and the contingency in place better than the other participants. The self-management intervention used in Study 2 (line graph intervention) was based on each participant's score at the end of each the session (32 trials run across four trial blocks) which may have been too thin a schedule of reinforcement for Oscar and Adam.

A final generalisation phase was conducted with each of the participants in this study. The results of Matt's and Adam's generalisation probes indicated that generalisation of skills to novel stimuli did occur in both the PEAK/T-IRAP generalisation probe and the table-top probe. Matt produced similar scores on the PEAK/T-IRAP for the generalisation probe as was produced at the independent level of responding. He was successfully able to generalise the skills learned to a table-top test of same/different. Adam's generalisation of same/different also generalised to novel stimuli but with poorer accuracy scores. Adam had begun to respond to the PEAK/T-IRAP independently towards the end of the training session and for this reason no prompts were provided during the PEAK/T-IRAP generalisation probe to allow for a true reflection of his ability to generalise. Adam demonstrated approximately 60% accuracy in both generalisation probes suggesting that he was able to generalise to some degree. Further training on the PEAK/T-IRAP may aid this. Oscar showed some generalisation of skills to novel stimuli on the table-top generalisation probe with 60% accuracy however he showed poorer generalisation to novel stimuli on the

PEAK/T-IRAP probe. Similar to Adam, Oscar had just begun to respond to the PEAK/T-IRAP independently towards the end of the research sessions and no prompts were provided during the generalisation probe. Further research could examine if either presentation produces greater generalisation as the results indicated in this study remain inconclusive for this particular research question.

One important point to note from this study was the participants' engagement with the PEAK/T-IRAP sessions. The BOSS data provides data on participants' behaviours when engaged with the PEAK/T-IRAP and their table-top work but additionally, in the case of Oscar, the data shows his motivation to engage with the PEAK/T-IRAP in comparison to his usual work. Oscar's challenging behaviours had a negative impact on his academic work as he often engaged in verbal protesting to escape from work (this also functioned as a pre-cursor behaviour to more intense challenging behaviour) with this verbal protesting reaching very high frequencies each day. However, in the case of the research sessions with the PEAK/T-IRAP Oscar rarely exhibited any challenging behaviours before, during or after the sessions. This particular case highlights the 'likeability' of the PEAK/T-IRAP as an academic tool.

Future research could include using other self-management interventions participants of a similar age and profile to examine if other interventions would have an impact on speed and accuracy of responding and if they would promote independent responding.

Chapter 4

Introduction

A multiple baseline design across three participants was used in Study 2 to examine the effects of a line graph self-management intervention on speed and accuracy of relational responding on a PEAK/T-IRAP. Findings from this study indicated that the self-management intervention was immediately successful for one participant, Matt. While all participants could engage with the self-management intervention it did not appear to be as effective for two of the participants as they required more prompt phases before reaching independent responding, accuracy scores did not increase and duration scores remained variable. Following upon the findings of Study 2, the current study aimed to examine the effects of two self-management interventions in building fluent relational responding on a PEAK/T-IRAP with one participant.

Study 3 used an alternating treatments design to compare the effectiveness of two types of self-management interventions on the accuracy and speed of responding on a PEAK/T-IRAP. Alternating treatment designs are useful for directly comparing the effectiveness of two, or more, interventions by quickly alternating each of the interventions, each of which is associated with a specific stimulus. This type of design can be used with a single participant. Sessions of each intervention are counterbalanced to prevent the effects of confounding variables such as time of day and sequence effects (Barlow & Hayes, 1979).

The interventions used in this study included a line graph intervention, as used in Study 2 (which targets speed and accuracy), and a colour block intervention (which targets accuracy only). As outlined in Study 2, the line graph intervention is based loosely on Precision Teaching (Lindsley, 1992) in which the participant is required to set aims and then graph his own performance following completion of the task. The colour block intervention also involves the participant self-managing his own behaviour by colouring in a number of colour blocks contingent on accuracy score of each trial block in the category PEAK/T-IRAP, for example, if Matt achieved seven correct trials in the first trial block on the PEAK/T-IRAP he coloured in seven blocks on the colour block chart. This intervention is based on the idea that children's learning can be greatly supported with the use of visuals, particularly children with ASD. Visuals can help students to focus on the task at hand as well as comprehend the task better (Roa & Gagie, 2006). Additionally, the colour block intervention provides immediate visual feedback to the participant which can increase task performance (Fuchs & Fuchs, 1986). Self-management strategies used in academic work have been shown to produce more on-task behaviour and more productive work time (DiGangi, Maag & Rutherford, 1991; Shimabukuro, Prater, Jenkins & Edelen-Smith, 1999; Trammel, Schloss & Alper, 1994) and, furthermore, these types of strategies can be used to implement more complex self-managed learning such as Personalised Systems of Instruction (PSI) which can be adapted for children (McLaughlin, 1991).

One participant, Matt, who also participated in Study 2 continued to the current study. Matt was selected for this study as the line-graph intervention in Study 2 had shown to be effective in promoting his independent responding, increasing his accuracy scores and decreasing his duration scores. Study 3 aimed to examine if another type of self-management intervention, the colour block intervention, would have better effects on Matt's accuracy and speed of responding as it was a more visual intervention with a thicker schedule of reinforcement in comparison to the line graph intervention.

As the line graph intervention was successful for Matt only in Study 2 (and was not effective for Adam and Oscar) this study sought to examine if the colour block intervention would produce greater accuracy and speed of responding scores. It was hypothesised that because this type of intervention was more visual and had a thicker schedule of reinforcement (reinforcement was provided at the end of each trial block rather than the end of each session) that Matt would demonstrate more accurate and faster responding. Should the colour block intervention have produced these favourable results the aim was for this intervention to be introduced to Oscar and Adam with whom the line graph intervention was not successful.

Two PEAK/T-IRAPs, matched for difficulty, were used in this study which were associated with each intervention type. As Matt had been previously exposed to non-arbitrary stimuli (in which stimuli were physically different and differences were made very salient) a category PEAK/T-IRAP was used in this study to increase the complexity of relational responding required during the intervention. The category PEAK/T-IRAP involves using category responding, for example responding "same" when presented with visuals of a dog and a cat as they belong to the category of animals. This type of responding is more complex than the responding required in Study 2 as the differences between the category stimuli are not as salient i.e. when presented with visuals of a pear and an apple the participant is required to respond as though these stimuli are the same as they are both fruit despite that they are not identically the same. The category PEAK/T-IRAPs used in this study included an animal/food T-IRAP and a clothes/transport T-IRAP which were associated with the colour block intervention and line graph intervention respectively.

Implementation of each self-management intervention was counterbalanced across sessions as is customary for an alternating treatments design.

Method

Participants

One participant from Study 2 participated in Study 3. Matt is aged five and has an autism diagnosis. For further participant information see participants section of Study 2. Continued consent was obtained from Matt's parents before beginning Study 3 (see Appendix 6). As this study sought to examine if a different type of intervention (colour block intervention) would be more effective in improving speed and accuracy scores and increasing independent responding in comparison to a line graph intervention Matt was selected for this study as the line graph intervention was successful for Matt in Study 2.

Settings and Materials

Research sessions were conducted in the same way as Study 1. Materials used included a T-IRAP (see Study 1 materials section for a more detailed description) and hard copies of a line graph and colour block sheets were also used for each intervention.

Design

An alternating treatments design was used to compare the effectiveness of two self-management interventions aimed to promote fluent responding using the T-IRAP. The goal setting and self-monitoring aspects of self-management were manipulated using a colour block intervention and line graph intervention.

Ethical Considerations

Ethical considerations were similar to those outlined in Study 1. An information sheet and informed consent form had been sent home in Matt's schoolbag for Study 2 and parental consent was received for this study. As Study 3 is a continuation of Study 2 a continued consent form was issued to Matt's parents (see appendix 6).

Interobserver Agreement

All data in this study were collected using the T-IRAP program which records data automatically, therefore no IOA data were collected.

Procedure

Two self-management interventions were used to promote fluency in responding on the PEAK/T-IRAP. These included a colour block intervention and a line graph intervention which are outlined in further detail below,

Two different T-IRAPs were used and were assigned to each of the interventions. The stimuli used were based on the categories food, animals, clothes and transport. For example, in the PEAK/T-IRAP a correct response when presented with visuals of a horse and a cat on the screen would be to press the "D" key for "same". When presented with visuals of a horse and a burger the correct response was to press "K" for "different" as these do not belong in the same category (see *Figure 14* and *Figure 15* for an example). Coloured stickers were attached to the "D" and "K" keys to make them more salient. An animals/food T-IRAP was associated with the colour block intervention while a clothes/transport T-IRAP was associated with the line graph intervention. Two different T-IRAPs were used within the study to ensure that any difference noted in fluency of responding was due to the self-management intervention rather than increasing familiarity with the stimuli in one T-IRAP. The category responding also increased the complexity of relational responding required in this study and is derived from PEAK targets (e.g. Sorts Item by Class)

Pre-intervention probe. To ensure that Matt could correctly identify the stimuli in each of the categories (animal/food/clothes/transport) two probes were conducted. For Probe 1 Matt was presented with four empty boxes and given a visual from each of the four categories (animals, food clothes and transport) which were identical to those used in the T-IRAP. He was provided with the verbal antecedent “Sort” and was required to place each of the visuals in the correct category box. For Probe 2 Matt was required to tact the category that each of the stimuli belonged to. The researcher held up one of the visual stimuli and provided the verbal antecedent “What category is this from?”. Matt responded by tacting either animals/food/clothes/transport. A total of 24 trials were run for each of the probes. A plus (+) was recorded if Matt responded correctly and a minus (-) was recorded if he responded incorrectly. No reinforcement or corrections were provided for these probes.

Following the probes, Matt continued to the alternating treatment design intervention. Before beginning the T-IRAP session the researcher conducted a brief free-operant preference assessment to determine Matt’s most preferred items. A variety of items were kept on deprivation to contrive an establishing operation.

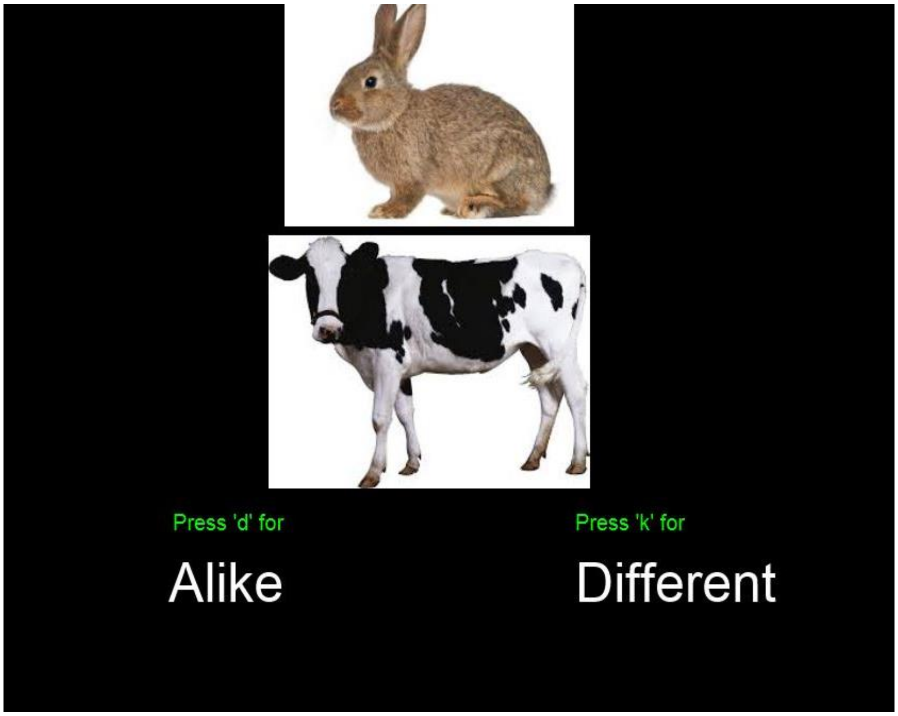


Figure 14. Two similar stimuli

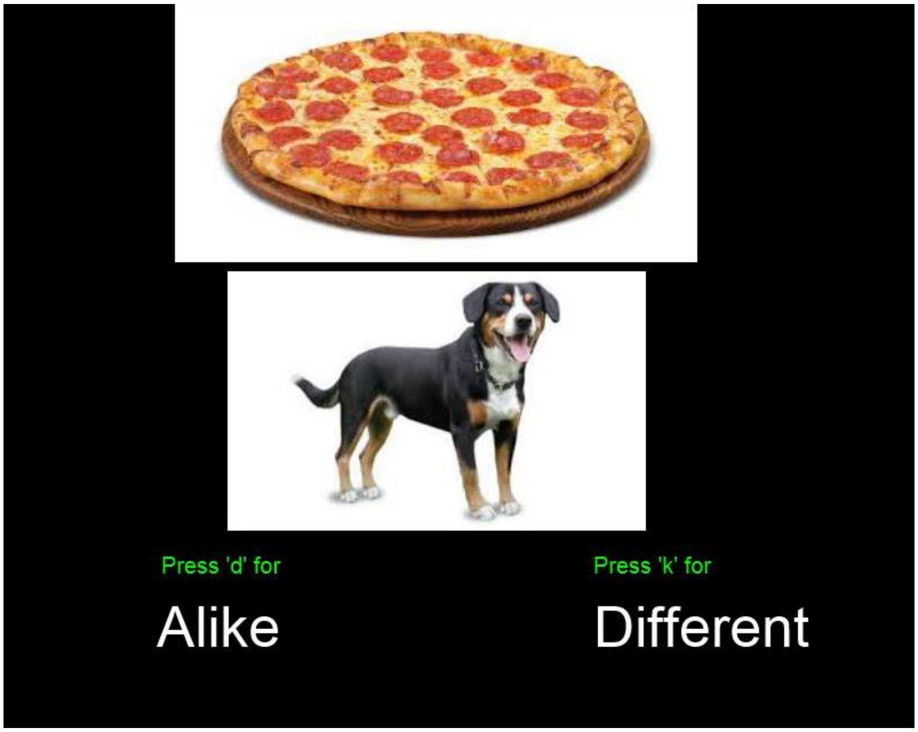


Figure 15. Two different stimuli

Colour block intervention. The colour block self-management intervention targeted increasing accuracy of responding on the PEAK/T-IRAP. The animals/food PEAK/T-IRAP was used for this intervention. The PEAK/T-IRAP was composed of four blocks of eight trials which allowed for 32 trials in each session.

At the end of each eight trial block the researcher showed Matt a colour block visual (See *Figure 16* for an example). The researcher indicated to Matt how many of the trials he had responded to correctly in the previous trial block. Matt then coloured in on the sheet the number of correct trials. The colour of the marker used to shade in the blocks was contingent upon the number of trials Matt responded to correctly. If he responded correctly to five trials or less he coloured the block yellow. Orange was used if he responded to six trials correctly. Red and green were used for seven and eight correct trials respectively. Different colours were used to allow for greater discrimination between the number of correct trials.

Positive reinforcement was provided based on the preference assessment conducted at the beginning of the session. Differential reinforcement was used to provide greater quality or quantity of reinforcement contingent on a greater number of correct responses with Matt receiving his most highly preferred item when he responded to eight trials correctly. Matt coloured in the colour block at the end of each trial block which allowed for a total of four opportunities across the 32 trials in the session.

	Visual of reinforcer	Visual of reinforcer	Visual of reinforcer	Visual of reinforcer
8.				
7.				
6.				
5.				
4.				
3.				
2.				
1.				

Figure 16. Colour block intervention visual- as correct responding was achieved the participant filled in the blocks with a specific colour for the number of correct trials.

Line graph intervention. The line graph intervention was implemented in the same manner as Study 2 and it targeted accuracy and speed of responding. A clothes/transport T-IRAP was used with this intervention. At the beginning of the T-IRAP session Matt was shown two line graphs one which was designated for accuracy of responding and the other for speed. Matt was encouraged to mark on each of the graphs the target he had to reach before earning his preferred item (e.g. 90% accuracy and duration of 170 seconds). Matt then completed the T-IRAP (all 32 trials) and the researcher indicated the score he had achieved for him to mark on the graph again. Matt held the marker and was shown where to place a mark on the chart. Differential reinforcement was provided contingent on meeting the criteria, with greater reinforcement provided if Matt met both speed and accuracy criterion and lesser reinforcement for meeting one criterion. If the participant did not reach either criterion a lesser preferred item was provided as reinforcement.

The accuracy target was set at 90% for the intervention. The speed of responding target was initially set at 180 seconds and was then reduced based on Matt's own speed of responding. The 180 target was based on Matt's results in study 2 in which he never exceeded 180 seconds to respond to 32 trials. This was selected to allow for Matt to contact the reinforcement contingency.

Results

An alternating treatments design was used to investigate the impact of two self-management interventions on accuracy and speed of responding on two category based PEAK/T-IRAPs. Before implementing the alternating treatments design, two table-top probes were conducted to examine if the participant could 1) sort each of the stimuli into the relevant category and 2) tact the category each stimulus was from. The results of these probes are shown in *Table 8* which show that Matt could competently sort and tact each of the stimuli used in the T-IRAP.

Table 8

Category Probes

Sort	Tact
100%	100%

The alternating treatment design was put in place following these probes. The results of these interventions are shown in *Figure 17*. The graph shows accuracy and speed of responding for the colour block intervention and the line graph intervention. The colour block intervention is shown using square data points while the line graph intervention is shown using circular data points. Accuracy is depicted with a solid black line and speed of responding is shown using a dashed black line. Duration data is graphed on the secondary y-axis and accuracy data is graphed on the primary y-axis. Accuracy and duration data for the PEAK/T-IRAP were calculated using the same methods as outlined in Study 1.

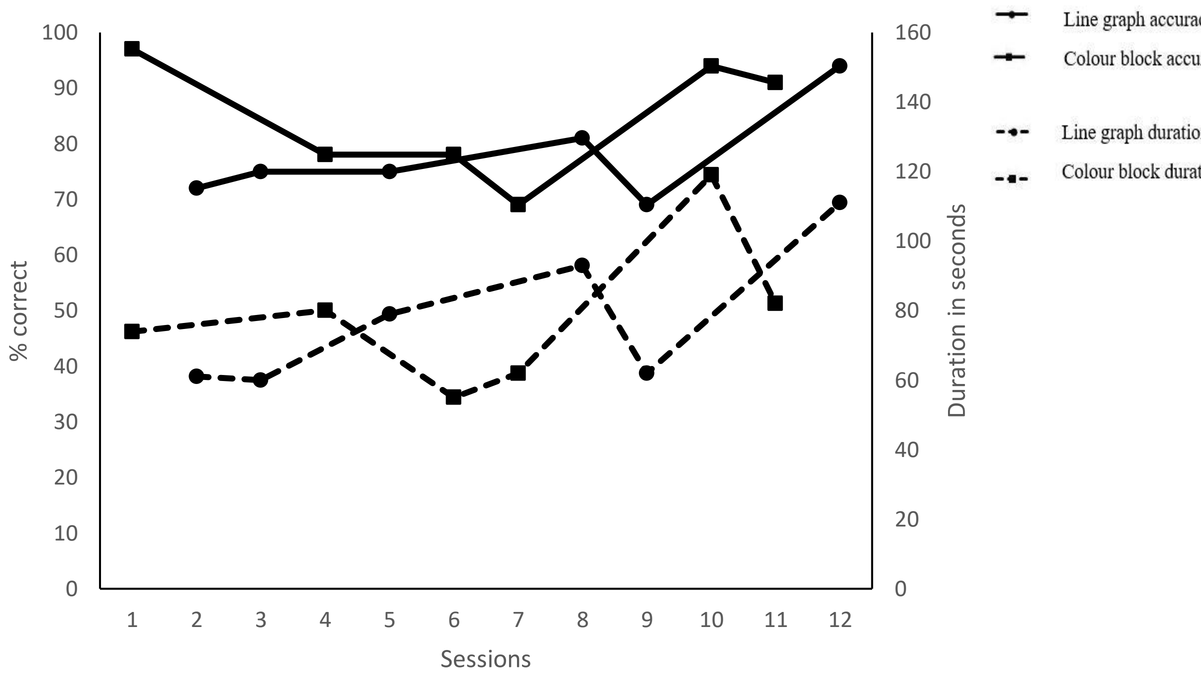


Figure 17. Results of the alternating treatment design showing accuracy and speed of responding on the T-IRAP for two self-management interventions.

Colour block intervention

The colour block intervention produced relatively high accuracy scores with some variability in the data paths on the animal/food PEAK/T-IRAP. Accuracy scores ranged from 69-97% with a median accuracy score of 84.5% and a mean score of 84.5%. Duration of each PEAK/T-IRAP session (speed of responding) also remained relatively low while showing some variability. The participant completed the PEAK/T-IRAP session which included 32 trials (four blocks of eight trials) between 55 and 119 seconds with a median duration score of 77 seconds and a mean of 79 seconds.

Line graph intervention

The line graph intervention produced high accuracy scores and low duration scores on the clothes/transport PEAK/T-IRAP. Accuracy scores ranged from 69-94% with a median score of 75% correct and a mean of 78%. Duration scores were quite variable with a range of 60-111 seconds to respond to 32 trials (four blocks of eight trials), a median score of 70.5 seconds and a mean of 78 seconds.

In summary, the results suggested that both the animal/food T-IRAP and the clothes/transport T-IRAP were matched for difficulty as the participant could readily sort all of the stimuli into the relevant categories. The results indicate that the colour block intervention and the line graph intervention were both successful in maintaining high accuracy scores and fast responding. The graph shows that the colour block intervention was slightly more favourable in producing more accurate responding while there did not appear to be any difference in the interventions on speed of responding.

Discussion

An alternating treatment design was used in Study 3 that examined the effect of two self-management interventions on the accuracy and speed of responding on two category PEAK/T-IRAPs which were matched for difficulty levels. The results showed that both interventions were effective in producing accurate and fast responding on the PEAK/T-IRAP. The colour block intervention was shown to be more favourable as there was generally more accurate responding when the participant was subject to this intervention (mean of 84.5% accuracy for colour block and 78% accuracy for line graph). Both the line graph and colour block interventions produced similar speed of responding. There was some variability in responding as shown in the graph which could be attributed to the participant's motivation. Although items were kept on deprivation for this research to contrive an establishing operation it is important to note that this participant had also participated in Study 2 and may have become satiated on these items towards the end of Study 3.

This study used category based PEAK/T-IRAPs which the participant had not been exposed to previously. The stimuli used in these T-IRAPs were based on categories rather than the very salient non-arbitrary stimuli as previously used in Study 2 (e.g. star and square). While the category T-IRAP cannot be considered to contain fully arbitrary stimuli as some of the stimuli did have physical similarities, in particular the animal stimuli as all animals had four legs, hair etc. this is a step towards arbitrary applicable relational responding which is especially noteworthy with the profile and age of the participant. Given that the category PEAK/T-IRAP was more difficult that the PEAK/T-IRAP presented in Study 2 the self-management interventions were particularly successful in producing accurate and fast responding.

The colour block intervention allowed for a thicker schedule of reinforcement as the participant received a reinforcer at the end of each block. Despite this, the colour block intervention produced only slightly more favourable accuracy scores. The colour block intervention also focused on accuracy only while the line graph intervention focused on both speed and accuracy. Little difference was seen between both interventions on the speed of responding. This could be explained by considering that the participant had already been exposed to the line graph intervention in Study 2 and was therefore aware of a contingency between speed of responding and access to a reinforcer.

This study immediately followed Study 2 to address some of the issues presented by the line graph self-management intervention. As this intervention was successfully implemented for Matt and appeared to have a positive impact on his speed and accuracy of responding (accuracy data increased and duration data decreased) as well as his independent use of the PEAK/T-IRAP a colour block self-management intervention was put in place to examine its effect in comparison to the line graph intervention. As outlined, the results indicated that the colour block intervention produced slightly more accurate responding but that both interventions were matched for speed of responding data. In terms of a social significance, the accuracy means as outlined represent an approximate difference of two correct trials which can be viewed as a socially significant difference. The colour block intervention targeted accuracy scores only while the line graph intervention targeted both speed and accuracy. It is interesting to note that there was little difference between both interventions on the speed of responding scores which suggests that this may not need to be targeted in a self-management intervention and may only need to be targeted if the participant is exhibiting particularly long response times. Alternatively, the speed of responding could have been due to the participant's exposure to the PEAK/T-IRAP in Study 2 in which faster responding had already been reinforced. Future research could examine the impact of two such interventions on participants that had not been exposed to the T-IRAP previously. Additionally, the results indicated that a participant with high functioning skills could learn to graph his own data output from the T-IRAP which could facilitate goal setting and self-monitoring.

The participant, Matt, also expressed a preference for the colour block intervention as he enjoyed colouring in the blocks with a crayon which allowed the participant to become more involved. This intervention is also more visual which can appeal to many children with ASD who may comprehend the visual layout and may aid their understanding of the contingency better.

Future directions for this study could involve using the colour block intervention with a participant who had not been exposed to any type of self-management intervention previously or who was unable to use the T-IRAP independently. Other visual and interactive types of self-management interventions could also be used as the participant in this study expressed a preference for the colour block intervention as he was able to colour in each block himself.

Chapter 5

Introduction

The previous studies sought to teach basic relational responding to both low and high functioning preschool children with ASD using the T-IRAP. Results of these studies were varied as some participants were successful in manipulating the T-IRAP independently while others required prompts to do so. Study 3 built upon the complexity of relational responding as it involved category responding rather than very salient non-arbitrary stimuli as used in Studies 1 and 2. For study 3 the participant was required to respond to stimuli that were not identically the same but rather the stimuli belonged in the same category, for example, a dog and a rabbit are the same as they are both animals but a sheep and a burger are different as they do not belong in the same category class. Given the need for research on interventions or procedures to teach more complex relational responding, (Dymond & Roche, 2013) Study 4 aimed to teach analogies which built upon the complexity of relational responding required in Study 3 as analogies require relating entire relational networks. As the results of Study 3 indicated that the T-IRAP was successful in teaching more complex relational responding, Study 4 sought to teach analogies via the T-IRAP also.

According to an RFT perspective, equivalence-equivalence responding (or analogies) involves relating entire relational networks to one another. Analogical responding is therefore more complex than relating relations and is one of the more advanced types of relational responding. Equivalence-equivalence responding is thought to be a core element for problem solving (Cassidy, Roche & O’Hora, 2010) and, also, an important aspect of intelligent behaviour (Sternberg, 1985).

Analogical responding, along with other types of relational responding, is often required in IQ tests or subscales although they may not be obviously apparent as analogies. Cassidy et al. (2010) outline several examples of questions from the Wechsler Intelligence Scale Children 3rd Edition (WISC-III) which target analogies, for example, "In what way are a piano and guitar alike?" in which the participant must abstract an equivalence relation between piano and guitar and musical instruments. This type of responding requires the participant to take into account both the function and topography of the stimuli as well as the relations between the stimuli. More complex analogies are included in the WISC-III such as "How are anger and sadness the same?" (Cassidy et al., 2010) in which the participant is required to relate relations which are generally viewed in an opposition relation. These are just a sample of test questions from the WISC-III which target analogies and it is evident that analogies (or equivalence-equivalence responding) play a role in IQ and IQ measures.

At the time of writing, the PEAK curriculum does not include methods for teaching analogies, however, previous RFT research has suggested that analogies can be taught by establishing equivalence- equivalence relations (and, by extension, equivalence-nonequivalence relations). Previous behavioural research has shown that typically developing children aged nine can engage in equivalence-equivalence responding while five-year-olds cannot do so without extensive training (Carpentier, Smeets & Barnes-Holmes, 2002). This study sought to examine if basic analogies can be taught to a five-year-old participant with ASD using the RFT procedure in conjunction with positive reinforcement and other behavioural methodologies.

The current study involved one female participant, Lily who is five years old. The analogies used in this research are based on categories and stimuli that the participant is familiar with from her day-to-day life. This is important to note as the participant is receiving early intervention from her current preschool it would not be appropriate to use analogies based on nonsense stimuli. An alternating treatments design was used to compare table-top methods and the T-IRAP for presenting analogies.

Table-top presentation of trials is a common teaching method used in ABA schools particularly during Discrete Trial Training (DTT) which involves directly teaching specific targets with programmed consequences for correct and incorrect responses to the prescribed antecedent. For example, DTT can be used to teach matching to sample in which the child is presented with an array of four stimuli on the table and provided with the verbal antecedent "Match" and also given a stimulus to match to one of those in the array. If the child correctly matches the stimulus he is provided with positive reinforcement (on an appropriate schedule of reinforcement), if he responds incorrectly he is provided with a correction or additional prompt such as a reduced array of stimuli (Smith, 2001). This type of presentation of teaching trials can be used to teach a variety of targets including matching to sample, listener discrimination, tacting programs (Smith, 2001). Given the popularity of table top methods in teaching in ABA schools, the current study seeks to examine how table-top methods compare to the T-IRAP in presenting analogies.

There are number of research questions to be addressed in this study which include the following a) can analogies be presented to the participant using the equivalence: equivalence paradigm on the T-IRAP and table-top methods? b) can the participant respond to analogies independently? c) can the participant respond to novel analogies independently? d) how do the T-IRAP and table-top methods compare regarding generalisation of analogy skills to novel stimuli with a participant with ASD?

Method

Participants

One participant took part in Study 4. Lily was a five-year-old girl diagnosed with autism. She was recruited from an ABA-based early intervention preschool. She has a formal diagnosis of autism made by an independent clinical psychologist in accordance with criteria in the *Diagnostic and Statistical Manual Fifth Edition* (DSM-V; American Psychiatric Association, 2013). She has a reasonable verbal repertoire and can vocally construct sentences such as “I want play time”. She exhibits some tantrum behaviours which appear to be escape maintained. Lily was selected for this study as she was capable of sitting at a desk and attending to materials presented to her. An additional factor was that she could engage in vocal verbal behaviour which was important as some of the prompts used in the intervention required the participant to tact the relations between stimuli.

Settings and Materials

Research sessions were conducted in the same manner as Study 1. Materials included a T-IRAP (see Study 1 for a more detailed description), printed visual stimuli for table-top sessions, a timer, pen and paper for data collection.

Design

An alternating treatments design with a baseline probe was used to compare the effectiveness of a T-IRAP and table-top methods in teaching analogies. T-IRAP and table-top sessions were counterbalanced as is customary in an alternating treatments design.

Ethical Considerations

A research ethics proposal was submitted and approved by the Departmental Ethics Subcommittee of the Psychology Department in Maynooth University for this study. Similar to Study 1, an information sheet and informed consent form were sent to the participant's parents in the participant's schoolbag. Please see Study 1 ethical considerations for further details. As pre- and post- intervention assessments were not used this study these were not included in the information sheet or consent form (See appendices 4 and 5 for these forms)

Interobserver Agreement

IOA data were collected for 36% of the Table-top sessions. Trial-by-trial IOA was calculated with 98% agreement. Trial-by-trial IOA was calculated by dividing the number of agreements by the total number of trials and multiplying by 100 to obtain a percentage. IOA data were not collected for T-IRAP sessions as data collection is computerised.

Procedure

Baseline probe. An initial baseline probe was conducted to determine if Lily was already capable of analogical responding. The researcher placed three of the analogy cards (which are described in detail below) on the table and asked Lily to identify two cards that were the same or the card that was different from the other two. Lily responded vocally or by pointing to the stimulus. A plus (+) was recorded on the data sheet if she identified the correct stimulus and a minus (-) was recorded if she responded correctly. Ten of these trials were run.

Intervention sessions. An establishing operation was contrived by placing a number of preferred items on deprivation for this study to be used as positive reinforcement. Analogies are typically written as A:B : C:D in which the relation between AB is generally the same as CD, for example, black: white : day: night in which there is an opposition relation between black/white and also an opposition relation between day/night. For this study, the participant will be required to assess the relations between two relations and then identify the relation between these relations e.g. apple: banana (same relation) : sheep: gate (different relation) which is then a relation of difference between the two relations. Three equivalence relations were selected for this study which were as follows:

Apple: Banana

Orange: Pear

Sheep: Cow

Three non-equivalence relations were also selected which were as follows:

Apple: Spoon

Orange: Chair

Sheep: Gate

These relations were presented in a visual format in the table-top and T-IRAP sessions (see *Figure 18*. and *Figure 19.* for the visual representation of these relations as analogy cards). Visuals of the relations were used rather than text as the participant was unable to read text. Equivalence-equivalence relations, equivalence- non equivalence relations and non equivalence- non equivalence relations were presented in both the T-IRAP and table-top sessions.

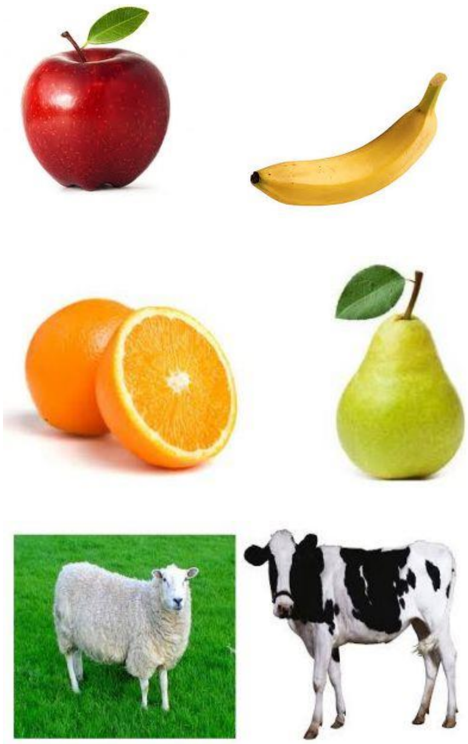


Figure 18. Equivalence relations.

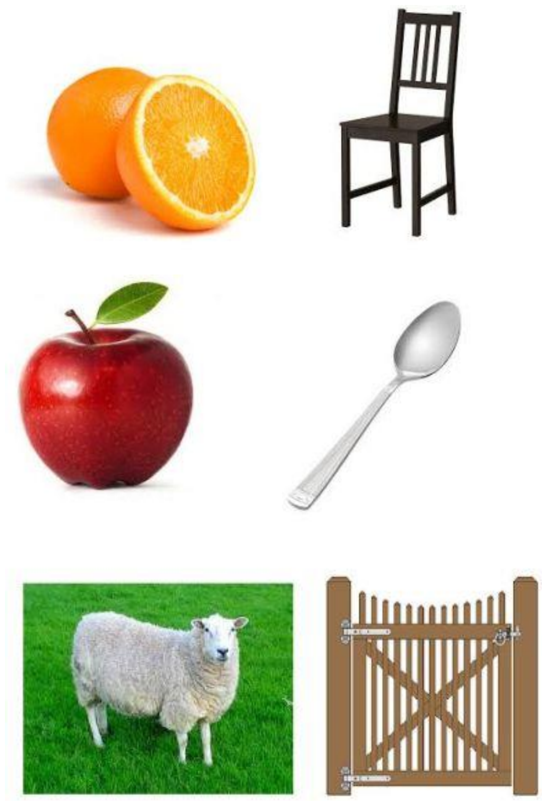


Figure 19. Non-equivalence relations.

Table-top. During the table-top sessions, cards with the words "Alike" and "Different" were placed on the table on the left and right of the participant respectively. Analogy cards were placed above the response options. This positioning is similar to that of the T-IRAP. When the analogy cards were similar (e.g. equivalence-equivalence relation apple: banana :: orange : pear) the participant was required to touch the response card "Alike" when the analogy cards were different (e.g. equivalence- non equivalence relation apple: banana :: sheep : gate) the participant was required to touch the response card "Different".

The researcher began the sessions with a general script "You're going to see some pictures on the table and I will explain to you how to do this work. There is a picture of an apple and a banana and they are alike because they are fruit. Here is a picture of an orange and a pear and they are alike because they are fruit. This means that these two pictures are alike. When they are alike you touch this card. Next we have a picture of a sheep and a cow and these two pictures are alike because they are both animals. Then there is a picture of an orange and a chair, they are different. That means that these two pictures are different. When the pictures are different you touch this card".

Most to least prompting, based on the participants' learning history, was used across the sessions to encourage correct responding e.g. gestural prompt, tacting the equivalence/nonequivalence relation, fleeting gestural prompt. During the table-top sessions the researcher manually manipulated the visual stimuli. The response cards (Alike/Different) remained in a constant position throughout the research sessions. Positive reinforcement was provided for correct responses (FR1 schedule, in the form of verbal praise). Incorrect responses were corrected using an increased prompt. The table-top session consisted of four blocks of eight trials. At the end of each trial block positive reinforcement was provided in the form of a preferred tangible.

Accuracy of responding was recorded using pen and paper. The duration of the table-top sessions was recorded using a timer. This timing included duration of work time and did not include the time the participant had a break or was engaged with a reinforcer.

T-IRAP. A T-IRAP was adapted to present analogies for this research. As the T-IRAP can present two target stimuli, analogy cards were made by the researcher which presented both pictures for the first half of the analogy (e.g. apple: banana) in one image using Microsoft Word and Irfan View photo software. This allowed for both parts of the analogy (apple: banana :: sheep: cow) to be presented on the T-IRAP in visual format.

Stimuli were presented on a laptop computer screen during the T-IRAP sessions. The same stimuli were used as in the table-top sessions. Both analogy images were presented at the top of the screen and the two response options (Alike/Different) were presented at the bottom left and right of the screen. The participant was provided with the same general script as outlined in the table-top sessions except during the T-IRAP sessions the participant was required to press the “D” key if the stimuli were alike and the “K” key if the stimuli were different. Coloured stickers were placed on the “D” and “K” keys of the laptop computer to make them more salient. A correct response (e.g. pressing “D” key when presented with apple: orange :: sheep: cow) on the T-IRAP cleared the screen and the next trial was presented. A red “X” was presented on the screen below the analogy stimuli following an incorrect response (e.g. pressing “K” key when presented with sheep: gate :: orange: chair). The participant was required to select the correct key to move to the next trial. An increased prompt level was used for the correction of an incorrect response. Positive reinforcement was provided (verbal praise) for each correct response. A total of 32 trials were presented during the T-IRAP session which included four blocks of eight trials (similar to the table-top procedure). At the end of each block positive reinforcement was provided in the form of a preferred tangible item.

Generalisation phase. The final phase of this study involved two generalisation probes including table-top and T-IRAP methods to determine if Lily could generalise the relational responding skills learned from the intervention to novel stimuli. Separate sets of stimuli were used for both the table-top generalisation probe and the T-IRAP generalisation probe.

***Generalisation probe 1*.** The first generalisation probe was conducted using the same procedure as previous table-top sessions. The participant was presented with two analogy cards and the response cards (Alike/Different). Novel stimuli were used in the generalisation phase and the participant was required to respond independently to each trial. A total of 32 trials were run in four blocks. When the participant responded to the trial, the researcher removed the stimuli and presented the next trial. No correction or reinforcement was provided. At the end of each eight trial block the participant received a break. See *Figure 20.* for stimuli used.

Figure 20. Novel stimuli used in the table-top generalisation probe

Generalisation probe 2. The second generalisation probe was conducted in a similar manner to the T-IRAP procedure as previously outlined. The participant was presented with four blocks of eight trials on the laptop computer and she was required to press “D” if the analogy cards were alike (e.g. equivalence- equivalence) and “K” if the analogy cards were different (e.g. equivalence- non equivalence). A correct response cleared the screen and automatically moved on to the next trial. An incorrect response produced a red “X” below the analogy cards and the participant was required to press the correct key before the next trial was presented. Novel stimuli were used in the generalisation T-IRAP which had not been taught during the intervention phase. See *Figure 21.* for stimuli used.

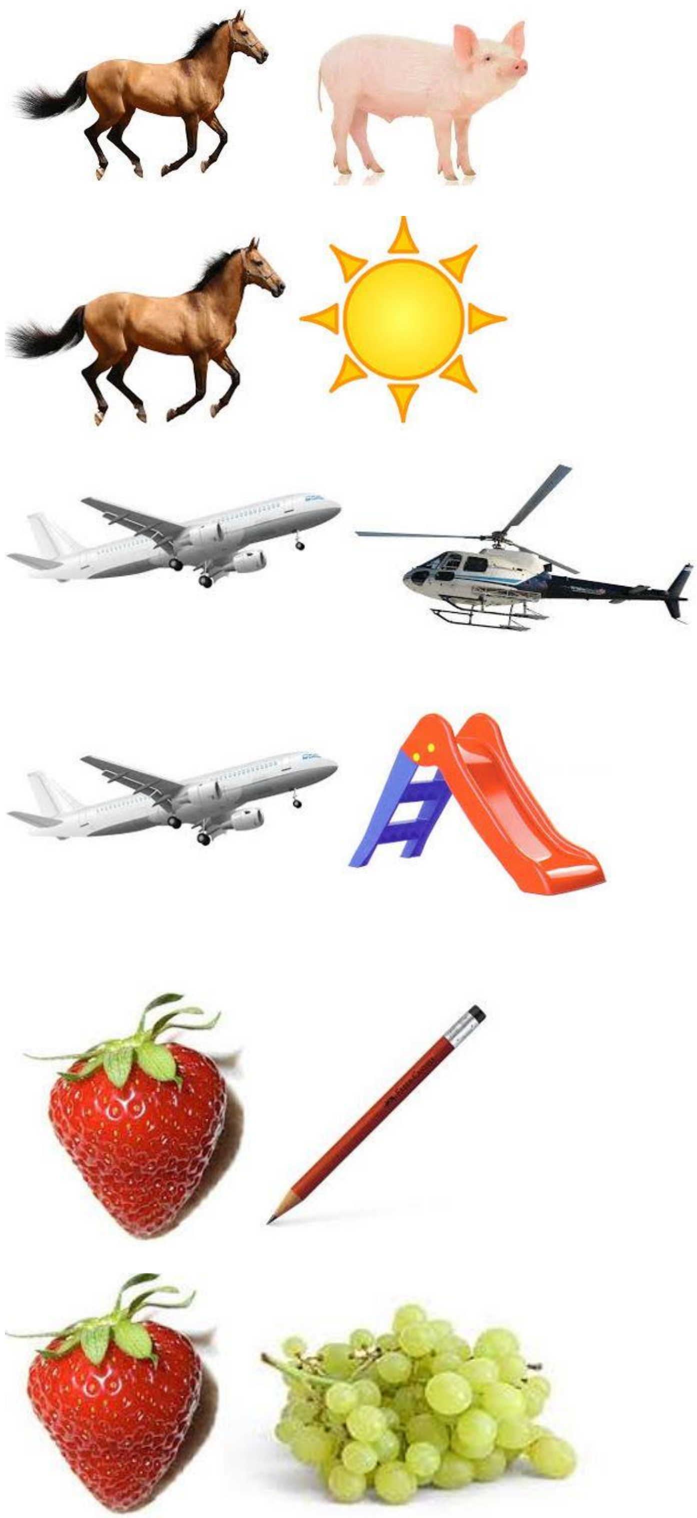


Figure 21. Novel stimuli used in the T-IRAP generalisation probe.

Results

An alternating treatment design with a baseline probe was implemented to compare the T-IRAP and table-top methods in teaching analogies. The results are shown below in *Figure 22*. Table-top data are shown using a solid (undashed) black line while T-IRAP data are depicted using a dashed black line. Accuracy data for table-top and T-IRAP data are shown using a square data point and duration data are indicated by a triangle data point. Accuracy data are graphed on the primary y- axis while duration data are graphed on the secondary y- axis. Accuracy and duration data for the PEAK/T-IRAP were calculated using the same methods as outlined in Study 1. *Figure 22.* also shows the results of probes G1 and G2 which refer to table-top and T-IRAP generalisation probes respectively.

Due to time constraints as it was thought Lily might be moving from the preschool a reduced learning criterion was applied during the prompting phase and independent phase (see *Figure 22*.). This was implemented as it was considered important to a) attempt to demonstrate independent responding to analogies post-training and b) attempt a demonstration of independent analogy responding towards novel stimuli which was included in the final generalisation phase. (Additionally, Lily exhibited behaviour that suggested that she was reluctant to allow the researcher to provide prompts, particulary towards the end of the prompting phase in which she vocalised statements such as “Be careful! Stay there!” if a prompt was provided).

A baseline probe was conducted initially before implementing the alternating treatments design to ensure that the skill being targeted, equivalence-equivalence relational responding, was not currently in the participant’s repertoire. The results of the baseline probe indicated that Lily was unable to identify analogy cards that were alike or different and therefore she could not engage in equivalence-equivalence relational responding as presented to her.

Most-to-least prompting was used during the sessions including gestural prompts, echoic prompts, vocal prompts and tacting the relations which were faded back across the sessions as Lily progressed. The prompts used were individualised according to Lily's usual teaching methods in the preschool. Prompts were faded as rapidly as possible as Lily's learning history suggested that she could become prompt dependent and she was also a rapid learner.

The results as shown on the graph indicate that the T-IRAP produced more rapid responding in comparison to table-top methods. Additionally, the duration of T-IRAP sessions was more stable than the duration of table-top sessions which showed very variable data trends. Accuracy data for the T-IRAP and Table-top were relatively similar during the prompted phase of the alternating treatments design. When the participant was capable of responding independently the T-IRAP then produced more accurate responding in comparison to Table-top.

Two generalisation probes were conducted- one on the T-IRAP and the other using Table-top methods. The results indicated that the participant produced greater generalisation when engaging with the table-top generalisation probe, however, the T-IRAP produced faster responding on its generalisation probe.

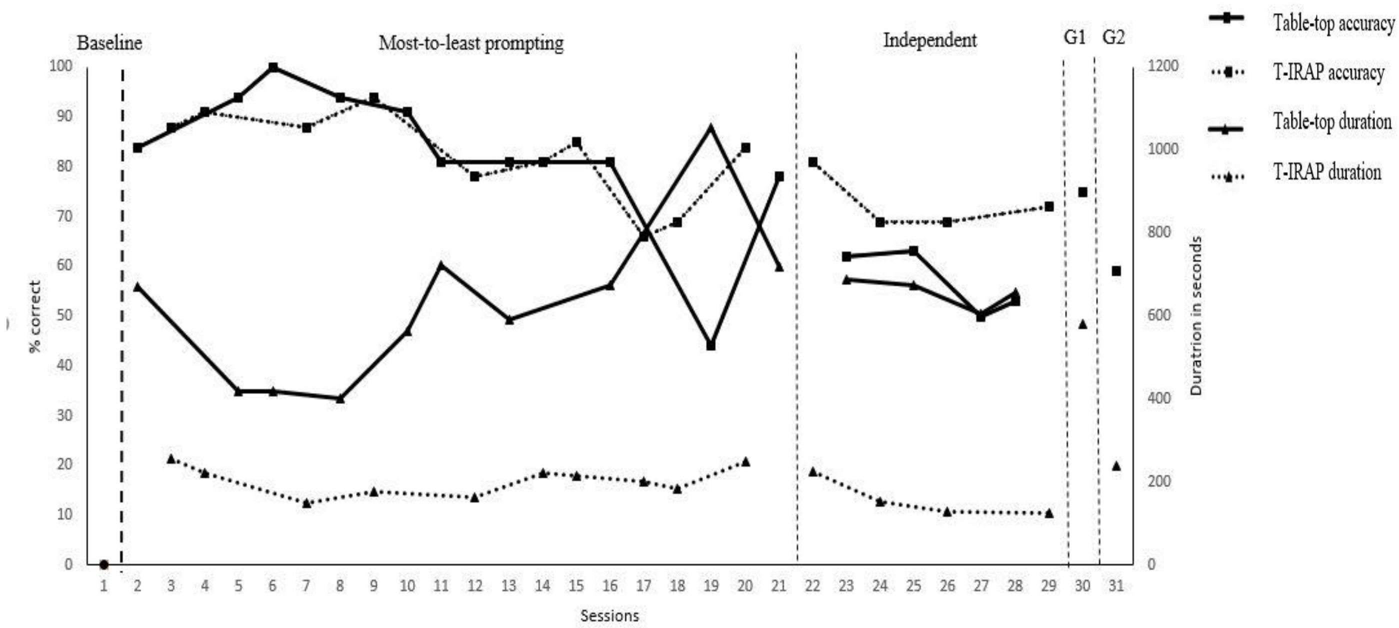


Figure 22. Alternating treatments design to compare table-top methods and the T-IRAP in teaching equivalence-equivalence responding. G1 refers to table-top generalisation probe while G2 refers to T-IRAP generalisation probe.

In summary, results from Study 4 indicated that Lily was not able to engage in equivalence-equivalence responding in the baseline probe. An alternating treatments design was used to compare table-top methods and a T-IRAP to teach analogies (equivalence-equivalence responding). Most-to-least prompting was used across sessions with the T-IRAP producing faster responding than the table-top methods. During the prompted phase, both interventions produced similar accuracy scores. On reaching independent responding, the T-IRAP produced more accurate responding as well as maintaining faster responding in comparison to table-top methods. Results from both generalisation probes suggested that Lily could generalise equivalence-equivalence responding to novel stimuli. The T-IRAP generalisation probe produced faster but less accurate responding to novel stimuli in comparison to table-top methods.

Discussion

Study 4 aimed to teach analogical responding to a preschool participant with ASD using RFT procedures which built upon Study 3 by placing a greater emphasis on increasing the complexity of relational responding. An alternating treatments design with baseline probe was used to examine the use of a T-IRAP and table-top methods in presenting analogies. The results of the baseline probe suggested that the participant could not engage in analogical responding. Results of the alternating treatments design suggested that the T-IRAP produced faster responding that was also more stable while duration data for the table-top procedures were variable. There was little difference between the T-IRAP and table-top methods on accuracy data during the most-to-least prompting phase. During the independent responding phase, however, the T-IRAP produced greater accuracy and continued to produce faster responding. Owing to time constraints, as previously outlined, the research sessions moved to the generalisation phase once independent responding had been achieved. The generalisation phase indicated greater accuracy of generalisation to novel stimuli in the table-top probe (75%, 582 seconds) while the T-IRAP generalisation probe produced faster responding (59%, 238 seconds).

This study employed the use of the RFT account of analogies which proposes that analogies involve the relating of entire relational frames or equivalence-equivalence responding. It is noteworthy that this study also included equivalence- non equivalence stimuli as presented in both table-top methods and the T-IRAP in which the participant was required to select the answer “different” when presented with an analogy card that contained two stimuli which were in the same relational frame and an analogy card that contained two stimuli that were not in the same relational frame e.g. apple: banana ::

orange: chair. The participant was capable of responding to all of the following independently equivalence- equivalence (alike), equivalence- non equivalence (different) and also non equivalence- non equivalence (alike). The participant was able to tact the relation between the first set of relations, then tact the relation between the second set of relations and finally tact the relation between these relations. Initially, Lily engaged in this relational responding with prompting from the researcher and she then began to tact aloud independently and finally she engaged in analogical responding with novel stimuli independently.

A variety of prompts were used in the most-to-least prompting phase of the alternating treatments design which included gestural prompts, echoic prompts and vocal prompts. As Lily progressed through this phase she began to show some independent responding and the researcher provided differential reinforcement for this. Lily began to emit behaviours which suggested that she wanted to engage in each of the trials independently for example, when the researcher provided a prompt she began the trial again, pushed the researcher’s hand away from the materials or made vocalisations such as “Be careful, stay there”. This accounts for some of the variability in the data paths as shown in the results section and as a result the researcher moved to independent responding as soon as was possible.

Another aspect which contributed to some variability in responding particularly in the table-top sessions was Lily’s preference for the arrangement of some of the stimuli. In the table-top sessions Lily re-arranged the order of the stimuli and did not begin the trial until the stimuli were in her preferred order, for example Lily preferred to have any analogy card that had a visual of an apple on it above any of the other analogy cards. Despite the order in which the researcher presented them Lily liked to re-arrange them herself. This type of rigid behaviour can be a characteristic of children with ASD and, in this case, resulted in greater time being spent on table-top trials. This was not an issue during the T-IRAP sessions as it was not possible for Lily to arrange the stimuli nor did she express any distress or negative behaviours if the stimuli were not in her preferred arrangement.

Additionally, Lily frequently called out for the researcher and asked to play the “matching game”. During her usual table-top work with her tutor in the preschool she was asked to select what she would like to work towards and she often asked for the researcher to do a research session with her as her reinforcer. She had also been observed to seek out the laptop computer and try to begin a session herself. While this is anecdotal evidence it does provide support for the idea that the analogy research sessions, using an interactive computerised teaching tool (T-IRAP), were a preferred activity for her and that it may not have been too difficult for her.

The results from Study 4 are very interesting in light of previous research which suggested that five-year-olds cannot engage in analogical responding unless provided with extensive training (Carpentier, Smeets & Barnes-Holmes, 2002). The results of the current study, although this is very preliminary research, suggest that a five-year-old with ASD can appear to engage with analogies independently. Although training was provided to the Lily in this study it could not be considered extensive as prompts were faded very rapidly as outlined. Another point that must be addressed is that stimuli used in previous research were arbitrary nonsense stimuli (e.g. a square with five circles, a cross shape). These stimuli were used to ensure that the participants were relating relations analogically and not a result of previous knowledge. However, in applied practices it is difficult to justify the use of nonsense stimuli particularly as the participant in this study was attending the preschool for ABA intervention in accordance with her autism diagnosis. It is always preferable in these situations to use stimuli that are practical and meaningful for the participant, particularly in the initial stages of preliminary research when the outcomes are unknown and ultimately the results may show that an intervention was ineffective and having used nonsense stimuli the participant may have gained little from the intervention.

Bearing the results of Study 4 in mind, future research could expand on this by using arbitrary stimuli to teach equivalence- equivalence responding, using the RFT procedures, as the current study tentatively suggests that this type of responding could be demonstrated by a five-year-old. As this is preliminary research, there are a number of other avenues in which future research could explore which could include pre- and post-analogy training IQ assessments. This would be particularly interesting research to conduct given the link between analogies and IQ/cognitive tests. As IQ scores are widely used and provide a benchmark on which to provide clinical advice and interventions it would be very socially significant if an RFT based procedure to teach analogies had a positive impact on IQ scores. Future studies could also examine the generalisation of trained equivalence-equivalence relations on typical analogy components of IQ measures. A further research project could examine if analogy reversals and the fluency in which these can be done have an impact on IQ measures. Such reversals, which involve responding with the 'wrong' answer, have been used in previous studies for other relational frames (Lyons & Murphy, under submission) with the idea of teaching relational flexibility. Given that equivalence-equivalence relations are thought to be more complex than frames such as co-ordination, distinction and opposition it could be worth exploring the impact of each of these reversals on IQ measures in comparison to analogical reversals with preschool aged participants. Reversals were not included in the current study as some of the participants were unable to complete the T-IRAPs independently as they were, without reversals. As a follow-up, it would be interesting to investigate if those that could use the T-IRAP independently could engage with reversals and how many training sessions this would require as well as any impact on IQ.

One limitation of this study was that the same stimuli were used in both the table-top and T-IRAP conditions which meant it was not possible to keep account of the cumulative learning across sessions. As this research is preliminary in nature and the participant had never been exposed to analogies previously it would have been particularly difficult to match analogical relations for difficulty. Additionally, as analogical responding is thought to be a complex skill, presenting too many exemplars of analogies may have been overwhelming for the participant. Nonetheless, future research should take into account this limitation and consider using different stimuli in different conditions if comparing table-top and T-IRAP methods in similar research.

In summary, this study demonstrates that analogies can be presented on a T-IRAP and table-top methods using the RFT procedure of equivalence- equivalence responding which can be adapted for early learners who cannot read by presenting visuals. The participant was capable of responding to equivalence- equivalence relations, equivalence-non equivalence relations and non equivalence- non equivalence relations. Furthermore, Lily demonstrated generalisation of these skills in both table-top and T-IRAP methods with table-top methods producing more accurate generalisation of analogical responding. These findings are influential given that previous research has suggested that typically developing children aged five cannot engage with analogical responding without extensive training.

Chapter 6

General Discussion

The current research was comprised of four studies which sought to teach various relational responding skills to eight preschool children with ASD aged 3-5 years old. Study 1 involved a multiple baseline design across four participants which incorporated PEAK DT targets into a T-IRAP. Pre- and post- assessments of cognitive and general ability were also conducted. The results indicated that two of the four participants could successfully manipulate the PEAK/T-IRAP independently while the remaining two participants could do so with prompts. Accuracy of responding to the T-IRAP remained relatively high across all participants while speed of responding generally decreased across sessions. Some differences in pre- and post- assessments were noted. Results from pre- and post-intervention assessments of language and cognitive ability showed some variability across time. Results suggested that participants who could engage with the PEAK/T-IRAP independently and with most fluency showed greater increases in the pre- and post-intervention measures. The generalisation probes indicated that one participant only could generalise the skills to novel stimuli.

Study 2 aimed to address some of the issues noted in Study 1 including poor generalisation and lack of independent responding to the PEAK/T-IRAP. This study included multiple exemplar PEAK/T-IRAP and a self-management intervention (line graph intervention). Results indicated that participants showed greater generalisation following the multiple exemplar PEAK/T-IRAP. However, the self-management intervention was successful for one participant only, Matt. When the intervention was implemented Matt, showed independent responding while his accuracy scores remained high and duration scores showed a decreasing trend indicating faster responding. The remaining two participants required further prompt phases before they began to respond independently.

To further investigate self-management interventions, Study 3 used an alternating treatments design to compare the line graph intervention (as used in Study 2) with a different type of self-management intervention (colour block intervention). The line graph intervention targeted accuracy and speed of responding while the colour block intervention targeted accuracy only. Results indicated that both interventions produced similar scores for speed of responding while the colour block intervention produced more accurate scores on the PEAK/T-IRAP. This study also increased the complexity of relational responding by including category-based PEAK/T-IRAPs.

Study 4 further increased the complexity of relational responding required by teaching analogies using RFT procedures to a five-year-old girl with autism. An alternating treatments design was used to compare the T-IRAP and table-top methods in presenting analogies. The results of this study showed that the T-IRAP produced much faster responding in comparison to the table-top methods. During the most-to-least prompting phase the accuracy scores for the T-IRAP and table-top methods were similar, however, in the independent responding phase the T-IRAP produced higher accuracy scores. Generalisation results showed that the participant could successfully generalise the skill to novel stimuli in both T-IRAP and table-top measures of generalisation.

The summary of each study, as outlined above, indicates that this research achieved a number of goals. These included incorporating PEAK with the T-IRAP, incorporating self-management strategies with the T-IRAP and, also, using RFT procedures and the T-IRAP to teach analogies. It is particularly important to take into consideration the age and profile of the participants in these studies when looking at the results. All participants were young, preschool children aged between three and five who all had primary diagnoses of autism and were all receiving specialised early behavioural interventions as a result of this.

Studies 1, 2 and 3 all demonstrated that PEAK-DT targets could be incorporated into the T-IRAP computer programme. The first two studies focused on ‘Matching’ and ‘Which One Doesn’t Belong’ goals. The T-IRAP then presented same/different relations to participants to target these goals. Study 3 also targeted same/different relations in the T-IRAP as well as category based responding which is included in the PEAK-DT module in goals such as ‘Sort Items By Class’ and ‘Receptively Label Items By Class’. This demonstrates not only the versatility of the T-IRAP in presenting various targets but also how PEAK targets can be incorporated into other teaching tools. Given that the PEAK is showing great promise in terms of its psychometrics properties and practical use (Dixon et al, 2014) it is a positive result that some of its targets can be incorporated into the T-IRAP as the T-IRAP has been shown in this research to be a beneficial educational tool for children with ASD. Research on PEAK has indicated that it correlates with measures of IQ including Peabody Picture Vocabulary Test and the Illinois Early Learning Standards (Dixon et al, 2014). As outlined, the relational frames as taught to fluency on the T-IRAP have potential to produce some increases in IQ, by combining PEAK and the T-IRAP there is potential for a great learning tool to enhance IQ. Furthermore, as PEAK is aimed towards a wider range age range than other curriculums (e.g. VB-MAPP; Dixon et al, 2014) the T-IRAP and PEAK together could also be very appealing for an older age of students who may already have the computer skills necessary to use the T-IRAP. Finally, as the current research has suggested that the T-IRAP presentation is appealing for students combining

PEAK and the T-IRAP could be a very enjoyable way for students to learn new targets as well as generalise and maintain skills learned in more traditional teaching methods. Future research, could look to incorporate some PEAK targets on to a tablet application in which students could set up their own profile and use this to manage and record their own scores on the application.

BOSS (Shapiro, 2004) data were collected for Study 1 and findings indicated that participants emitted greater on-task behaviours during the PEAK/T-IRAP sessions in comparison to their table-top work. As a result of this, Study 2 sought to investigate if these results were replicable with three new participants. BOSS data from Study 2 showed very similar results in that all participants showed greater on-task behaviour during the T-IRAP sessions and more off-task behaviour during their usual table-top work sessions. Research has shown that faster presentation of learning trials allows for fewer opportunities for off-task behaviour and can increase correct responding (Carpine, 1976; Binder, Haughton & Van Eyk, 1990). This type of responding is afforded by the T-IRAP which may have produced, or helped to produce, the results shown in the BOSS data. It is not possible for teachers to present and manipulate learning trials for students as fast as computerised methods. Teachers also have to record the data and provide the appropriate reinforcement or correction. Another possible explanation for the BOSS results is that the T-IRAP presents minimal information on screen which could help participants, particularly those with ASD who may also present with attentional difficulties, attend to the task at hand.

One limitation in comparing the BOSS results of the T-IRAP and table-top sessions was that the tasks in these observation sessions differed from each other. For the T-IRAP sessions, participants were always engaging with a relational responding task. However, for the table-top observations participants could have been engaging in a number of table-top tasks such as a listener responding programme or tacting programme. Future research could match the tasks e.g. record BOSS data when participants are engaging with a matching-to-sample table-top task and also when they are engaging with a same/different T-IRAP task. It was not possible to match the tasks as not all participants had matching-to-sample targets as part of their IEPs, however, the researcher was consistent in conducting the BOSS observations when the participants were engaging in table-top work rather than other types of teaching such as natural environmental teaching to best control the BOSS results across conditions.

Each of these four studies all indicated a similar result in that the participants appeared to enjoy the relational tasks presented to them. Data from the BOSS in Studies 1 and 2 showed that participants produced more on-task behaviour when engaged with the PEAK/T-IRAP and greater off-task behaviours during their usual table-top work. Supplementary to this, data were collected on Oscar's work refusal which also showed favourable results towards the PEAK/T-IRAP. The participants also exhibited behaviour which suggested they enjoyed the research sessions including spontaneously asking if they could "play the computer game" or "do the matching game", asking for the researcher and searching for the materials required to complete the research sessions. A general conclusion can be made based on this data and anecdotal evidence that the participants did not find the research sessions aversive and that the RFT procedures presented were enjoyable and not too difficult.

It is possible that the presentation of the research material on a laptop computer had an impact on the appeal of the research sessions. Computer based learning has been shown to produce more on-task behaviour and is an enjoyable learning experience (Heimann, Nelson, Tjus & Gillberg, 1995; Williams, Wright, Callaghan & Coughlan, 2002). Given that participants in the study did not usually use a computer as part of their academic work the research sessions could have been highly motivating. However, some participants received up to 37 sessions, by which time one would expect they may have become satiated had it been a factor of ‘novelty’ in using the computer, but participants remained enthusiastic throughout all the sessions with one participant requesting to do a research session when data collection was complete.

The T-IRAP has been illustrated to be a very useful and effective tool in presenting various types of relational responding tasks to children with ASD. It can be used to present any type of visual stimulus which can allow for huge arrays of multiple exemplars, it is relatively easy to use (although some brief training may be necessary), all data is collected electronically and it is free to download. However, this tool is not intended to replace 1:1 teaching in a classroom, rather it can be used to teach specific targets, to focus on generalisation of skills, for maintenance of skills and to promote fluency of skills. The T-IRAP could form part of a child’s learning as it has shown to be enjoyable and produces greater on-task behaviour. Furthermore, with technology becoming more widespread in day-to-day life it is worth noting the importance of teaching computer skills to young people as a socially significant goal.

While this research has shown the T-IRAP to be a very useful tool in teaching relational responding, it is important to note that some of the participants showed great difficulty in using the T-IRAP independently. It is possible that some students may require training on same/different relations using table-top methods, which would be more familiar to them, before engaging with the T-IRAP for generalisation or fluency measures. In this way, the T-IRAP may not be immediately accessible to all students of this age and this is a consideration which must be taken into account before using the T-IRAP to teach relational responding. Future research could examine if there are any specific pre-requisite skills which may be required by a student before engaging with the T-IRAP.

With the exception of one participant in Study 1, Josh, all participants tolerated the schedule of reinforcement used in the T-IRAP sessions. During the participants' usual academic work, the schedule of reinforcement varies across tasks according to the individual child and other factors such as difficulty of the task and response effort required to complete the task. These participants are accustomed to thick schedules of reinforcement ranging from fixed ratio of one to variable ratio of three. It is noteworthy that participants had little issue with completing eight consecutive trials on the T-IRAP when their table-top schedules are much thicker. As the T-IRAP can present trials very rapidly these eight trials can be complete quickly without the issue of ratio strain arising.

The issue of scrolling did arise with some participants particularly towards the end of the research sessions. Scrolling within the T-IRAP sessions involved some participants pressing the "D" and "K" keys at random irrespective of the stimuli presented. To overcome this issue, the researcher provided contingent praise upon the participant looking at the computer screen and then responding. The T-IRAP also provides a red 'X' when an incorrect response is provided which allows for immediate and consistent feedback. This also helped to overcome the issue of scrolling as participants noticed this and understood that they had to provide the correct response before the next trial was presented. This consistent feedback was helpful for other participants to engage in correct responding as one of them, Matt, referred to the red ‘X’ as a ‘trap’ and he wanted to avoid it.

The studies carried out in this research have shown that RFT and ABA can combine to teach basic language skills and have the potential to achieve even greater results than ABA alone. This type of research is important for showing the methods in which RFT ideas can be put into practice. Some previous research has shown how this can be done (Cullinan, Barnes-Holmes & Barnes-Holmes, 2001; Murphy & Barnes-Holmes, 2010; Rehfeldt & Barnes-Holmes, 2009;) and the current research adds to this particularly as participants included preschool children with ASD of which early intervention is of utmost importance. As RFT is beginning to merge with ABA it is important to have data and evidence to support their use, how they can be combined, how this would look and if participants (especially those with autism and other diagnoses) can complete the tasks.

One limitation of this research is that no procedural integrity measures were taken. This was predominantly due to a lack of availability of observers to collect data on procedural fidelity. As the researcher conducted all research sessions herself and was aware of all research procedures this reduced the risk of deviating from the agreed procedure between staff. However, future research of a similar nature should include measures on procedural integrity where possible to ensure that the researcher or researchers are adhering to the procedural guidelines.

An additional limitation of the study was that slight adjustments had to be made on an individual basis in relation to vocal instructions given to engage with the T-IRAP. As ABA focuses on providing individual interventions it was necessary to vary the instructions based on the participant’s level of understanding. However, this may have contributed to the variation of results in that some participants could respond independently to the T-IRAP while others were unable to reach this goal.

In summary, this research indicated that the T-IRAP can be used to present PEAK targets, such as the relational frame of co-ordination, to preschool children with ASD. There were some increases in pre- and post- intervention assessments in the participants that could independently manipulate the T-IRAP which is a promising sign in terms of the effects of relational teaching on cognitive abilities.

The T-IRAP has been shown to be an efficient means of teaching relational frames and can be used in conjunction with self-management strategies such as precision teaching, although the types of self-management strategies may need to be adjusted and individualised for some participants. Additionally, the T-IRAP was also used with table-top methods to teach complex relational responding in the form of analogies to a preschool participant with ASD which produced high levels of accuracy in responding and positive generalisation results. The T-IRAP was also found to produce more on-task behaviour and less off-task behaviour in comparison to participants' table-top work. The T-IRAP was found to be highly motivating for the participants during the research sessions.

Future research recommendations have been made throughout, however some additional ideas for future projects could involve replicating some of the studies presented here given that this research is one of the first to use the T-IRAP with such a young population with ASD. Also, future research could include typically developing children of a similar age to examine their derivation of same/different (as this did not appear to be present with the current population), if there is any impact of relational training (of basic relational frames) using the T-IRAP on tests of cognitive and general ability and a comparison on the number of sessions required to learn the skills presented to the participants in this research.

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Table of Appendices

Appendix 1

Informed Consent Form for Participants

The current research is being undertaken by June Dennehy, a Doctoral student in Psychological Science (Behaviour Analysis and Therapy) in Maynooth University. June Dennehy has been working as an ABA tutor in PRESCHOOL NAME REMOVED for the past year and will be conducting research within PRESCHOOL NAME REMOVED. The research will be supervised by Dr. Carol Murphy, B.A., Ph.D., BCBA who is also the Course Manager of the Doctorate in Psychological Science (Behaviour Analysis and Therapy).

- This research will examine the effect of teaching concepts such as same and different, opposite, bigger than and smaller than on the child's cognitive abilities. The research will also look at whether or not a computer programme (known as a Teaching- IRAP) can be used to teach these concepts and other aspects of a curriculum (known as PEAK). The information sheet outlines the purpose of the study in greater detail.
- The research will involve the use of tests of cognitive ability. The researcher will not provide the results of these tests to the school or the parents. If parents request these results they will be asked to make a formal written request to the researcher. The researcher and supervisor will give advice that the results of these tests should not be used to guide any clinical decisions or teaching as the researcher is not qualified to interpret these results.
- The researcher will adhere to all ethical guidelines as outlined by the Behaviour Analyst Certification Board and the Psychological Society of Ireland throughout the entire study.
- All of the data collected during this research will be anonymised and the child's identity will not be revealed in any publication or presentation of the data. All the data will be stored on a computer in a password protected file using false names for each participant. Data will be stored for 10 years as is standard practice.
- There will be no negative consequences for refusing consent for your child to participate. There will be no penalty for neither you nor your child should you decide not to allow his/her participation. You may withdraw your child from participation at any stage of the experimental phase of the study.

Please tick if you do/do not consent to your child participating in this research.

I do consent to my child participating _________

I do **not** consent to my child participating _________

I confirm that I have read and understand the above points outlined as well as the accompanying information sheet.

___________________________ Parent

___________________________ Parent

___________________________ Researcher

___________________________Date

Contact details

If you have any other further questions please contact the researcher, June Dennehy at JUNE.DENNEHY.2012@mumail.ie or Dr. Carol Murphy, Department of Psychology, Maynooth University on (01) 7086723 or Carol.A.Murphy@nuim.ie

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 Chairman of the Research Ethics SubCommittee, Dr. Andrew Coogan. Tel: (01) 7086624. Email: andrew.coogan@nuim.ie. Please be assured that your concerns will be dealt with in a sensitive manner.

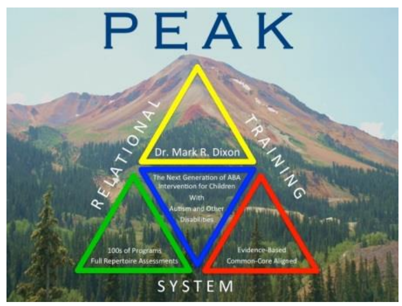
Appendix 2

Information Sheet for Doctoral Research

This information sheet outlines details on the research that will be conducted with the participants. Please contact the researcher, June Dennehy, if you have any questions.

What is the purpose of this research?

This research will involve the use of an assessment and curricular tool known as PEAK (Promoting the Emergence of Advanced Knowledge). This is a new tool used to test both typically developing children and children with autism and provides a PEAK score. The research will also use a computerised programme called the Teaching-IRAP. This is a programme which can present tasks to the participant rapidly. The T-IRAP can be used to teach different relational frames (e.g. same/different, bigger than/smaller than) which are important for language.



This research seeks to address a number of questions- Is there a link between the amount of training required to teach relational frames and an individual's PEAK score? Is there an impact in teaching relational frames on the participant's cognitive skills? Can the T-IRAP be used to teach some of the skills addressed in PEAK?

What will my child be required to do?

Some assessments of cognitive ability (Vineland Adaptive Behaviour Scales, Bracken School Readiness Assessment and Reynolds Intellectual Assessment Scales) and a PEAK assessment will compose the initial stage of this research. Following this your child will be presented with the T-IRAP which will teach each participant various relational frames such as same/different, bigger than/smaller than, based on their own abilities. Participants will be taught to use an interactive computerised teaching programme (T-IRAP) which will present stimuli (e.g., identical pictures of a dog) and the child will press a key meaning Same or Different. Pre-training may be necessary to teach the child how to interact with the programme. Positive reinforcement will be used in training and pre-training.

For the second part of the research some of the programmes from PEAK will be presented on the T-IRAP e.g. matching pictures and labelling. Each participant will make his/her way through their tasks while the researcher will collect data on how much time the participant spends paying attention to their work. Data will also be collected on each participant's attention during their usual everyday work.

Your child will be given frequent breaks and positive reinforcement as is usual for him/her. At the beginning of each session your child will be asked if he/she would like to do this particular type of work with the researcher. If he/she declines or indicates in any way that he/she does not want to participate he/she will not be required do so.

The research can be conducted either during school hours or outside of school hours, depending on parent preference. This can be discussed. The assessments will be run across a number of sessions (approximately 4) and the teaching sessions will last approximately 30 minutes, three times a week. The research will begin in November 2015 and will cease June/July 2016 approximately.

How will the data be stored?

Each participant will be given a false name and all data and information will be stored under this false name. The data will be stored in a password protected file on the researcher's computer. Only the researcher will have access to the data. The data will be destroyed after 10 years as is standard practice. However, the key identifying each child with his/her false name will be destroyed immediately after the data has been analysed. Any hard copies of data or information will be stored in a locked press in the Department of Psychology, Maynooth University.

The participants' raw data can be made available to parents on request up until the data is analysed. Following data analysis the key identifying each child with his/her false name will be destroyed and therefore it will not be possible to provide data after this point. The assessments of cognitive ability will only be made available on formal written request from a participant's parent. As the researcher is not qualified to interpret results from such assessments for clinical purposes, parents who do request this data will be provided with advice from the researcher and supervisor to indicate these results should not be used to guide any clinical decisions.

Does my child have to participate? Can I withdraw consent?

There is no obligation to provide consent for your child to participate. If you decide not to allow participation there will be no negative consequences arising from this decision. There will be no penalty for you or your child should you decide not to allow participation. Participation is entirely voluntary. Should you change your mind, you are free to withdraw consent for participation at any time. Please inform the researcher via email or in person if this is the case.

Are there any possible risks for my child in participating in this research?

If your child has experienced seizures or experiences or has experienced any discomfort when looking at a television or computer screen it is advised that your child does not participate in this study. It is also advised to notify PRESCHOOL NAME REMOVED of this condition.

Please note that this is **research** and the researcher cannot guarantee any benefits to participating in this study. This research is not a treatment of any kind.

Researcher Details

Name: June Dennehy, B.A., Doctoral Student

Address: REMOVED

Email: JUNE.DENNEHY.2012@mumail.ie

Supervisor Details

Name: Dr. Carol Murphy, BCBA-D

Address: Department of Psychology,
Maynooth University

Email: Carol.A.Murphy@nuim.ie

Contact no: 01 7086723

Appendix 3

Continued Consent Form

I would like to thank you for your co-operation throughout this current research. We are approximately half-through the research training sessions. I would like to ensure that you are still comfortable with providing consent for your child to participate in this research. If you have any questions or concerns please do not hesitate to contact the researcher. There will be approximately X amount of sessions left to complete the research.

Please sign and return this form if you wish to **withdraw** your child from the research.

___________________________ Parent

___________________________ Parent

___________________________ Researcher

___________________________ Date

Appendix 4

Informed Consent Form for Participants

The current research is being undertaken by June Dennehy, a Doctoral student in Psychological Science (Behaviour Analysis and Therapy) in Maynooth University. June Dennehy has been working as an ABA tutor in PRESCHOOL NAME REMOVED for the past two years and will be conducting research within PRESCHOOL NAME REMOVED. The research will be supervised by Dr. Carol Murphy, B.A., Ph.D., BCBA who is also the Course Manager of the Doctorate in Psychological Science (Behaviour Analysis and Therapy).

- This research will seek to teach concepts such as same and different, opposite, bigger and smaller using a computer program called a Teaching-IRAP. The research will also look at levels of on-task behaviour during the T-IRAP sessions and during normal table-top work. The information sheet outlines the purpose of the study in greater detail.
- The researcher will adhere to all ethical guidelines as outlined by the Behaviour Analyst Certification Board and the Psychological Society of Ireland throughout the entire study.
- All of the data collected during this research will be anonymised and the child's identity will not be revealed in any publication or presentation of the data. All the data will be stored on a computer in a password protected file using false names for each participant. Data will be stored for 10 years as is standard practice.
- There will be no negative consequences for refusing consent for your child to participate. There will be no penalty for neither you nor your child should you decide not to allow his/her participation. You may withdraw your child from participation at any stage of the experimental phase of the study.

Please tick if you do/do not consent to your child participating in this research.

I do consent to my child participating _________

I do **not** consent to my child participating _________

I confirm that I have read and understand the above points outlined as well as the accompanying information sheet.

____________________________ Parent

____________________________ Parent

____________________________ Researcher

____________________________Date

Contact details

If you have any other further questions please contact the researcher, June Dennehy at JUNE.DENNEHY.2012@mumail.ie or Dr. Carol Murphy, Department of Psychology, Maynooth University on (01) 7086723 or Carol.A.Murphy@nuim.ie

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 Chairman of the Research Ethics SubCommittee, Dr. Andrew Coogan. Tel: (01) 7086624. Email: andrew.coogan@nuim.ie. Please be assured that your concerns will be dealt with in a sensitive manner.

Appendix 5

Information Sheet for Doctoral Research

This information sheet outlines details on the research that will be conducted with the participants. Please contact the researcher, June Dennehy, if you have any questions.

What is the purpose of this research?

The purpose of this research is to use a computer program to teach concepts such as same/different, opposite, bigger/smaller. This computer program is called a Teaching-IRAP (T-IRAP) and it presents images on the screen e.g. 2 images of a square. The research will also look at levels of on-task behaviour when the participant is engaged with the Teaching-IRAP in comparison to their levels of on-task behaviour during their usual desk work. On-task behaviour includes the participant listening to their instructing teacher and actively completing tasks.

What will my child be required to do?

Your child will be presented with the Teaching-IRAP which will teach each participant various concepts such as same/different, bigger than/smaller than, based on their own abilities. Participants will be taught to use Teaching-IRAP which will present stimuli (e.g., identical pictures of a dog) and the child will press a key meaning Same or Different. Pre-training may be necessary to teach the child how to interact with the programme. Positive reinforcement will be used in training and pre-training. The participant will be working through these tasks with the help of the researcher.

Your child will be given frequent breaks and positive reinforcement as is usual for him/her. At the beginning of each session your child will be asked if he/she would like to do this particular type of work with the researcher. If he/she declines or indicates in any way that he/she does not want to participate he/she will not be required do so.

The researcher will also be observing the participant while they are engaged in their usual table-top work with their tutor. During these sessions the researcher will be recording the participant’s level of on-task behaviours. Similarly, while the participant is completing the Teaching-IRAP sessions an observer will record their level of on-task behaviour.

The research will be conducted during school hours. There will be 2-3 sessions per week with each session lasting no more than 30 minutes.

How will the data be stored?

Each participant will be given a false name and all data and information will be stored under this false name. The data will be stored in a password protected file on the researcher’s computer. Only the researcher will have access to the data. The data will be destroyed after 10 years as is standard practice. However, the key identifying each child with his/her false name will be destroyed immediately after the data has been analysed. Any hard copies of data or information will be stored in a locked press in the Department of Psychology, Maynooth University.

The participants' raw data can be made available to parents on request up until the data is analysed. Following data analysis, the key identifying each child with his/her false name will be destroyed and therefore it will not be possible to provide data after this point.

Does my child have to participate? Can I withdraw consent?

There is no obligation to provide consent for your child to participate. If you decide not to allow participation there will be no negative consequences arising from this decision. There will be no penalty for you or your child should you decide not to allow participation. Participation is entirely voluntary. Should you change your mind, you are free to withdraw consent for participation at any time. Please inform the researcher via email or in person if this is the case.

Are there any possible risks for my child in participating in this research?

If your child has experienced seizures or experiences or has experienced any discomfort when looking at a television or computer screen it is advised that your child does not participate in this study. It is also advised to notify PRESCHOOL NAME REMOVED of this condition. /

Please note that this is **research** and the researcher cannot guarantee any benefits to participating in this study. This research is not a treatment of any kind.

Researcher Details

Name: June Dennehy, B.A., Doctoral Student

Address: REMOVED

Email: JUNE.DENNEHY.2012@mumail.ie

Supervisor Details

Name: Dr. Carol Murphy, BCBA-D

Address: Department of Psychology, Maynooth University

Email: Carol.A.Murphy@nuim.ie

Contact no: 01 7086723

Appendix 6

Continued Consent Form

I would like to thank you for your co-operation throughout the research. It is greatly appreciated.

I would be interested in continuing on with some research as a follow-on from my previous research. The research will be conducted in the same way as the previous research. Sessions will be conducted 2-3 times per week for no more than 20 minutes per session. The research will re-commence in September 2016 and will cease in December 2016 approximately.

This research will examine if a computer program called a Teaching-IRAP can be used to teach concepts such as same/different.

Please ask for an information sheet if you would like any more details on the purpose of the study.

All the data and information collected will remain private and confidential. A false name will be used when storing any data and in any write-up which may follow data collection.

You are free to withdraw consent at any stage of this research by informing the researcher in person or via email (please see contact details below).

I consent to my child continuing research as outlined above.

____________________________________ Parent

____________________________________ Researcher

____________________________________ Date

Contact details

If you have any other further questions please contact the researcher, June Dennehy at JUNE.DENNEHY.2012@mumail.ie or Dr. Carol Murphy, Department of Psychology, Maynooth University on (01) 7086723 or Carol.A.Murphy@nuim.ie

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 Chairman of the Research Ethics SubCommittee, Dr. Andrew Coogan. Tel: (01) 7086624. Email: andrew.coogan@nuim.ie. Please be assured that your concerns will be dealt with in a sensitive manner.