Empirically testing the use of computerised equivalence-based instruction for teaching categorisation to young children.

Thesis submitted in partial fulfilment of the requirements for the Degree of Doctor in Philosophy

Ronda Barron M.Sc.

Supervisors

Dr Sinéad Smyth and Professor Pamela Gallagher

School of Nursing and Human Sciences, Dublin City University

External Supervisor

Professor Julian Leslie

School of Psychology, Ulster University

Dublin City University

January, 2016

Declaration

I hereby certify that this material, which I now submit for assessment on the programme of study leading to the award of Doctor in Philosophy is entirely my own work, and that I have exercised reasonable care to ensure that the work is original, and does not to the best of my knowledge breach any law of copyright, and has not been taken from the work of others save and to the extent that such work has been cited and acknowledged within the text of my work.

Signed: (Candidate) ID No.: Date:

Acknowledgements

"Categorization is not a matter to be taken lightly. There is nothing more basic than categorization to our thought, perception, action, and speech."
Lakoff (1987, p. 5)

Entering into the study of a topic so complex and diverse is one that was not taken lightly, the journey which has led to these very words being written, has been long, exciting and challenging. This journey, was not one that was undertaken alone, many people have accompanied and supported me along the way. Attempting to convey the magnitude of appreciation that I have with words, almost appears futile, words are simply not enough. Those who have been on this journey from the beginning, my supervisors, Sinéad, Julian and Pamela deserve my upmost appreciation. First and foremost Sinéad, there is no doubt that without her wisdom, knowledge, guidance and patience this process would not have been possible. Her work ethic and sense of mentorship are inspiring. Her investment in this journey and belief in me, especially when at times I had none, has enabled me to see the forest through the trees. When something seemed to be too complex there was one person whom could be counted on to assist, Julian. His expert knowledge, kindness, patience and support have been invaluable and most deserving of my appreciation. Pamela who has always shown her support and kindness, ready to assist in any form must also be given special thanks.

The staffing team in the School of Nursing and Human Sciences deserve many thanks for their help, support and guidance over the years and for making my experience there a memorable one. As postgraduate students, we grow and develop over the course of study, sharing our trials and tribulations along the way. Heartfelt thanks must be given to my cohort, my friends in H101, whom have been unending in their support. More importantly, my appreciation must be given to those who truly made this body of research possible, the children whom participated, their parents and the staff who worked across the various schools.

My friends and family, especially Mary, my mother, have been relentless in their support over these years of study. There are too many people to name individually but my heartfelt thanks must be expressed, for keeping me together through the darkest of times, for words of advice, hugs and endless cups of coffee. My friends and family

have yet to realise that a PhD is just the beginning of what I have no doubt will be, a lifetime dedicated to similar investigations. For this, I offer my apologies.

When I consider how Skinner described love, “What is love except another name for the use of positive reinforcement? Or vice versa.” (1948, p. 282). I am fortunate to say that during the PhD process, I have encountered nothing but positive reinforcement. Beyond the explanation of words, my heartfelt appreciation must be given to the people whom I hold most important, Cian and Heather. The measures that have been undertaken to ease this process and the sacrifices made to support me are insurmountable. For the unwavering love, support and encouragement, I have no words other than simply, thank you.

Table of Contents

Table of Abbreviations

AARR	Arbitrarily applicable relational responding
ABC	Antecedent behaviour consequence
APF	Audience-paced feedback
ASD	Autistic Spectrum Disorder
CPS	Classroom performance systems
DRR	Derived relational responding
EBI	Equivalence based instruction
ERS	Electronic response systems
GRS	Group response systems
IE	Interactive engagement
ILS	Interactive learning systems
IQ	Intelligence quotient
IR	Infrared
IRIS	Interactive audience response systems
ISRS	Interactive student-response systems
MET	Multiple exemplar training
M	Mean
MMA	Members of the Montessori Schools Association
MTS	Matching-to-sample
OTM	One- to-many
PLS	Preschool language scale
PRS	Personal response systems
RAI	Relational Abilities Index
RF	Radio frequency
RFT	Relational Frame Theory
SaN	Sample- as- node
S^D	Discriminative stimulus
SD	Standard deviation
SRS	Student-response system
TULSA	Child and Family Agency (Irish State)
WRS	Wireless response systems

List of Tables

List of Figures

List of Appendices

Abstract: Empirically Testing the Use of Computerised Equivalence-based Instruction for Teaching Categorisation to Young Children.

Ronda Barron MSc

Three empirical studies investigated equivalence based instruction (EBI) as a method of teaching categorisation to young children (3-6 years). In empirical Chapters 2-4 six conditional discriminations were training using a touch screen matching-to-sample (MTS) programme and tested for emergence of three derived (untrained) three-member classes. Chapter 2, Experiment 1 successfully tested EBI, modified MTS procedure with neurotypical children and findings were replicated in Experiment 2 with children with Autistic Spectrum Disorder. Chapter 3 compared the efficacy of the EBI, modified MTS procedure with a traditional teaching aspect. In terms of direct teaching time no significant differences were demonstrated indicating that the EBI procedure may have application in mainstream educational settings. Chapter 4 investigated if EBI is effective to teach generic skills (Irish Primary Curriculum), and examined group contingencies across three experiment which took place within two mainstream educational settings with slightly older populations (5-7 years). Using an electronic student response system, individual and group data were recorded per trial. Significant differences were found between pre and post intervention category knowledge. The findings overall provide support for EBI to teach simple and complex category membership using group contingencies in traditional education settings. Additions to the literatures include the first known comparison of equivalence based instruction (EBI) with another established method for teaching categorisation (Chapter 3). Chapter 4 provided the first known study to combine EBI with existing technologies to examine group contingencies.

Chapter 1: A Behaviour Analytic Account of Categorisation an Overview of the Literature

Introduction

How humans classify and organise information is essential to our everyday interactions. Knowing that eating a certain small round berry, which perhaps was red, would cause death, but that a larger oval shaped berry also red was safe to consume would likely result in placing those berries into two categories; food which is safe and food which is dangerous. Human ability to apply this prior knowledge to new situations is made possible by our ability to categorise the objects and experiences from the world in which we live. Miller and Dollard (1941) recognised how categorising diverse experiences such as the example given contribute to adaptation and survival of the human race. The processes which underlie human ability to categorise or classify information have been the topic of study since the days of Plato. Earlier literature of philosophical conjecture, laid the groundwork which later led to experimental psychological work on concepts (Fisher, 1916; Hull, 1920; Hull, 1939). While research on categorisation continued from the behavioural perspective (Kuo, 1923; Gengerelli, 1927; Smoke, 1932), research investigating concept or categorisation formation has not been a major focus of the field (Zentall, Galizio & Critchfield, 2002). What research had been conducted had little impact outside on fields outside of behaviour analysis, within the cognitive literature little to no acknowledgment is given to published research from the perspective of behavioural psychology with exception to Hull's, 1920 paper (Medin & Rips, 2005; Murphy, 2002). And, it is a held belief that behavioural perspectives on categorisation faded in the middle of the last century (Medin & Rips).

Behaviour analysis is the scientific study of the relationship between the environment and the behaviour of a species (human and non-human). Skinner (1969b) outlined two main categories of variables that influence behaviour; phylogenetic and ontogenetic variables. Phylogenetic variables can be seen as genetic traits passed down via reproduction and are thus inherited. In conjunction with an individual's environment these inherited traits contribute to both respondent and operant behaviour. Respondent behaviour is a behavioural process which occurs as a response to some stimuli. Respondent type behaviours are essential to an organism's survival, often functioning as protection against harmful stimuli. Involuntary action which is not learned (inherent) is characteristic of respondent behaviours such as a pupil flickering when exposed to direct sunlight. If this behaviour did not occur long-term exposure to direct light could lead to blindness (Cooper, Heron & Heward, 2007; Skinner).

Operant behaviour refers to behaviour that 'operates' on the environment, behaviour which produces an effect on the environment. Unlike respondent behaviours operant behaviours are not involuntary but are controllable by the individual. Ontogeny therefore, refers to the selection of behaviours as a result of their consequences. Skinner viewed such operant behaviour as "an evolved process" his standpoint one which views operant behaviour selected through the phylogenetic process of natural selection. Because, such selection provided a way by which individuals could acquire behaviour which was adaptive to environmental changes over their lifetime (Skinner, 1981, p. 502). The key difference with ontogenetic variables is that the observable changes occur within the lifetime of the individual. Skinner emphasised how these changes can be momentaneous versus occurring over long periods of time or across multiple generations as seen within natural selection Therefore, a central assumption of the science is that observable behaviour is a function of the interaction between the organism and environmental variables (Skinner, 1969b; 1981). The science of behaviour analysis is one that focuses upon behaviour defined in observable and measurable terms (Baer, Wolf & Risley, 1968). The identification of rules or laws that govern such relationships in a predictable manner is therefore the goal of the science (Cooper et al., 2007).

Within the behaviour analytic research community the most commonly used type of research design favoured is that of single case/subject research designs (SCRD) (Kazdin, 2010). The name SCRD may suggest that these groups of research methods are limited to, or focus upon, one individual at a time, however, this is a more common misconception and these designs have application with pairs or small groups of participants. Within SCRD the independent variable (IV); the intervention, treatment, instruction and so forth, should be clearly operationally defined to provide clear understanding of what is being measured on the dependent variable (DV); the behaviour change of interest for example, hitting or attention in class. One concern with these designs is external validity, how can one tell if the IV while successful with one DV or individual, will it be successful with another? Within single case and small group research, the essence of external validity is found in replication (Kazdin). Indeed, with applied education or research settings the question of generality is not always the primary concern, often success is measured on an individual basis. SCRD offer a host of benefits, the very nature of these designs allows the gathering data in situations that would otherwise be considered difficult, if not impossible to conduct a study involving treatment and control groups. Applied researchers are most often concerned with individual differences. Therefore group comparison designs, often used outside of Applied Behaviour Analysis research, do not provide the needed information, as these group designs often hide individual differences (Kazdin; Kennedy, 2005).

Zentall et al. (2002) discussed how the traditional cognitive views of categorisation or classification whereby category members are said to be units of mental representation or knowledge do not allow for the idea of behaviour-environment relations. The process of providing an account of categorisation in observable and measurable terms becomes increasingly difficult when hypothetical constructs such as the term conceptualisation are used to describe a process. From a behavioural perceptive it is possible to examine the circumstances under which these behaviours are said to be present; what individuals say and what they are specifically doing when they are said to be behaving in this manner (Zentall). Keller and Schoenfeld (1950) attempted to account for the lack of behaviour-environment relations in the existing theoretical perspectives by offering a behaviour analytic description of what makes up a concept. They described a concept as being a group of objects which induce a response, for example presenting a stool induces the behaviour of sitting. When an individual responds in the same way to a group of objects, these objects then make up a class which can then be called a concept (Keller and Schoenfeld; Zentall).

The behavioural analytic perspective would therefore see a category as being a stimulus class that the members of which, under a specific context, occasion common responses. These classes include stimuli that may have an explicit learning history, whereby encountering novel stimuli may through that past learning history, transfer to a stimulus class. Keller and Schoenfeld (1950) furthermore described the categorisation process as being one of generalisation within classes of stimuli (e.g., people have legs) and discrimination between classes (e.g., not everything that has legs are people -. Furniture). Zentall emphasized that any plausible account of categorisation must also explain how categories add and lose members, and how they may merge and fracture. In addition, an explanation of how categories share members that may belong to different categories under different circumstances and how the spontaneous transfer of function from one member to another occurs must be provided (Zentall et al., 2002, p. 238).

Zentall, Wasserman and Urcuioli (2014) outlined two main types of classes; perceptual and associative classes. Perceptual classes share common physical characteristics. In contrast, an associative class may comprise an object and its various symbolic representations. For example, an earth worm, across just a few symbolics, a picture of a worm, a worm itself, the printed word WORM, the spoken word “worm”, none of these representations share common physical characteristics. The critical aspect of an association class lies in that, members within limits of the given class can in fact be interchangeable and substituted with one another. The construction of an associative class often means that there is little to no visual similarity between members of the class. In the same instance that a spider and a worm do not share any physical similarities, a worm and the printed word WORM do not share similarities. Natural categories often comprise fuzzy boundaries and more often contain stimuli which are both perceptual and associative (Zentall et al., 2002; 2014).

When discussing category structure, Zentall et al. emphasised three broad ranges of relations which appear to unite members within a category. The first concept they defined is that of stimuli which are grouped primarily upon their shared physical similarities, known as perceptual concepts. The second, relational concepts, are stimuli grouped based upon relations between features, differing to those stimuli in perceptual concepts. Finally, associative concepts comprise of a stimuli group on the premise of shared function. A key emphasis is that what one is taught about one member of a class is immediately and successfully transferred to other members of the class without further training (Zentall et al., 2002). In their 2014 paper, Zentall et al. (2014) called attention to the associative process by illustrating how “when children are taught that socks, hats and pants, etc. are all clothing” and later learn that apparel is a synonym for clothing they automatically without any further or explicit training call socks, belts and other members of a clothing category by apparel” (p. 133). Hull (1939) proposed that secondary stimulus generalisation may be a means of accounting for the development of such associate classes.

The theories discussed thus far indicate that much of the research regarding categorisation has been done so in an attempt to establish control over category knowledge or that research has focused on the specific type of knowledge which is required to produce categories. Zentall et al. (2002) however, emphasised that the focus should be on identifying functional relationships between behaviour and the environment that in turn provide the basis for conceptual behaviour to occur. Moreover, the complexities facing an analytic challenge become much more evident as category membership inclusion becomes more complex. A behaviour analytic account of categorisation, like many other research traditions (including cognitive psychology), has included attempts to create artificial categories through an experimenter-selected protocol rather than using every day real world or natural stimuli (Zentall). Barsalou (1992) stressed how often within these protocols participants are required to respond to examples and non-examples of category members with the goal being ‘‘to establish high degrees of control over category knowledge’’ (p. 31). The types of learning paradigms nonetheless are reminiscent of discrimination learning (Zentall).

Stimulus Equivalence

According to McIlvane (2013), discrimination in the broad sense relates to the ability of organism to differ behaviour when stimulus conditions change. The fundamental analytic unit within behaviour analysis specifies a relationship involving (A) antecedent stimuli that occasion behaviours, (B) the behaviours of the organism and (C) the consequential stimuli that follow behaviour influencing the probability of the behaviour occurring in the future. Within applied behaviour analysis, this unit is often referred to as ABC (antecedent-behaviour-consequence; three term contingency) analysis (McIlvane). Discrimination learning therefore is concerned with the ability of an organism to behave adaptively as a function of experience. In this three-term contingency the likely hood of the behaviour occurring in the future is as a result of either punishing (decreases the future probability of the behaviour occurring) or reinforcing (increases the future probability of the behaviour occurring) consequences. McIlvane illustrated that “If the organism reliably exhibits one pattern of behaviour in relation to Stimulus A and a different pattern in relation to Stimulus B, then one says that discrimination of A versus B has been established” (p. 132). Within the behaviour analytic field, category or concept learning in non-humans has been investigated, first to establish categorisation abilities within specific species, and second to find out if interspecies similarities and differences exist. An additional community of researchers has focused primarily in research with humans; with which this thesis is concerned.

Much like the first documented discussion of categorisation the principal concept of stimulus equivalence dates back to Aristotelian times (Whitaker, 1996). However, outside of mathematical disciplines the theory was one unknown across psychological perspectives Bruner et al. (1956) are the exception. In 1982, Sidman and Tailby described a series of tests to determine if through teaching a few relations directly to one another would this process result in derived or untrained relations to emerge, they termed this process stimulus equivalence. Stimulus equivalence involves the establishment of at least two conditional discriminations. A conditional discrimination procedure as previously discussed involves four-term contingencies usually by presenting or arranging stimuli in a manner in which differencing, three-term contingencies (ABC contingencies) operate.

Training arrangements typically involve the simultaneous presentation of a discriminative stimulus (S^D) which evokes behaviour because, in the past, that behaviour has been reinforced in its presence and or stimulus delta ($S\Delta$) which has the function of weakening a behaviour (making it less likely to occur in the future) because in the past that behaviour has been extinguished in its presence. Depending on the presence or absence of another antecedent stimulus, a stimulus is found to change function, thus acting as either an S^D or $S\Delta$, this is termed a conditional stimulus (the 4th term in the contingencies). It is termed so because it establishes the conditions under which a discriminative stimulus functions as either an S^D or $S\Delta$. This process is often seen as reflective of the real world whereby situations often involve complex conditional discriminations (see Figure 1.1 for an example demonstrating S^D or $S\Delta$).

The most commonly used paradigm in conditional discrimination learning is that of match-to-sample (MTS) training and testing. Within this type of training arrangement, the conditional stimulus is called a sample stimulus (e.g. cat) the other stimuli are called comparison stimuli, or comparisons (e.g. apple, dog and ball). Within a computerised MTS task the sample stimulus is typically presented at the top centre of a screen. Depending upon methodology, the sample disappears either following selection or after a short time period and an array of comparisons then appear across the bottom of the screen (e.g. left, centre and right). During training, feedback is given upon selection of a comparison as to whether the selection was correct or incorrect and no feedback is given during testing phases (Sidman).

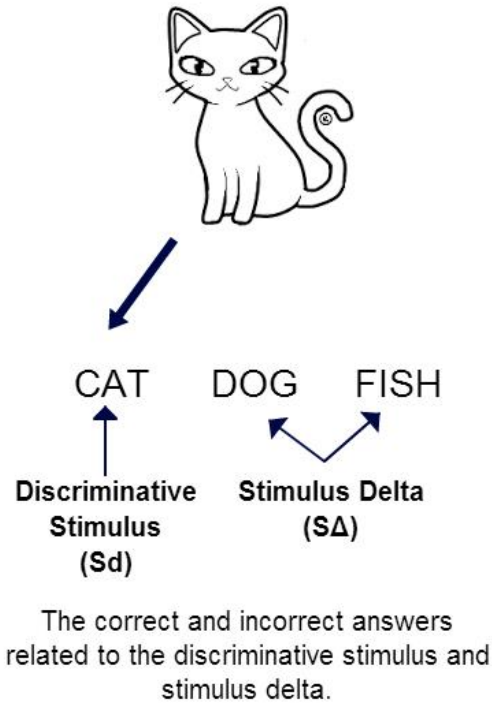


Figure 1.1. Simple representation of correct and incorrect answers related to the discriminative stimulus and stimulus delta.

Sidman and Tailby (1982) outlined certain features of equivalence responding which combined the mathematical properties of reflexivity, symmetry and transitivity. In order for a stimulus equivalence class to be said to have emerged, all three properties must be demonstrated. Reflexivity is evaluated by tests for generalised identity: matching a single stimulus to itself (cat to cat, A to A, etc.) however this should occur without explicit training. Symmetry is tested for by means of reversibility which follows training to establish the selection of a comparison A (dog) upon sample B (cat) or A-B matching. Symmetry is evaluated by testing for the reversal B-A matching, in the presence of sample B (cat) the comparison stimulus A (dog) is selected from an array of comparisons. A test for the emergence of derived relations typically involves a combined test for transitivity. Tests for transitivity are often combined and require a minimum of three stimuli. If an individual learns to match B (dog) in the presence of A (cat), and also to match C (fish) in the presence of B (dog), then transitivity occurs when an untrained relation A-C matching (cat-fish) and the reversal (symmetry) of the untrained C-A relation (fish-cat) is demonstrated. If demonstrated along with the properties of reflexivity and symmetry, it can then be said that an equivalence class has been formed. The emergence of equivalence relations has provided a way for researchers to experimentally examine what Sidman (2009) called an elusive kind of stimulus generalisation. One explanation of this generalisation effect provided is that of transfer of function. Any stimulus function applied to one member of an equivalence class will transfer to the others in the absence of direct training (Dymond & Rehfeldt, 2001).

Sidman (1994) clarified that his theory was not one that originally attempted to account for the processes that underlie the equivalence class formation, but was first and foremost a descriptive functional, behavioural explanation of the phenomenon observed "My own theorizing has been directed not so much at an explanation of equivalence relations but rather, at the formulation of a descriptive system -- a consistent, coherent, and parsimonious way of defining and talking about the observed phenomena" (p.536). Sidman's seminal paper (1971) was an applied study, which examined reading skills in institutionalised adolescent male with severe mental retardation. The participant had never shown evidence of reading comprehension prior to training, but had demonstrated the ability to match pictures to corresponding spoken words. During training the participant was directly taught to match five printed words to the spoken word using the conditional discrimination procedure previously outlined. With no further training the participant could then match printed words to pictures and pictures to spoken words demonstrating the development of a stimulus class. These results could not be explained in terms of visual-visual generalisation due to physical resemblances as printed words and pictures do not share many similar properties. Sidman later suggested that the words had become symbols for the pictures (Sidman, Wilson-Morris & Kirk, 1986).

Since Sidman's seminal paper (1971) stimulus equivalence has surprisingly received little attention in applied settings using stimuli which are naturally encountered in the real world (Zentall et al., 2002). Basic research under laboratory conditions which allow for stringent experimental control has been favoured in an attempt to establish which conditions and variables are responsible for this phenomenon. Barnes-Holmes, Hayes, and Roche (2001) published a paper "*The (not so) strange death of stimulus equivalence"* the authors highlighted a lack of transfer from basic to applied research, a sentiment which has been shared by proponents in the field Sidman (2009) and Rehfeldt (2011). As a result of such calls for more naturalist research in more recent years researchers in the applied context have begun to examine the application of equivalence procedures. This methodology for teaching functional skills within educational settings is known as Equivalence Based Instruction (EBI) which will be explored in more detail later in the current Chapter and Chapters 2-4. This is not to state that research in the area of equivalence has been lacking, in contrast this is an area which has produced over forty years of empirical research.

Barnes (1994) illustrated that one of the main reasons for the research attention given to equivalence centres on the fact it is not accounted for by the concept of conditional discrimination. Conditional discrimination procedures do not predict the emergence of this untaught performance when traditionally defined. If taught to choose B in the presence of A and C in the presence of B, when later tested without reinforcement, selecting A in the presence of C and C in the presence of A is often shown. For the A and C stimuli, there is an absence of differential reinforcement as a conditional discriminative stimulus regarding each other, therefore neither should control selection of the other (Barnes). A further motivation for research interest in stimulus equivalence comes from the suggestion it is closely related to complex human behaviour, specifically verbal behaviour. Although research in stimulus equivalence and verbal behaviour grew as separate areas, similarities between the two quickly became evident (Hayes, 1989). This separation within the behavioural field echoes the spilt in research directions that is found in traditional psychological research. Research work across these two areas have enabled those in the behavioural field to counter the arguments of Chomsky (1959) and other linguists, who have claimed that behavioural theories cannot account for the acquisition and use of language, particularly behaviours which occur for the first time without direct training (Hall & Chase, 1991). The body of equivalence literature has provided positive evidence towards a theory of language and cognition and in addition has raised many questions and criticisms.

Research in stimulus class formation has been documented across a variety of verbally-able human populations, but equivalence as defined by Sidman has not unequivocally been demonstrated by non-verbal humans and non-human populations (Barnes, McCullagh & Keenan, 1990; Devany, Hayes & Nelson, 1986; Dugdale & Lowe, 1990; Hayes, 1989; Hughes & Barnes-Holmes, 2014; Sidman et al., 1982; Zentall et al., 2002; Zentall et al., 2014). Researchers within the field of stimulus equivalence have therefore taken upon themselves to investigate these types of formations, in an attempt to establish if equivalence class formation can indeed be found in non-verbal human and non-human populations. Many similarities can be found in research conducted with non-humans with responding performances seen in human populations across the literature. Zentall and Smeets (1996) discussed how much research in basic learning processes has studied stimulus classes, which often contain stimuli which are similarity based, perceptual classes. Research has shown that as similarity decreases, correct responding to test stimuli decreases in a direct proportion and this function is known as stimulus generalisation (Spence, 1937; Riley, 1968). Non similarity-based classes can often be described as arbitrary as they may be related by other functions than physical similarities. Zentall and Smeets discussed how even across a broad range of stimuli in similarity-based classes minimal change is found in response, however, at the boundary of the category where similarity becomes more difficult to determine, an abrupt change in response strength is demonstrated.

Sidman (1994) suggested that equivalence is foremost a primary behavioural process, he advocated that the formation of equivalence classes is a critical element in the foundation of language, but that language itself is not a determining factor in this process. If true, then the demonstration of equivalence relations in individuals with non-existent spoken language repertoires or non-naming individuals should be entirely possible (O'Donnell & Saunders, 2003). Many studies have demonstrated equivalence in human participants, but have a commonality, all participants' shared a pre-experimental history of engaging in some form of human language (Miguel, Petursdottir, Carr, & Michael et al., 2008). It has been suggested that documentation of the participants' pre-experimental language skills and characteristics would enhance contributions to the stimulus equivalence literature. This baseline will strengthen observations of correlations between participants' current language abilities and performance (Miguel). More specifically, Dube and McIlvane (1996) suggested that more research in the area of stimulus equivalence with children between the ages of 18 and 36 months should be conducted to add to the data supporting that equivalence classes can be demonstrated prior to the development of language. It is at the age of approximately 36 months that children experience a sudden burst of new language. Dube and McIlvane suggested that more research with this population would benefit knowledge of stimulus equivalence as an underlying behavioural process.

Equivalence demonstration by a preverbal human, near the ages suggested by Dube and McIlvane (1996), would lend support to the account that equivalence is an emergent process resulting from contingencies of reinforcement, rather than language development. Similar to research in categorisation in other fields of psychology, this relative neglect of minimally verbal/non-verbal populations or infant populations is difficult to explain. de Alcantara Gil, de Oliveira, & McIlvane (2011) offer an explanation for the scarceness of research which echoes that given by Murphy, 2002. Issues in relation to expenses, logistical support, and, perhaps, methodological insufficiency, when verbal instructions are ruled out are highlighted as variables that restrict or limit research in these populations. Children who are more verbal (e.g., aged 24+ months) pose a lesser challenge to behaviour analytic researchers using methods such as matching-to-sample (Boelens, Van Den Broek & Klarenbosch, 2011; Pilgrim, Jackson & Galizio, 2000; Jordan, Pilgrim & Galizio, 2001; de Alcantara Gil, de Oliveira & McIlvane, 2011), but children at this age have already gained substantial verbal skills as speaker and listener. Importantly, the problem of developing necessary performance baselines in pre-verbal children has been identified (de Alcantara Gil et al., 2011). O'Donnell and Saunders (2003) emphasised how typically developing children in the critical age range (e.g. before 21 months) are often not accessible, and at this age lengthy individual sessions over long drawn out training courses are not tolerable. Researchers have nonetheless endeavoured to control for these variables and create an appropriate methodology to support research with pre-verbal infants.

Findings from research with children as young as 21 months have shown the formation of equivalence classes consisting of colours (Pelaez, Gewirtz, Sanchez & Mahabir, 2000). In 2011, de Alcantara Gil et al., conducted a study within a day care environment with a slightly younger population, three pre-verbal participants (16-21 months). The study was designed to be representative of a more naturalistic environment and took the form of a play session. All stimuli and materials used consisted of manipulative tactile objects (toys) two; 10 minute sessions were conducted weekly. Initial training comprised simple discrimination and discrimination reversal trials whereby S+ and S− toys were presented within two windows. When the toy defined as S+ was touched on a trial, the participant could play with that toy. If the participants selected the S− toy, the trial ended without a play opportunity. Identity matching followed, which comprised the participant being allowed to play with a sample toy, the comparison S+ (matching) and S− (non-matching) toys were presented within two windows and the consequence for correct and incorrect responses were the same as in simple discrimination trials. The results support the position that pre-verbal children can master simple and conditional discrimination performances via conditional discrimination procedures. de Alcantara Gil et al. suggested pre-verbal children may in fact be capable of performing using other procedures modelled after those used with older populations. A further point de Alcantara Gil et al. make is that, such methodology may have a greater value than examining stimulus equivalence potential in pre-verbal children and may lead to protocols that have real world generative value, in terms of application to a variety of populations and settings.

Relational Frame Theory

Hayes et al. (2001) discussed how language and the words we use can be seen as ideas or symbols, their description one which is reminiscent of that given by Murphy (2002). Hayes (1989) suggested that, because of an extensive learning history of symmetrical responding with conditional discriminations, equivalence class formation develops. Hayes furthermore suggested, that the phenomenon referred to as ‘Sidman equivalence’ could be classed as relational associations involving language, his stance being that such processes involve extensive training with symmetrical responding via conditional discrimination procedures, and that equivalence is therefore only one of these possible relations. Within Relational Frame Theory (RFT) many types of relational responding exist and are termed relational frames (Hayes). Relational frames are defined by three properties; the first is mutual entailment which refers to the derived bi-directionality of some stimulus relations, the concept of symmetry in stimulus equivalence. That is to say if within a specific context a stimulus A is related to stimulus B, then a relation between the B and A can be entailed. The second property termed combinatorial entailment is comparable to combined transitivity within stimulus equivalence. Combinatorial entailment represents instances, whereby two or more relations in which the property of mutual entailment has been acquired, join or mutually combine (O’Hora, Roche, Barnes-Holmes and Smeets, 2002). If we use the example of ‘more-than’ it can be said that, if ‘9’ is more-than ‘5’, and ‘5’ is more than ‘1’, then a more-than relation is entailed between ‘9’ and ‘1’, and that a less-than relation is entailed between ‘1’ and ‘9’. Hayes and Barnes (1997) explained that, a transformation of stimulus function occurs as a result of an altered function of an event, effecting change in another event within the network and leading to derived relations between them to form. Hayes and Barnes clarified that, within RFT, labelling of stimulus classes can be described as arbitrarily applicable stimulus relations. Within the natural language context words and objects do not share any similarity and therefore can be deemed as arbitrary responding for example, the spoken word ‘worm’ and the physical insect ‘worm’ share no similarity.

A fundamental process in the theory of relational responding is based upon contextual cueing. Previous research has demonstrated how human and non-humans alike respond to formal properties between stimuli, hue, brightness and length (e.g., colour hues in pigeons; Wright & Cummings, 1971). Humans can additional respond to other relations that are controlled through specific contextual cues. According to Hayes and Barnes (1997) mutual and combinatorial entailment are regulated by contextual cues (C rel), the transformation of stimulus function is regulated by other additional contextual cues (C func). Within RFT relational responding to contextual cues is viewed as being established at a young age, often during early language acquisition stages of development. During these early stages of development, children are often presented with learning situations which involves receiving an object and then being asked to repeat the name of the object (Hayes & Barnes). To illustrate a child sees the object ‘milk’, then hears the name ‘milk’ which is followed by the child saying the object name ‘milk’. Furthermore, children are often taught to identify such objects upon hearing a name, hear ‘milk’, then see ‘milk’. While these relations may initially be directly trained, training may subsequently lead to the emergence of untrained/derived relational responding (DRR). Contextual cues such as ‘is’ predict that, if the object is ‘milk’ (object ‘milk’ - name ‘milk’) the reversal of this is also true, ‘milk’ is the name of the object (name ‘milk’ - object ‘milk’). While training initially involved the process of differential reinforcement, says ‘milk’ - receives object ‘milk’ versus says ‘orange’ - does not receive an object ‘milk’. Consequently over time, the child, in the absence of differential reinforcement may identify milk when asked ‘Where is your milk?’ (Hayes & Barnes).

Derived arbitrarily applicable relations, referred as a ‘relational frame’ can be conceived as a type of generalised operant behaviour. Through a process of differential reinforcement patterns or repertoires of relational framing are brought under the control of contextual cues (e.g. the word ‘is’ or ‘if’; Barnes, Lawlor, Smeets and Roche, 1996). It is these generalised operant behaviours which have been used by proponents of RFT to explain one of the key features of human language. There are many differing types of stimulus relations associated with human language which may also be explained in terms of generalised operant behaviour (Barnes et al.,). Contextual cues such as ‘more’ or ‘less’ for example given enough exposure to differential reinforcement, which cup has more water, which bag has more sweets, may in time produce additional relational responses that come under the control of the contextual cue ‘more’. Gross and Fox (2009) highlight how such relational responses can be arbitrarily applied to other events or objects, even when those events do not occasion the relational response. To clarify, consider children’s clothing, size thirteen shoes are bigger than size one shoes, even though physically the former is smaller in size as such many relations other than equivalence can be derived in this manner, for example relations of comparison and opposition (Dymond & Barnes, 1995; Green, Stromer & Mackay, 1993; Gross & Fox; Barnes & Roche, 1996). Gross and Fox stress that, examination of derived stimulus relations may provide researchers with a valuable model for analysing language and other complex human behaviour.

The arbitrary nature of derived stimulus relations is comparable to how humans use spoken language within natural language contexts, as mentioned previously words and their physical representations often share few formal properties. The printed word ‘worm’ shares no similarity to a physical ‘worm’, yet, humans tend to use and respond to arbitrary spoken words as if they are not only equivalent but share the psychological functions or meaning associated (Gross & Fox, 2009; Sidman et al, 1982). The phenomenon of deriving complex networks of relations following minimal direct training, therefore may account for the extraordinary and complex use of human language (Barnes-Holmes, Hayes, Dymond, & O’Hora, 2001). Proponents of RFT challenge experimental evidence from the stimulus equivalence literature, suggesting that non-human subjects have been able to demonstrate stimulus equivalence. Support in favour of the RFT position that equivalence is only formed by language-able humans is supported by several published research papers. Devany et al. (1986) compared the performance of three groups of children (normal functioning levels, retarded with speech capabilities, and retarded with a language deficiency) to determine whether language capabilities influence an individual’s ability to form equivalence classes. Language-able children performed better on the stimulus equivalence test than those without language, supporting a positive correlation between ability to speak and performance on equivalence tests. Much empirical evidence has been conducted which finds an association between derived stimulus relations and language development. However it can be argued that in non-typically developing populations, impediments other than language ability may be present and therefore data may not accurately reflect all non-verbal populations (McLay, Church

& Sutherland, 2014). Researchers have provided evidence indicating that the ability to derive stimulus relations is connected to cognitive and verbal skills (Barnes et al.,; Cassidy, Roche & Hayes, 2011; Devany et al.,; O'Hora, Pelaez, & Barnes-Holmes, 2005; O'Hora et al., 2010).

It is claimed that the ability to derive stimulus relations emerges in early childhood, distinctively in infancy and that there is a gradually development of this ability which emerges at approximately the same time as language skills (Lipkens, Hayes & Hayes, 1993). One key argument is the non-demonstration of convincing or unequivocal demonstration of such relations in language deficient humans and non-humans (Barnes et al, 1990; Devany et al., 1986; Dugdale & Lowe, 2000; Hayes, 1989; Sidman et al., 1982; Zentall et al., 2002; Zentall et al., 2014). Dube and McIlvane (1996) in opposition to the language argument stress that, one limitation of RFT is the theories reliance on such studies which have failed to show equivalence class formation in language deficient humans and non-humans and that any future positive finding of equivalence class formation in non-humans could pose problems for RFT. Recently Hughes and Barnes-Holmes (2014) discussed how proponents of RFT have acknowledged that limited forms of derived behaviour may be indeed be demonstrated by non-humans in the absence of an explicit history of reinforced equivalence responding.

Sidman however presented a different argument against the RFT position. This argument was based on the role of a history of multiple exemplar training: "I do not understand how any number of examples can give rise to generalised arbitrary relations like reflexivity, symmetry, transitivity, and so on. Because the exemplars would possess no measurable feature in common, it is not at all evident that one might be able to generalise an arbitrary relation solely from exemplars" (Sidman, 1997, p.364-365). Sidman's argument is one that holds true when one considers how many of the classes, found within natural categories (which are used in language), often comprise stimuli which combine arbitrary and non-arbitrary features (Zentall et al., 2014). Derived stimulus relations therefore present a challenge to behaviour analysts, because more than often, the results do not meet the expectations that would be anticipate under a strict conditioning paradigm; and as a result such relations are often called derived or emergent. The counter argument to that proposed by Sidman centres on how a combination of arbitrary contextual and social cues, which control relational responding, results following early language training and that responding is not formed solely on the formal properties of the related stimuli. For humans, it is therefore a learned ability to arbitrarily apply relational responses to stimuli based on contextual cues (Gross & Fox, 2009). Thus, Hayes et al. (2001) emphasized how contextual cues specify both the relevant relations and the functions to be transformed in a relational frame. They use a metaphor of a frame ‘‘to emphasize the idea that this type of responding can involve any stimulus event, even novel ones, just as a picture frame can contain any picture’’ (p. 34).

Several relational frames have been specifically identified and studied to date. These include frames of coordination, opposition, distinction, comparison, hierarchy, and deictic frames of perspective-taking (Gross & Fox, 2009; Hayes et al., 2001). Gross and Fox clarified that relational frames networks do in fact describe behavioural repertoires and not hypothetical or inferred mental structures, or knowledge constructs. Explicitly, relational frames refer to contextually controlled patterns or repertoires of relational responding, that individuals learn through the contingencies of reinforcement established in conjunction with their verbal and social communities (Gross & Fox). Arbitrarily applicable relational responding (AARR) is the keystone of human language and cognition and therefore Hayes stated the simplest RFT definition of verbal behaviour is ‘‘the action of framing events relationally” (p. 43). For that reason, the definition of verbal stimuli provided by Hayes et al. is that ‘‘stimuli that have their effects because they participate in relational frames’’ (p. 44).

Relational Frame Theory incorporates and unites a number of previously established behavioural principles, to offer an explanation of many of the complex aspects of human language and cognition (Rehfeldt & Barnes-Holmes, 2009). RFT has provided a behavioural account which has allowed for the examination of complex psychological phenomena, previously considered outside of the remit of behaviour analysts. The incorporation of behavioural principals have given way to provide explanations of many covert behaviours for example, human anxiety (Dymond, Dunsmoor, Vervliet, Roche & Hermans, 2014; Friman, Hayes & Wilson, 1997), fear (Cochrane, Barnes-Holmes & Barnes-Holmes, 2010; Smyth, Barnes-Holmes & Forsyth, 2006), rule following (Barnes, Healy & Hayes, 2000; Tarbox, Zuckerman, Bishop, Olive & O’Hora, 2011), self-awareness (Dymond & Barnes, 1995; Dymond

& Roche, 2013) self-concepts (Barnes, Lawlor, Smeets & Roche, 1996; Merwin & Wilson, 2010) and hierarchal classification (Slattery, Stewart & O'Hora, 2011).

Another common criticism of RFT surrounds the lack of a detailed description regarding the history of reinforced relation responding; a requirement before a frame of coordination can be actualised (Stremmer, 1995; Leigland, 1997; Clayton & Hayes, 2012). Clayton and Hayes stressed that this lack of accountability for individual histories, can nonetheless be an oversight, versus a weakness in the theory and that other researchers (e.g., Horne & Lowe, 1996) have already provided a detailed account of possible histories, which would lead to equivalence established as an operant consistent with the view held by RFT researchers. According to Gross and Fox (2009) the history of the acting organism is the foundation for bringing about verbal stimulus functions, both the speaker and the listener are seen to be engaging in verbal behaviour. The speaker by generating words based on relationally framed events, the listener by reciprocating and vice versa. The RFT approach to studying verbal behaviour has led to a growing body of empirical research, applications, and conceptual analyses, including providing the theoretical basis for a popular form of psychotherapy known as acceptance and commitment therapy (Hayes, Strosahl & Wilson, 1999; Hayes et al., 2001).

Recent research has re-examined the concept of intelligence using RFT (Cassidy et al., 2011). Their research has proposed a theoretical framework for the analysis of 'intelligent' behaviours by introducing the practices of the standard measurement of intelligence, the intelligence quotient (IQ) and some key features of commonly used IQ tests. The proposed framework provides a rationale for the construction of interventions to raise intelligence quotients as calculated by standardised IQ tests. Specifically, that training skills in derived relational responding (DRR) by using multiple exemplar training (MET) can accomplish this goal. In the first study eight typically developing children took part, of which half were assigned to a no treatment control group. All participants at baseline underwent testing of intellectual ability through the Wechsler Intelligence Scale for Children (WISC-IIIUK; Wechsler, 1992). The four participants within the experimental group were exposed to multiple exemplar training in stimulus equivalence and the relational frames of same, opposite, more-than, and less-than over multiple sessions over several weeks. Reassessment of intellectual ability was conducted for all participants following completion of each experimental phase. The results of Cassidy et al. experiment showed significant improvements for the experimental group.

The second study Cassidy et al. (2011) conducted was with an additional eight children who had a range of educational and behavioural difficulties. Study 2 differed to study one, firstly an improved multiple-exemplar-based relational frame training intervention was used and secondly, the measure of intelligence was through the WISC (IV-UK) a newer version of the previous test. In addition, a new measure, the Relational Abilities Index (RAI) was administered at baseline and following the intervention. The RAI was devised as a means to ensure that relational skill repertoires were changing as a result of the MET intervention. Study 2 was conducted over approximately nine months, a considerably longer period of time than Study 1. For seven out of the eight participants IQ test results increased by at least 1 standard deviation (SD) a statistically significant improvement. All participants showed increases in relational ability as assessed by the RAI. Relational ability, and in particular the fluency of relational learning, were correlated with rises in IQ (Cassidy et al.,). The findings of both studies demonstrated the first preliminary evidence that an RFT-based intervention may be effective in raising the fluency of cognitive skills for both neurotypical and non-neurotypical populations.

Naming Theory

Another alternative theory to Sidman's stimulus equivalence was presented by Horne and Lowe (1996). They suggested that the development of stimulus classes is dependent on the emergence of language. This process of equivalence class formation as emergent is one that is based on assumptions of internal processes. Horne and Lowe proposed that equivalence relations are formed as a result of an individual's learning history, of naming and hearing named relations, whereby names relate to classes of objects. They proposed that the process of class formation, instead of establishing a direct relation between each stimulus and another stimulus as seen within the stimulus equivalence literature, is as a result of a common name being used to describe each stimulus. This assigned common name is deemed sufficient to establish a stimulus class and the emergence of new stimulus-stimulus relations is derived from these common names. In illustrating their position consider a 'dog', in the context of being both spoken 'dog' and heard by the individual 'dog', each stimulus is then treated in a similar way; as if the stimuli were functionally equivalent. The focus of naming theory is on verbal processes and it is these verbal repertoires which allow positive performances on equivalence tests; these performance successes are described as a secondary outcome of naming. According to Horne and Lowe several functional classes of verbal behaviour which include tacts (labelling), mands (requests) and intraverbals (regulated by verbal discriminative stimuli, thematically related words or sentences e.g. red ball) are proposed as being different variants of naming. Many phenomena, such as categorisation, symbolic behaviour, meaning and rule-governed behaviour, are accounted for under naming theory and it is proposed that naming behaviour is a pre-requisite for success in stimulus equivalence tests.

Several authors have presented opposing arguments to naming theory. According to Dube and McIlvane (1996), Horne and Lowe's (1996) account does not provide or make sufficient consideration of the various ways naming could be involved in tests of equivalence. Dube and McIlvane criticise the lack of literature to support naming as a fundamental process in class formation, because the suggestion of verbal behaviour as a causal variable is one that is convenient. Researchers examining equivalence class formation in non-human animals, concur that naming is unnecessary for the formation of equivalence classes and it is claimed that it may be that equivalence class formation, is what facilitates naming (Schusterman, Kastak, & Reichmuth, 1997). To support this argument, numerous field studies involving non-linguistic animals such as sea lions and primates are often cited, showing that such populations can form equivalence classes. Schusterman et al. argued that "The most parsimonious explanation for the appearance of equivalence in both humans and other animals is that the ability evolved in a social or ecological context, rather than as a result of linguistic competence" (p. 257). Further arguments discrediting naming theory are presented on the basis of measurement (Pilgrim, 1996). Pilgrim stressed how the ambiguous nature of naming theory, presents one that is difficult to discredit. Indeed, even when criteria are suggested by the authors that may change or disprove the influence of naming, that same criteria are later justified and used to support the influence of naming. For example, due to animals' lack of naming repertoires, they should not be able to demonstrate equivalence. However, if a non-human animal was able to accomplish this, it would not affect the determinants of equivalence in verbal humans (Pilgrim). This criticism is one which is reminiscent of those presented against the exemplar view of categorisation.

Studies have demonstrated equivalence classes in individuals with language and learning difficulties through the use of visual or auditory-visual stimuli, when naming was not a contingent response (Barnes, et al., 1990; Green, 1990; Saunders, Wachter, & Spradlin, 1988; Sidman, Wilson-Morris, & Kirk, 1986). Indeed, if one considers the literature from outside of the behaviour analytic field young children's receptive language vocabulary (listener behaviour) is often the first to develop. According to Bzoch & Leauge (1991), young infants (6-8 months old) symbolic word meaning often surpasses over 100 words by the first birthday. Speaker behaviour, as expressive syntactic development occurs at a much later stage in development, at around 18 months. In a study by McLay et al. (2014) children took significantly longer to acquire the directly taught skills when using the 'Name' teaching condition than when using the 'Select' teaching condition. McLay et al. emphasized how this finding aligns with what we know about language development, which shows that children acquire receptive understanding prior to mastering the expressive use of individual words. According to Peláez-Nogueras (1996) it can therefore be conceived "that functional transfer of behavior across members of stimulus classes can occur even long before expressive naming develops" (p. 1).

Despite the criticisms levelled at the theory, some research conducted with human populations has provided positive support in relation to naming theory. Typically developing children have demonstrated stimulus categorisation after being taught the relevant listener and speaker behaviours separately (Miguel et al., 2008). In this study a category sort test was used to assess emergent conditional relations of geographical relations. Training involved a three-choice, matching procedure which decreased the probability of conditional discrimination being under the control of incorrect comparisons, which in turn could result in failure during tests for equivalence reject relations and decreased the probability of high accuracy responding through chance. Other research has found that young children who have failed an equivalence test, when later taught to name the stimuli involved, often then produce equivalence responding on a subsequent test (O'Connor, Rafferty, Barnes-Holmes & Barnes-

Holmes, 2009; O'Connor, Barnes-Holmes & Barnes-Holmes, 2011; Wynn & Smith, 2003; Eikeseth & Smith, 1992 & Dugdale & Lowe, 1990).

Recently a study by McLay et al. examined the formation of equivalence classes among children with ASD and neurotypical children. Their findings contrasted with those reported in previous published studies. Two groups, children who had been diagnosed with ASD (the Autism Group, N = 10) and ten were neurotypical children (Neurotypical Group, N = 10), took part in the study. One of the pre-experimental testing phases consisted of standardised developmental tests and participants across both groups were matched on the outcomes of pre-experimental test scores. Half of the children were taught naming responses first, followed by selecting responses the other half were taught in the reverse order (McLay et al., 2014). Two of the six equivalence relations were taught before participants were tested to determine whether the remaining four equivalence relations were acquired without teaching. Five out of ten participants with ASD demonstrated the emergence of all four untaught relations while the other five participants showed variability. In the neurotypical children nine out of ten demonstrated the emergence of all untaught relations. Variation in teaching conditions was found to have had no significant effect on outcomes. The results of the McLay et al. study fail to support the claim that the acquisition of naming responses is a pre-requisite for the emergence of untaught equivalence relations.

McLay et al. (2014) presented a variety of explanations for the inconsistencies found within published naming theory literature. Firstly, procedural differences between experiments such as the number of practice opportunities and a greater number of stimulus–response relations were taught and tested. Secondly, variations in the types of stimuli utilised varied greatly across the literature. Additionally, participants often underwent naming training as a remedial strategy versus naming being a specific teaching strategy. There was significant variation among the children with ASD in terms of the likelihood that these children would demonstrate the emergence of untaught equivalence relations. There are two main possible explanations they provided for why some children in the Autism Group demonstrated the emergence of untaught relations and some did not. The first is that the difference is due to the differences in rate of development. The second is that it is due to differences in prior teaching history.

A significant and strong negative correlation between age and number of derived relations was found in this study. In other words, when matched on receptive vocabulary scores, the older children in the ASD group required the greatest number of teaching trials to reach the mastery criterion and they were the least likely to demonstrate the emergence of untaught equivalence relations. They also tended to have the lowest functional academic scores on the ABAS-II. In the McLay et al. (2014) study it was the children with higher levels of pre-requisite skills (as measured by rote counting and counting with one-to-one correspondence), higher functional academic scores and higher communication scores who required fewer trials to reach criterion. This provides further indirect evidence for a link between rate of development and the emergence of untaught equivalence relations. This observation suggests that it may be the rate of development of the child and not autism per se, which is the major determinant of whether or not equivalence relations will emerge during teaching. A similar conclusion was reached by O'Connor et al. (2011) who argued that children with higher levels of language skills can be expected to acquire equivalence relations more rapidly regardless of whether or not they have a diagnosis of ASD.

Interestingly McLay et al. (2014) found significant variation among the children with ASD in terms of the likelihood that these children would demonstrate the emergence of untaught equivalence relations. Four variables were used to assess the likelihood of untrained equivalence relations emerging, autism status, scores on the functional academic domain of the ABAS-II, age, and rate of acquisition. The study found that those children who scored higher on the measure of functional academics were more likely to demonstrate the emergence of untaught relations. The Adaptive Behaviour Assessment System (ABAS- II) presented some new findings in the literature; this assessment has not been used in published research. ABAS- II measures adaptive functioning across 10 different domains, one of which is Functional pre-academics (children 0–5 years of age) or Functional Academics (5–21 years of age). One possible explanation McLay et al. provided is the correlation between functional academic scores and the emergence of untaught equivalence relations simply reflects differences in the rate of development or prior experience with the type of learning task used with the children during the study. Additionally, it was found that children who required fewer teaching trials to reach mastery of the taught stimulus–response relations were significantly more likely to demonstrate the emergence of untaught equivalence relations. The rate of acquisition was additionally found to be the best predictor of the emergence of untaught equivalence relations.

The findings of McLay et al. (2014) indicated that the variation in teaching conditions had no significant effect on outcomes, a significant correlation between numbers of trials required to reach mastery criterion in the ‘Select’ Condition was strongly correlated with the emergence of symmetry and transitivity. In addition the same correlation was found in the number of trials to criterion in the ‘Name’ Condition. These results indicated that children, who acquired the taught discriminated responses more rapidly, were more likely to demonstrate the emergence of untaught equivalence relations regardless of experimental condition. A significant difference between the number of teaching trials required for children in the ASD Group and children in the Neurotypical Group to reach mastery criterion was found providing support that children with autism require a significantly greater number of teaching trials in order to meet mastery criterion. The results of this study mirror those found in previous research involving children with ASD (McLay et al, 2013; 2014; LeBlanc, Miguel, Cummings, Goldsmith & Carr, 2003). The use of language matched ability in the McLay et al. study has provided a unique perspective in the examination of differences in performance between the children with ASD and the neurotypical children. The overall results indicate that the variability seen are unlikely to be the result of language ability, but may be a characteristic that is associated with the way in which children with ASD acquire and generalise new skills. Indeed, children with a diagnosis of ASD may present with delay in a significant number of skill domains other than language ability and these skill deficits may vary across each individual.

Equivalence Based Instruction

Stimulus equivalence has been extensively studied in the field of behaviour analysis in recent decades (e.g., Elias, Goyos, Saunders & Saunders, 2008; Galizio, Stewart & Pilgrim, 2004; Slattery, Stewart & O'Hora, 2011), using a procedure whereby the training of at least two conditional discriminations results in the derivation of others. As outlined previously, having been taught the relation A1-B1 (i.e., given a stimulus arbitrarily designated as A1, select another stimulus, B1) and the relation B1-C1, an individual may, without further instruction, derive reflexive (A1-A1, B1-B1 & C1-C1), symmetrical (B1-A1 & C1-B1), and transitive (A1-C1, C1-A1) relations between those stimuli (Sidman & Tailby, 1982). The prevailing method of training and testing equivalence relations has been through use of match-to-sample (MTS) tasks as outlined previously in Chapter 1. Sidman's (1971) seminal study introduced the notion of stimulus equivalence as a means of teaching a developmentally delayed teenager to read. Since that time however, most equivalence research has focused on computerised laboratory based experiments testing theories of the processes underlying stimulus equivalence (e.g., Horne & Lowe, 1996; Hayes et al., 2001). Research has additionally been conducted using more traditional methods of responding such as paper and pencil protocol to study stimulus equivalence, more specifically, whether stimulus equivalence can emerge from conditional discriminations established by verbal instructions (Eikeseth, Rosales-Ruiz, Duarte & Baer, 2012). In these studies, researchers have tended to employ meaningless stimuli with which the participants have no pre-experimental history. The application of stimulus equivalence to real world teaching (referred to as equivalence based instruction; EBI), in contrast, has received relatively little attention.

Within traditional educational settings, much learning for children and adults alike takes place in a variety of group settings. Teachers typically do not have the opportunity to engage in one-to-one work with students and are required to make educational content accessible to an increasingly diverse student population. According to Crow (2008) technology of universal design which incorporate a "theory or practice pertaining to design, development, and implementation of communication, information, and technology products and services that are equally accessible to individuals who are disabled and non-disabled" (p. 53). Crow emphasised that such technology which bridges the gap between such a diversity of students, has not yet been accomplished, in a productive and cost-effective manner. Skinner developed and advocated for a variety of teaching machines for example, machines to teach completion of mathematic skills and spelling skills. Skinner advocated that such machines give students '*competence and confidence*' (Skinner, 1960, p189). Skinner (1961) stressed that as the population of individuals who require education grows that simply building new class and providing more teachers would not be sufficient. In contrast he suggested that education itself would need to become more sufficient. Skinner proposed that this could be achieved through revision and simplifying of curricula, textbooks and the improvement of classroom techniques. The computerised technological advances that currently exist were not available to Skinner yet his vision is one that still has relevance and application today.

Twyman (2011) recognised how the novelty of new technologies and devices do not necessarily translate into positive educational outcomes. She discussed how historically within education when a new technology becomes prevalent in the class (e.g., lectern, chalkboard, overhead and slide projectors, videos, DVDs, desktop computers, interactive whiteboards, etc.) an opportunity for reform presents itself. A key emphasis for Twyman is that, it is not the medium that changes outcomes (handing a child an iPad) but the interaction between the learner and the medium, and the contingencies that ensue. Twyman's view is one that echoes that of Skinner, in that the technology or machine does not teach. The technology should serve as a type of bridge that brings the student into contact with the teacher who developed the teaching material. Such technology or machines should therefore be labour saving, because the materials developed by one teacher could be accessed by an indefinite number of students and that the effect on these students would be similar to that of one to one tuition as programmed feedback and the potential for practicing /learning without requiring one-to-one instruction exist (Skinner, 1960; Skinner, 1961).

Equivalence based instruction offers behavioural researchers an opportunity to merge scientifically validated equivalence procedures, behavioural principals and techniques with emerging technologies. One such area of the literature that may provide a useful tool in this examination is that of active student responding. Heward (1996) defined active student responding as occurring when a student makes a detectable response to ongoing instruction. Active responding still requires engagement and effort on the part of the teacher and Pratton and Hales (1986) gave an educator's perspective, defining active responding as a "deliberate and conscious attempt on the part of the part of the teacher to cause students to participate overtly in a lesson" (p. 211). As a teaching technique, active learning has been the topic of numerous studies across a variety of populations and across age groups from preschool to university level. The benefits found with active responding include increased student engagement, increased scores and retention of information and a reduction of off-task behaviour (Colbert, 2005; George, 2010; Martyn, 2007). These type of benefits are those which Skinner (1960) envisioned through his teaching machines.

Research using EBI to teach adults in university settings include algebra and trigonometry (Ninness et al., 2009; Ninness et al., 2006), mathematics (Ninness, Rumph, McCuller, Harrison, Ford & Ninness, 2005), statistical interactions (Fields, Travis, Roy, Yadlovker, Aguiar-Rocha, & Sturmey, 2009), statistical inferences (Critchfield & Fienup, 2010), research design (Sella, Ribeiro & White, 2014; Walker & Rehfeldt 2012) and brain-behaviour relations (Fienup, Covey, & Critchfield, 2010). Although these studies used real world (rather than arbitrary) stimuli, they were still mainly laboratory based and so lacked ecological validity (Pytte & Fienup, 2012; Rehfeldt, 2011). Recognising the shortage of naturalistic research, Pytte and Fienup (2012) investigated if classes of neuroanatomical associations could be established with university students under naturalistic conditions. Brain regions represented on a diagram (term A), the region name (term B) and function (term C) were taught using a standard lecture format during which the lesson was delivered to participants (n=93) through a PowerPoint ® presentation using a MTS format. Testing was conducted using multiple choice quizzes. The results of the study provided the first known evidence of the effectiveness of EBI as a means of teaching in a natural educational environment. Pytte and Fienup's findings also add to the literature in support of EBI as an effective tool which may allow for tight control of learning outcomes thereby saving teaching time by eliminating unnecessary information covered in teaching courses.

Taylor and O'Reilly (2011) developed an intervention to promote generalisation in an applied community setting with six participants with mild intellectual disabilities. The intervention consisted of the participant groups (n2) being taught "using (a) stimulus equivalence training, (b) multiple exemplar training, or (c) single instance training to complete a supermarket shopping task analysis" (p. 1). The results indicated that stimulus equivalence and multiple exemplar training were equally effective in promoting generalisation with single instance training being the least effective. However the authors discuss that there are several limitations to the study, the low number of participants per group for instance makes it difficult to rule out threats to internal validity such as inter-subject differences. A second limitation the authors list is that the research could be seen to imply that the procedure established an equivalence class consisting of physically unrelated stimuli and stimuli involved in natural categories. During pre-test, the two participants who received equivalence training could already select the picture of the supermarket in response to the spoken word 'supermarket'. Talyor and O'Reilly suggested therefore that equivalence class consisting of the spoken word, a variety of pictures and actual supermarkets were already established. The additional trained printed word may have been added to an already existing stimulus class and therefore the generalisation demonstrated by the participants was simply the result of the existing class. Another difficulty they report is that the experimental design did not allow for precise determination of the effects the established natural category is supposed to have on generalisation.

The EBI literature mentioned in this chapter thus far has focused solely on adult learners. Indeed, the application of EBI in teaching educational goals in younger populations has produced an even smaller body of work. Research with young children has focused on teaching coin recognition (Keintz, Miguel, Kao & Finn, 2011), geographical relations (LeBlanc, Miguel, Cummings, Goldsmith, & Carr, 2003; Miguel et al., 2008) reading and spelling (de Rose, Souza & Hanna, 1996), verbal operants (Pérez-González, Herszlikowicz, & Williams, 2010) derived manding (Rosales & Rehfeldt, 2007) and Native American Languages (Haegele, McComas, Dixon, Mark, & Burns, 2011). These studies have focused on both neurotypical children (Miguel et al., 2008) or children with a diagnosis of Autism Spectrum Disorder (LeBlanc et al., 2003), and the majority of studies have used so-called table top MTS procedures where the researcher sits across a table from the child and places cards on the table for them to respond to. For example, Groskreutz, Karsina, Miguel & Groskreutz (2010) demonstrated equivalence class formation via table top procedures with a group of children diagnosed with Autistic Spectrum Disorder. The skills chosen reflected individualised educational goals identified from the participants individual educational plans. More recent research with young children have incorporated computerised responding to teaching relational frames that incorporate the use of real world visual stimuli (Kilroe, Murphy, Barnes-Holmes & Barnes-Holmes, 2014).

Positive result for computerised EBI have been demonstrated, Haegele et al. (2011) conducted a controlled study of preschool aged children. Six participants from two different classes took part, with the remaining 12 in each class acting as control. All 36 participants underwent two pre-experimental tests which consisted of a computerised determination of baseline performance and a generalised test using flashcards which had relations written on them. In Experiment 1, the intervention group of six participants was taught to pair numbers spoken in English with numbers written in one type of endangered Native American Language and to pair the same spoken numbers with written digits. Stimuli were presented in a computerised MTS program and participants responded by clicking on the chosen stimulus using the computer mouse. In Experiment 2, the other six participants in the second intervention group were taught to pair numbers spoken in English with numbers written in a second type of endangered Native American Language and to pair the same spoken numbers with written digits. The two tests that had been used pre-experimentally were re-introduced at post-testing for all 36 participants. It was reported that, across the two experiments, all participants who received computerised training demonstrated significantly higher accuracy rates at post-testing than the participant in the control groups where responding stayed at similar levels to those seen pre-experimentally. While the use of measures such as pre-testing of existing knowledge may not be necessary under laboratory conditions wherein arbitrary stimuli are often generated and unlikely to be pre-experimentally known, applied studies more often utilise non-arbitrary natural stimuli which participants may either demonstrate prior knowledge of, or may encounter instances of the targeted stimuli in the real world context (LeBlanc et al., 2003). Applied studies such as the current study, often occur over numerous sessions and these extended periods of time thus give rise to the possibility of exposure to targeted stimuli, even when participants are assigned within a control group. Published research within the EBI literature has noted such extraneous variables (time and natural exposure to the targeted skills) as limitations.

Haegele et al. (2011) trained participants in numbers from across two indigenous American languages using an MTS protocol. In addition, 24 of the 36 children who took part in the study were assigned to one of two control groups, which involved exposure to stimuli similar to that targeted in the MTS training protocol. The exposure in the control conditions being, a 15 minute language lesson in one of two indigenous American languages. The results for the children in both control groups at post testing indicated that this language exposure did not impact on the results of the study. In fact participants in the Dakota control had a slightly lower post-test score 30.32% than that seen in the pre-test 35.18%. This raises several questions as to why such extraneous variables (15 minute lesson per day) did not result in some gains being demonstrated. Was the length of exposure too short, did the type of exposure, group versus individual differ? If behaviours, like language, are underpinned by similar processes (AARR and DRR) then simple exposure to language would be expected to produce similar outcomes.

The Current Programme of Study

The growing body of EBI research in conjunction with a technological boom offer researchers a unique opportunity to explore the ecological validity of such procedures; designed to result in derived relational responding (DRR), and which incorporate behavioural principals and techniques to teach functional skills (Twyman, 2011). The incorporation of new technologies is a critically important step in this process, in particular to educational application (Skinner, 1960; 1961, Twyman, 2011). As previously discussed much of the EBI research to date has focused upon teaching generic skills and examination has typically be found with adult populations (Critchfield & Fienup, 2010; Fields et al., 2009; Fienup et al., 2010; Ninnes et al., 2005; Ninness et al., 2009; Ninness et al., 2006; Sella et al., 2014; Walker & Rehfeldt 2012). There is however a growing number and diversity of students within education who require, individualised programme content, tailored specifically to the individual learners needs (Crow, 2008; Skinner, 1960; 1961)EBI research which has targeted individualised skills for children has been limited and typically is table-top based (Groskreutz et al., 2010). EBI programmes delivered through or incorporating the latest computerised touch screen technology of which a dearth of research exists are extremely novel and may have a greater application with such populations. Traditional education nonetheless takes places within group teaching situations and generics skills that have functional educational relevance are targeted. Additionally, naturalistic teaching settings involve students responding to group instruction and contingencies. While EBI research to date has focused on teaching real world (rather that arbitrary) skills many were still laboratory based and lacked ecological validity (Pytte & Fienup, 2012; Rehfeldt, 2011). Currently no published research could be found which has included EBI procedures with incorporate group contingencies with young children.

The main aim of the current thesis was to empirically test EBI instruction using derived relational responding (DRR) procedures as a method of teaching categorisation to young children in novel and innovative ways through the incorporation of innovative computation technology. All empirical studies utilised behaviour analytic procedures which did not require verbal responding, but in turn focused on receptive and visual modalities. This allows for the examination of individuals who do not have or have limited verbal communication skills and populations with developmental disability. The first empirical study, Chapter 2, developed and tested a computerised, touch screen modified matching-to-sample (MTS) procedure. The incorporation of touch screen technology is relatively new in the literature (Still, May, Rehfeldt, Whelan & Dymond, 2015) and offers a novel approach to EBI. Each participant was trained in six conditional discriminations and then tested for the emergence of three derived (untrained) three-member classes. Generalisation to additional category members, which were not pre-experimentally known or targeted for training were also tested, post-experimentally. In Experiment 1, the procedure was found to be successful with neurotypical young children and in Experiment 2 these findings were replicated with children with a developmental delay, specifically children with Autistic Spectrum Disorder (ASD). Chapter 3, Study 2 comprised a study to compare the efficacy of the behaviour analytic EBI procedure with a traditional teaching approach. Research exploring the efficacy of EBI to traditional teaching approaches with young children is relatively unknown and research undertaken is this area is innovative in taking preliminary steps towards determining the ecological validity of EBI. The results of this study found that no significant difference was demonstrated in terms of direct teaching time, indicating that the EBI procedure may have application in mainstream educational settings.

Chapter 4 investigated if the EBI protocol with incorporated group contingencies in a small (n) group design is effective across three mainstream educational settings. Stimuli were chosen from the Irish primary curriculum; the six kingdoms of living things and while these generic skills were targeted, they have functional relevance to the children seduction. The EBI procedure offered an exciting, novel and innovative approach to learning these skills. Each participant responded individually using a computerised student-response system per trial, and computer software recorded the individual and overall group responses. Significant differences were found between pre and post intervention knowledge levels. Overall, the thesis provides support for the use of EBI procedures to teach simple and complex category membership, in both individual and small group educational settings.

Chapter 2 (Study 1): Derived Categorisation in Young Children with and Without Developmental Delay

One significant challenge that faces any applied study of EBI is the type of stimuli employed. In traditional, laboratory based analogue studies, researchers have tended to employ arbitrary stimuli, often nonsense words or shapes, for which participants have no pre-experimental learning history. The nature of EBI means that participants are being taught functional relations between, objects, concepts or events that they may encounter in the real world. In complex natural categories, class members often do not share physical characteristics (e.g. a worm does not share many of the physical characteristics of a butterfly). However, this is not always the case and class members frequently do share perceptual characteristics across multiple exemplars (e.g., all snakes have a forked tongue, limbless body, cylindrical shape and scaly skin) (Fields, & Moss, 2008; Fields, Reeve, Adams & Verhave, 1991; Fields, Verhave, & Fath, 1984; Murphy, 2002). Stimuli from within and between classes often have these types of variations such as colour, size and brightness therefore categorisation can be conceived in the same terms as stimulus discrimination and generalisation (Zentall et al., 2002).

These types of stimuli variations previously outlined certainly present problems for the study of EBI in natural settings, as certain controls are required to ensure that the tests are measuring experimentally taught and derived relations rather than pre-experimentally existing knowledge. Many studies have attempted to control for this type of knowledge through the use of pre-experimental testing (Fienup et al., 2010; Haegel et al, 2011) A primary aim of the current study was to individualise the content to be taught. Categories were identified through the use of a novel pre-experimental category sort test in the current study. This test also acted as a means to identify categories that the children demonstrated little to no previous knowledge of and also allowed for an attempt to control for obvious over lapping perceptual features. Additionally, pre-testing ensured that relations taught and tested were unknown in the context of their given category label and therefore built on individual deficits for each child.

The method of responding is also important in an EBI protocol. As discussed previously, much research involving adult learners has involved computerised MTS tasks but studies with young children often involve table top procedures. Within the literature difficulties have been reported regarding the use of click and point devices in young children and the required time that is needed to train the use of the device (Hourcade, Perry & Sharma, 2008; Shimizu, Yoon & McDonough, 2010). One type of response which has received little mention within the literature is that of interactive touch screen technology (Arntzen & Holth, 2011; Saunders, Drake & Spradlin, 1999 who used an early type of fixed touch screen). More recently Still et al., (2015) conducted a study to examine the emergence of derived relational responding and conditioned motivating operations to establish untaught mands (requests) with 11 non-verbal children with Autistic Spectrum Disorder (ASD). The results of the study demonstrated positive evidence and all but one participant demonstrated positive evidence of derived requesting and derived stimulus relations. Their study has been the first known published to employ a procedure whereby a touch screen tablet computer has been an integral part of the procedures to facilitate derived manding; requesting wants or needs such as objects or actions.

Many studies have demonstrated equivalence in human participants, but have a commonality in that all participants shared a pre-experimental history of engaging in some form of human language. It has been suggested that documentation of the participants' pre-experimental language skills and characteristics would enhance contributions to the stimulus equivalence literature. This baseline will strengthen observations of correlations between participants' current language abilities and performance (O'Donnell & Saunders 2003; Miguel et al., 2008). With the application of such procedures being delivered to younger population's the documentation of participant language ability becomes increasingly more important. Indeed the widespread availability of portable technology now means that devices are now transportable and no longer require a fixed location. This type of technology expands research and learning via computer based instruction to a much younger population and additionally to individuals with special educational needs such as those with physical or intellectual disability and offers a means of advancing the behaviour analytic field. Control and training of additional computer appliances such as a keyboard or mouse are eliminated and is much more enabling for the learner. Still et al. stress how such devices promote and foster independent communication skills in such non-verbal populations. Additionally, Still et al. emphasise that from a research context, results obtained from such automated devices are adventitious, as there is a reduced likelihood of researcher cueing and that data collection is more likely to be accurate.

Rehfeldt (2011) called for ecologically valid research to investigate the application of EBI to naturalistic educational settings. The purpose of the current study was to take some steps towards answering this call and advance the literature on equivalence based instruction by investigating the application of a modified match to sample procedure as a teaching protocol to teach category relations that involved untaught or emergent relations to young neurotypical children and then to extend it to a population with ASD. The aims therefore of the research are to firstly, to determine if participants would demonstrate individualised and functional derived category relations subsequent to exposure of a modified MTS protocol. Secondly to determine if an interactive computerised "touch-screen" modified MTS protocol with programmed feedback would be useful in demonstrating derived responding with young children in a preschool setting.

Experiment 1

Method

Ethical Issues

Ethical approval for the study was granted by Dublin City University Research Ethics Committee (see Appendix A) and this experiment adhered strictly to current guidelines of the British Psychological Society (BPS, 2010) and the Psychological Society of Ireland (PSI, 2010). Recruitment did not commence until ethical approval had been granted, once approval was granted a variety of day care services were contacted. All services contacted were either publically listed services, the researcher had prior knowledge of, or knew of individuals associated within the service provider. Recruitment of the sample was one of convenience, information and consent packs were offered to all parents of children within the classroom. The researcher made herself available to discuss any questions with both staff and parents during recruitment and the duration of the study.

The participating children all were required to give assent to take part in the study. Informed assent with this young population involved the use of a story board describing what would happen during the study, this contained both pictures and texts to ensure that the children would understand the content. If the child could write their name or make an attempt at writing their name, they signed off on the storyboard. A tick box was also available for those who could not write their name and the researcher read this section also “I want to take part” and “I do NOT want to take part” (see

Appendix A). In addition to this measure a means for the child to communicate distress was made available and all participants were given opportunities to practice using the card prior to the experiment, and were reminded of the card at each experimental session. A picture of a computer was used to indicate when the session would commence, this built in a familiar structure for the children to know when their turn would occur.

In order to maintain motivation during the training phases of the study the children gained access to reinforcers. Prior to, and during, experimental phases each child underwent preference assessments to establish reinforcers or rewards that had both high and low value. Access to reinforcement was built around correct responding during the training phases, for each correct response made the child received a token (star with a smiling face) on a board. Each token equalled to 30's of play with their preferred high value rewards. However to ensure maintained motivation and minimize any possibility of frustration, in the absence of any correct responses being made, the child gained access to toys which had a lower value for one minute.

The children who took part were young and to minimise fatigue and any possible frustration the duration of each session was kept short (30 minutes maximum inclusive of all breaks). Following each block a five minute break would occur, inclusive of time with reinforcers. This time meant that the child could move around the room, engage with peers and teachers before the next training or testing block.

If a child requested a break or showed any signs of distress the experimental session was immediately stopped and the session did not resume for a period of 24 hours. Further details can be found in the approved ethics application (see Appendix A).

Participants

Five neurotypical preschool-age children who attended a day care service took part in Experiment 1. The inclusion criteria for participation included good receptive language, no major visual or motor problems and no pre-existing knowledge of the categories to be trained as set out in the criteria for category exclusion. Three boys and two girls (n5) took part in the study. All participants spoke English as their first language, Participant 3 however were bilingual speaking both English and Polish in the home (see Table 2.1 for participant demographics).

Table 2.1. Participant 1-5 demographics.

Participant Number	Gender Male/Female o/Female	Commencement Age
1	Male	4 years 3 months
2	Male	4 years 6 months
3	Male	4 years 2 months
4	Female	4 years 2 months
5	Female	3 years 9 months

Settings and Materials

All participants were trained and tested individually. Experimental sessions took place twice weekly and session duration was set at a maximum of 30 minutes inclusive of breaks for each participant. All experimental sessions took place in a small quiet area located in the corner of the preschool class room which otherwise is used for individual work sessions.

An 8.9-inch Asus Eee PC T91 Touchscreen Netbook ® was used for all experimental phases, see Figure 2.1. The pre- and post-tests, and category training were conducted as a table top procedure. A picture card (5x5cm) representing the experiment was added to the participants' daily visual schedules located in the classroom, where available, otherwise the picture was shown to the participants. The picture showed a computer with the word work written underneath. A yellow card (8x5cm) with the word "break" typed on it in black was placed on the left corner of the work station. A token board with 12 grids was also used. Tokens consisted of yellow stars (3cm dimension). A standard countdown timer was also used to ensure consistent time with reinforcers.

A two choice preference assessment Fisher et al. (1992) was conducted using a variety of developmentally appropriate toys. Access to highly preferred reinforcers was contingent upon performance during training, each token earned equated to 30s of play. However, secondary reinforcers identified as having low to medium value were presented for one minute if no tokens had been earned. Pictures of the reinforcers were affixed to a board later presented as choices of reinforcers to participants following an experimental training block. A minimum break of 5 minutes occurred between each block of trials, this was inclusive of time with reinforcers earned.

Figure 2.1. Asus Eee PC T91 Touchscreen Netbook which used for all experimental phases. The screen has full 360 degree rotation and folds flat in either direction.

The standardised and norm referenced assessment of language used for Pre and Post-Test 1 was the Preschool Language Scale – Fourth Edition (PLS – 4; Zimmerman, Steiner, & Pond, 2002). All picture stimuli used for either category sorting, training or computerised phases of the experiment were obtained from (CD©; Silver Lining Multimedia, Inc, 2009). All stimuli were coloured images presented on a white background in printed form as 7x10 cm laminated pictures. The same images were used for the computerised phases in the form of bitmaps. Different stimuli were employed for each participant depending on the outcome of the pre-experimental sort tests. However, for ease of communication stimuli will generally be referred to using alphanumerics.

General Procedure

The general procedure used during the experiment consisted of two pre-experimental tests, eight experimental stages and two post-experimental tests. Experimental stages one to seven consisted of a modified and computerised three, three member matching to sample procedure to train and test categories identified for each participant. Stage eight consisted of a table top receptive identification procedure and each stage is outlined in detail below.

Pre-experimental Language Assessment

The first pre-experimental test consisted of a standardised and norm referenced assessment of language the Preschool Language Scale – Fourth Edition (PLS – 4; Zimmerman et al., 2002). The PLS-4 targets receptive and expressive language skills in the areas of attention, play, gesture, vocal development, social communication, vocabulary, concepts, language structure, integrative language skills, and phonological awareness. Raw and standard scoring is given for each of the two subsets (receptive and expressive language) and total raw and standard scores can be calculated based on scores for the two subsets. The test also provides a measure of age equivalence language ability. The purpose of this assessment was to establish the baseline language abilities for each participant. Retest time of the PLS-4 is at six month intervals and deviations from standardized administration, other than minor changes such as taking breaks or allowing the child to sit on the caregiver's lap, will invalidate the test results. Deviation from administration guidelines may result in practice effects in scores. Practice effects refer to gains in scores on tests that occur when a person is retested on the same instrument/test, or tested more than once on ones very similar to each other (Zimmerman et al., 2002, p. 122).

Pre-experimental Category Sort Test

The second pre-experimental test was a category sort test. The purpose of this test was to identify, for each participant, three categories of which they had little or no knowledge. This ensured that the programme was tailored to each participant's individual needs. During the category sort task, participants were required to sort 27 picture cards once into three corresponding category containers (9 cards per category). Participants were tested across a number of categories until three sets had been identified as meeting criteria. Those categories identified were finally tested as a set to ensure that they still met criteria and that minimal overlap in topography of images occurred.

During the category sort task, the participant sat at a table upon which four containers were placed. The researcher sat out of view behind to the right or left side of the participant. Participants were given the following instructions, "I want you to sort these pictures into these containers.” The researcher then pointed to each container and named what category was to be placed in each container. For example, “Animals” (pointing at Container 1), “Fruit” (pointing at Container 2) “Transport” (pointing at Container 3).The labels were repeated a second time again pointing to each container. After instruction, the researcher shuffled the picture cards. Each picture card was handed to the participant individually while he/she was simultaneously asked to ‘sort’. Those categories identified were finally tested as a set of three to ensure that they still met criteria and ensure minimal overlap in topography of images.

Correct responding was defined as the participant placing the picture card in the corresponding category container and self-corrected errors were accepted as a correct response. Incorrect responses were defined as placing the picture card in a non-corresponding container, at any other location on the table/floor or, making no attempt to place the card within 10 s. No feedback was given to the participants at any stage during testing and no corrective actions were undertaken by the researcher. If the participant did not respond within 10 s the researcher removed the picture card and immediately placed the next picture in the participant’s hand issuing the instruction ‘sort’. The non-placed card was then recorded as an incorrect response however this did not occur for any one participant. Categories for the computerised stages of the study were chosen based on the results of the pre-experimental category sort test. Category exclusion occurred when a participant placed more than three pictures from the same category set into the same container, regardless of the assigned category label. See Table 2.2 for the stimuli chosen for each participant.

Table 2.2. Experiment 1, Category sets and stimuli for each participant.

Participant	Stimuli	Set 1	Set 2	Set 3
		Insects	Fruit	Electrical
Participant 1	A	Ant	Cherry	Iron
	B	Fly	Strawberry	TV
	C	Grasshopper	Watermelon	Vacuum
		Accessories	Utensils	Fruit
Participant 2	A	Belt	Masher	Kiwi
	B	Ring	Grater	Peach
	C	Watch	Ladle	Pineapple
		Dairy	Vegetables	Furniture
Participant 3	A	Butter	Broccoli	Wardrobe
	B	Swiss Cheese	Carrots	Sofa
	C	Milk	Potato	Table
		Sweets	Vegetables	Furniture
Participant 4	A	Candy floss	Carrots	Wardrobe
	B	Lollipop	Peas	Sofa
	C	Popcorn	Potato	Desk
		Body parts	Musical Instruments	Furniture
Participant 5	A	Hand	Drums	Bed
	B	Leg	Piano	Wardrobe
	C	Eye	Guitar	Desk

Match-to-Sample (MTS) Pre-training

During MTS pre-training, participants were directly trained to match three identical shapes, presented in a quasi-random order on the tablet PC. The purpose of this stage was to familiarise the participants with the touch screen.

All participants had previous exposure to visual/textual or verbal instructions regarding the study before MTS pre-training. The participant was informed that he/she would be asked to match pictures. The researcher directed the participant to the tablet PC and explained verbally and with the use of the visual instruction board.

The read instructions were as follows:

1. *It's time for our computer work.*
2. *It's time to match pictures on the computer.*
3. *When you match pictures, you can earn tokens.*
4. *We can swap our tokens for some toys (or named preferred item/activity).*
5. *If you need to you can ask for a break.*

The researcher pointed to each associated item on the visual instruction board to show the participant while reading the instructions. Having read the instructions, the researcher demonstrated through modelling for one trial how to select the correct comparison while the tablet PC was placed on the table.

During each MTS pre-training trial, a black shape (triangle, square or circle) appeared in the top centre of the screen. The participant was required to touch this shape. It immediately disappeared from the screen and an array of three comparison shapes (triangle, square & circle) appeared in the lower area of the screen, one to the right, one to the centre and one to the left. The location of the comparison stimuli was randomized across trials. The researcher issued the instruction 'Match' at the beginning of each trial (appearance of the sample) and if no response was made after 5 seconds, the instruction was re-issued. A correct response was recorded by the computer if the participant used one or more of their fingers to touch the screen and select the corresponding picture from the lower portion of screen (e.g., if the sample was circle, select circle from the array of three comparison shapes). Correct responding was followed by the appearance of a green symbol on the screen. An incorrect response was counted if the participant selected a non-corresponding picture from the lower portion of screen. If an incorrect response was made, a red symbol appeared on the screen. The correct and incorrect symbols disappeared after 3 s duration and the next sample appeared on the screen.

As well as the visual feedback, following a correct response, the researcher delivered a token and verbal feedback (e.g., 'good matching', 'nice matching' or super matching'). No other feedback was given for incorrect responses. If after 5 s duration and no response occurred, the instruction "match" was re-issued. No participant failed to respond following the second instruction. Each MTS pre-training block consisted of 12 trials during which each of the three shapes was presented as a sample four times. At the end of the block the word “finished” appeared on the screen. The researcher indicated to the screen and stated ‘matching is finished’. For a visualisation of screen shots from the computerised training please see Appendix B. Participants were required to make 11 correct responses in a 12 trial block in order to proceed to the first experimental phase. Any participant who did not reach criterion was re-exposed to the MTS pre-training. Participants 1, 2, 3 and 5 required only one exposure to MTS pre-training. Participant 4 was the only participant to require more than one exposure to MTS pre-training. She met criterion after two exposures. More information on this can be seen in the results.

Phase 1. A-B Baseline Training

Participants were directly trained to pair the A and B stimuli (A1-B1, A2-B2, & A3-B3) using a MTS procedure as previously described. For example, choosing B1 from an array (B1, B2, & B3) was reinforced following the presentation of A1. Correct responding on trials was reinforced by the researcher delivering a token onto the token board. 12 stimulus trials were presented per block with each of the three trial types present four times in a quasi-random order. Participants were required to reach a criterion of 11 correct responses over 1 block to move forward to the next experimental phase. If a participant did not meet criterion, training continued for four blocks before remedial action was taken and if the participant did meet criterion he/she proceeded to Phase 2. For a schematic representing the computerised phases see Figure 2.2.

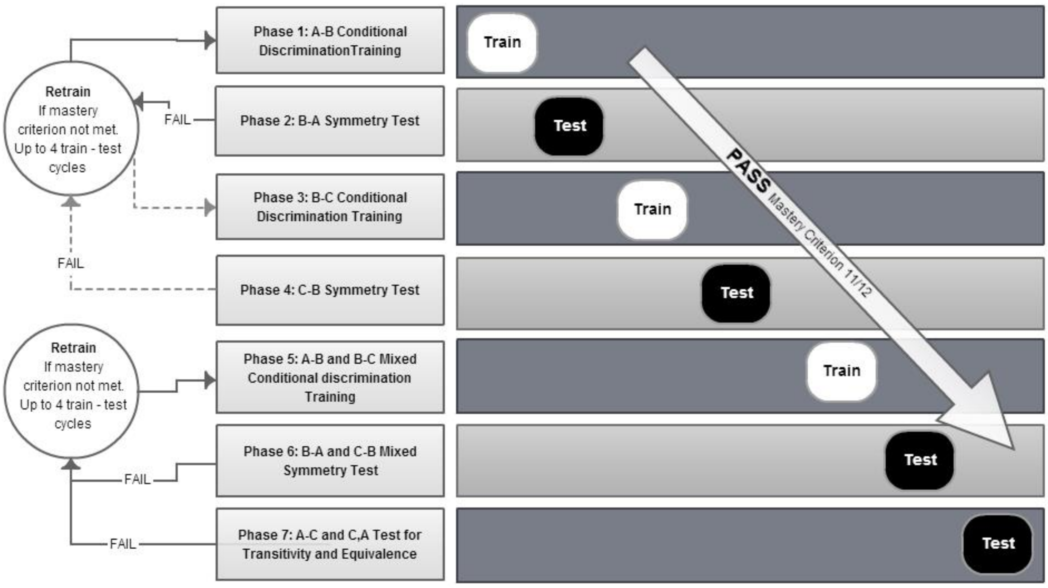


Figure 2.2. Schematic representative of computerised experimental Phases 1-7.

Phase 2: B-A Testing

Testing for derived symmetry (B1-A1, B2-A2 & B3-A3) followed A-B baseline training (A1-B1, A2-B2 and A3-B3) to examine if the directly trained were reversed. Criterion performance was set as in Phase 1: A-B training. If the participant did not met criterion, Phase 1 training restarted for a maximum of four train-test cycles, before remedial action was taken.

The instructions for testing phases differed from training because no reinforcement was to be provided. The participant was again informed that he/she was to match pictures. The researcher directed the student to the tablet PC and explained read the following instructions:

1. *It's time for our computer work.*
2. *It's time to match pictures on the computer.*
3. *You will not earn tokens this time for matching.*
4. *When we are finished matching we will go back to the classroom/work.*

The researcher pointed to each associated item on the visual instruction board to show the participant while reading the instructions aloud. The researcher did not give feedback to the participant at any stage of testing. If the participant did not respond within 5 minutes the researcher stopped the testing and returned to the prior training phase. It was decided pre-experimentally that this would occur for a maximum of four train-test cycles before remedial action was taken, however, remedial action was not required at any point following this or any of the subsequent tests. If the participant did meet criterion he/she proceeded to Phase 3.

Phase 3. B-C Training

The procedure was the same as in Phase 1 with the exception that participants were trained to match B1, B2 and B3 to C1, C2 and C3, respectively. If the participant met criterion he/she proceeded to Phase 4.

Phase 4. C-B Testing

Test for derived symmetry were the same as in Phase 2 with the exception that testing was for emergent C1-B1, C2-B2 and C3-B3 relations. If the participant met criterion he/she proceeded to Phase 5.

Phase 5. A-B, B-C Mixed Training

This phase combined training Phases 1 and 3. Specifically, participants were exposed to training trials in which they were required to pair all six A-B and B-C relations (A1-B1, A2-B2, A3-B3, B1-C1, B2-C2 and B3-C3). A 12 trial training block was employed in which each of the six trial types were present twice in a quasi-random order. Criterion performance was set as in Phase 1: A-B training (11 out of 12 trial correct) to proceed. If the participant did not met criterion, B-C training restarted for a maximum of four test cycles, before remedial action was taken. If the participant did meet criterion he/she proceeded to Phase 6.

Phase 6. Mixed B-A, C-B Testing

The testing procedure combined Phases 2 and 4. Participants were tested for all possible derived symmetry relations (B1-A1, B2-A2, B3-A3, C1-B1, C2-B2 & C3-B3). There were 12 trials in each test block and each of the six stimulus pairs was presented twice in a quasi-random order. The same criterion was used as in Phase 2. If participants did not meet this requirement they were re-exposed to Phase 5 mixed training. Following the four cycles, remedial action was taken. If the participant did meet criterion he/she proceeded to Phase 7.

Phase 7. A-C and C-A Symmetry Transitivity Tests

The procedure for Phase 7 was the same as in Phase 6 with the exception that participants were tested on the previously untested A-C and C-A relations (A1-C1, A2-C2, A3-C3, C1-A1, C2-A2 & C3-A3). This trial test block exposure consisted of 12 trials in which each stimulus pair was presented twice in a quasi-random order. The criterion to move on to the next Phase in the study was again set at 11 out of 12 trials correct. Remedial action was taken on the first instance that any participant failed to meet criterion for this phase.

Phase 8. Category Training

During Phase 8, participants returned to the table top procedures. During this phase, appropriate category labels were trained to each of the C stimuli (e.g., if C1 was *apple* then the category label trained was *fruit*). Using visual/textual or verbal instructions, the participant was informed that he/she would be requested to choose pictures of objects when the researcher named the category. The researcher directed the participant to the three pictures representing the C stimuli e.g. C1 (apple), C2 (ball), and C3 (car) and explained, 'I will give you a name such as, fruit and you will give me the one that is the same'. The researcher then placed the three C stimuli on the table in front of the participant and stated the category label (e.g., "Fruit"). The participant was required to respond by choosing the picture that was related to this category, in the example given C1 (apple). No feedback was given to the participants for incorrect responses. Correct responses were reinforced by the researcher saying, 'that was giving me… *the category name*', and delivering a token as used in Phases 1, 3 and 5.

Initially, participants were not expected to have category knowledge but a most-to-least prompt hierarchy was put in place to facilitate learning (Libby, Weiss, Bancroft & Ahearn, 2008). A correct response to a category training trial was recorded if the participant selected the corresponding picture at the designated prompt level, or unprompted, within 5 seconds of the instruction. An incorrect response was recorded if a participant selected an incorrect picture card, if the researcher engaged in corrective action, or if the participant made no attempt to select a card within 5 seconds of the instruction. For each trial, the researcher noted the level of prompt required. Each block consisted of 12 trials during which each of the three C stimuli were presented four times in a quasi-random order.

Corrective action was taken when an incorrect response was made. Incorrect selections were blocked and the researcher stepped back a level in the prompt hierarchy, while reissuing the instruction. Participants moved forward a step in the prompt hierarchy when they achieved 11/12 correct trials (92%). If a participant achieved less than 6/12 correct trials or 50% over three blocks, the researcher moved back a step in the prompt hierarchy.

Post-experimental Category Sort Test

A category sort test was used to test for the derived transfer of the categories trained in Phase 8. This phase involved the participants assigning each of the nine stimuli to one of the three categories established for the C stimuli. The procedure used was the same as in the pre-experimental category sort test.

Post-experimental Language Assessment

The language assessment was re-administered at the end of the study, six months after the first administration. The purpose of the follow up test was to determine if the children made gains outside of those normatively expected which may indicate a correlation between the EBI procedure and language ability. Such a finding may have implications for future research directions to specifically explore a language correlation with EBI procedures. However it must be noted that for validity purposes a minimum of six months should be allowed between testing. Due to time constraints regarding access to participants these tests were re-introduced at three months during Experiment 1 only and therefore and any findings in the post-experimental language assessment in Experiment 1 do not meet the validity guidelines due to practice effects. Additionally the children were engaged in education programs and therefore it is not claimed that any effects seen are of a direct result of the EBI program.

Results

Match-to-Sample (MTS) Pre-training

Participant performances in all MTS phases of the experiment can be seen in Figure 2.3. Participants 1, 2 and 3 only required one exposure to the MTS pre-training before meeting the criterion to move on to the experimental sessions. Participants 4 and 5 required two exposures.

MTS Training and Testing

Participant 1 required 120 trials (10 blocks) in order to meet the A-B training criterion of correct responding on 11 out of 12 trials in a block. This participant failed the subsequent B-A test for the emergence of symmetry relations (score of 7 /12). Following a second exposure to training (36 trials), Participant 1 passed the B-A test with a score of 11 out of 12 trials correct. The participant later met the criterion for B-C training after exposure to 72 trials (6 blocks) to meet criterion, and subsequently passed the C-B test for the emergence of symmetry relations at the first exposure. Only one exposure to A-B, B-C mixed training and testing was required; following 96 training trials (8 blocks) the participant scored 11 out of 12 on the mixed test. The participant went on to pass the A-C and C-A test for derived relations.

Participant 2 required 36 trials (3 blocks) of A-B training in order to meet the criterion of correct responding at 12 out of 12 trials correct. He subsequently passed the B-A symmetry test at 12 out of 12 trials correct. After 48 B-C training trials (4 blocks) he met criterion to progress to the test which he also passed. The participant passed A-B, B-C mixed training in just 12 trials and went on to pass the B-A, C-B test with a score of 11 out of 12 trials correct. He passed the subsequent combined A-C and C-A test for derived relations with a score of 11 out of 12 trials correct.

Participant 3 required 60 trials (5 blocks) to meet the criterion for A-B training. He subsequently passed the first exposure to B-A symmetry testing with 12 out of 12 trials correct. He required 36 B-C trials (3 blocks) to meet criterion at 12 out of 12 trials correct before passing the C-B symmetry test first time. Participants 3 required just 36 A-B, B-C mixed training trials (2 blocks) before passing the B-A, C-B test on the second exposure. He also passed the subsequent A-C and C-A test for derived relations with a score of 12 out of 12 trials correct.

Participant 4 required 84 A-B training trials (7 blocks) before passing the B-A symmetry test first time. She required 36 B-C training trials (3 blocks) before passing the C-B symmetry test. This participant required just 12 A-B, B-C mixed training trials (1 block) to score 11 out 12 trials correct and passed the B-A, C-B test with a score of 11 out of 12 trials correct. She then passed the A-C and C-A test for derived relations with a score of 11 out of 12 trials correct.

Participant 5 required 96 A-B training trials (8 blocks) before passing the B-A symmetry test on the first exposure. She went on to pass the C-B symmetry test after 72 B-C training trials (6 blocks) to meet criterion at 11 out of 12 trials correct. She passed the Mixed B-A, C-B test after 60 trials (5 blocks) and also passed the A-C and C-A test for derived relations.

Overall, the maximum amount of training required for any one type of relation was 120 trials over two exposures to A-B training for Participant 1. For all other phases, Participant 1 required just one exposure to the train-test cycle. Participant 3 required 36 trials over two exposures to the mixed B-A, C-B test. The other three participants required just one exposure to each test. The smallest number of training trials required was 12 for Participants 2 and 4 in the mixed training and testing. The relations tested in the mixed test had been trained and tested in the previous phases.

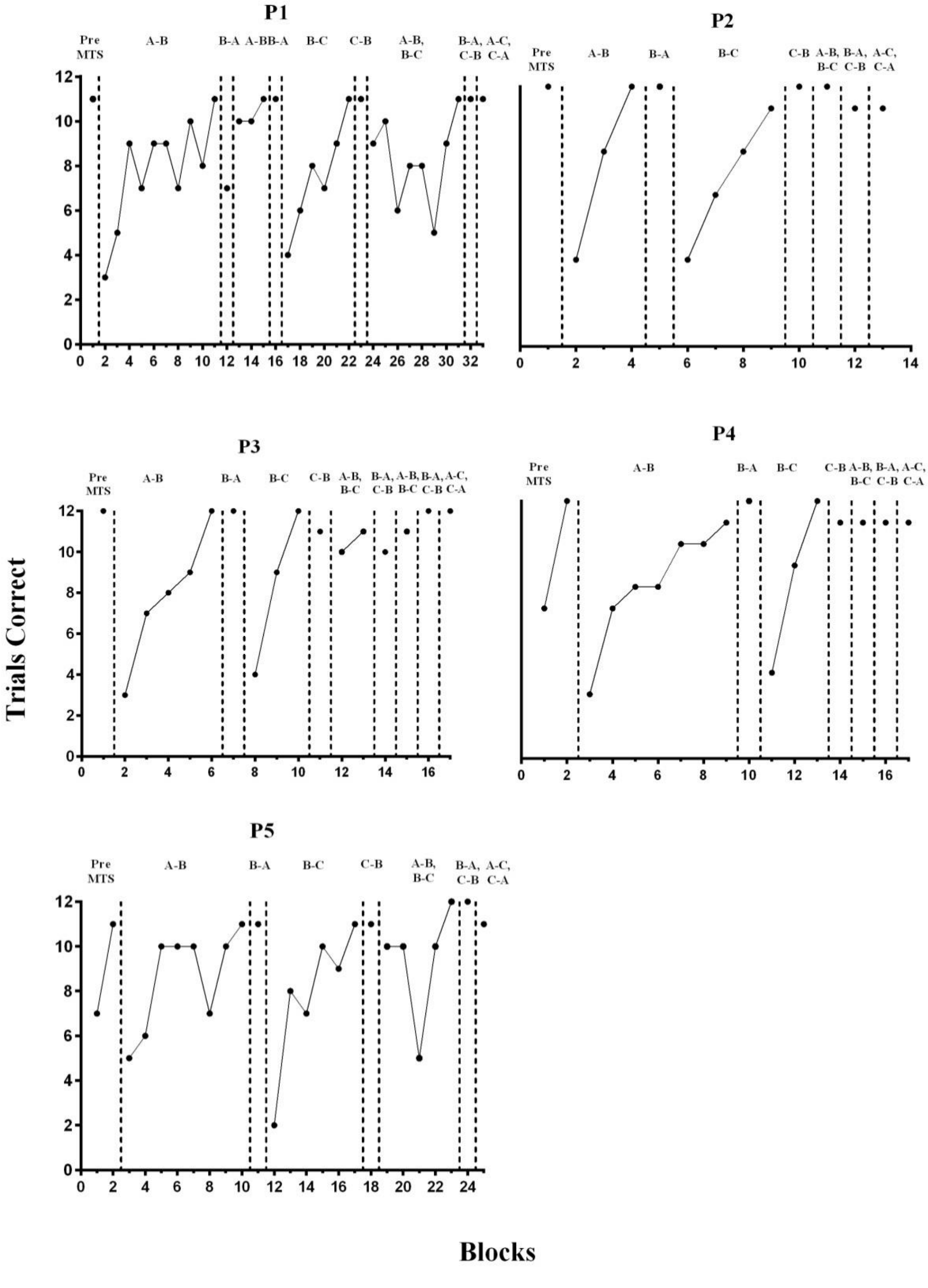


Figure 2.3. Participant 1-5 results for MTS Pre-training, A-B Training, B-A Testing, B-C Training, C-B Testing, Mixed A-B, B-C Training, Mixed B-A, C-B Testing and A-C, C-A Symmetry Transitivity Testing.

Category Training

From Table 2.2 it can be seen that the largest number of trials to criterion was 108 by Participant 5. Participant 4 required the smallest number of training trials at 60. Participants tended to require the most training blocks at the gestural prompt stage of the hierarchy. However, Participant 5 completed this level after only two blocks but subsequently required 5 blocks at the independent level.

Table 2.3. Experiment 1, Trials Correct to Criterion Category Training for Participant 1-5.

Participant	Full Physical	Light Physical	Gestural	Independent	Total Correct
1	12	11	44	11	78/96
2	12	12	32	11	67/84
3	12	12	28	12	64/72
4	12	12	19	11	54/60
5	12	12	18	48	90/108

Category Sort Testing

The three categories chosen for Participant 1 were Insects, Fruit and Electrical (see Table 2.1 for actual stimuli). Nine stimuli were used for each of the three categories (27 stimuli in total). These consisted of the three stimuli in each category that had been trained and tested in the MTS procedure, and an additional six category members that not been used in the intervention but that had been tested in the pre-experimental category sort test. Correct categorisation on the post-experimental category sort test could therefore be divided into three types; learned through the MTS training, known pre-experimentally and additional category members.

The results of the category sort test showed that Participant 1 was able to correctly sort all nine stimuli that had participated in the MTS training (3 for each of the three categories). This indicated a transfer of the category function from the three C stimuli to their respective B and A stimuli. As expected, the participant also correctly sorted stimuli that had been successfully categorised during pre-experimental testing one from category insects and two from the fruit category. In addition, four further stimuli in the insect category, four in the fruit category and five in the electrical category were correctly sorted.

Participant 1 incorrectly sorted just three of the 27 stimuli at post-testing. These were all untrained stimuli; two from the insect category (butterfly & ladybug) and one from the electrical category (camera). As can be seen in Figure 2.4 all three stimuli were pre-experimentally miscategorised with a stimulus that was chosen for use during MTS training.

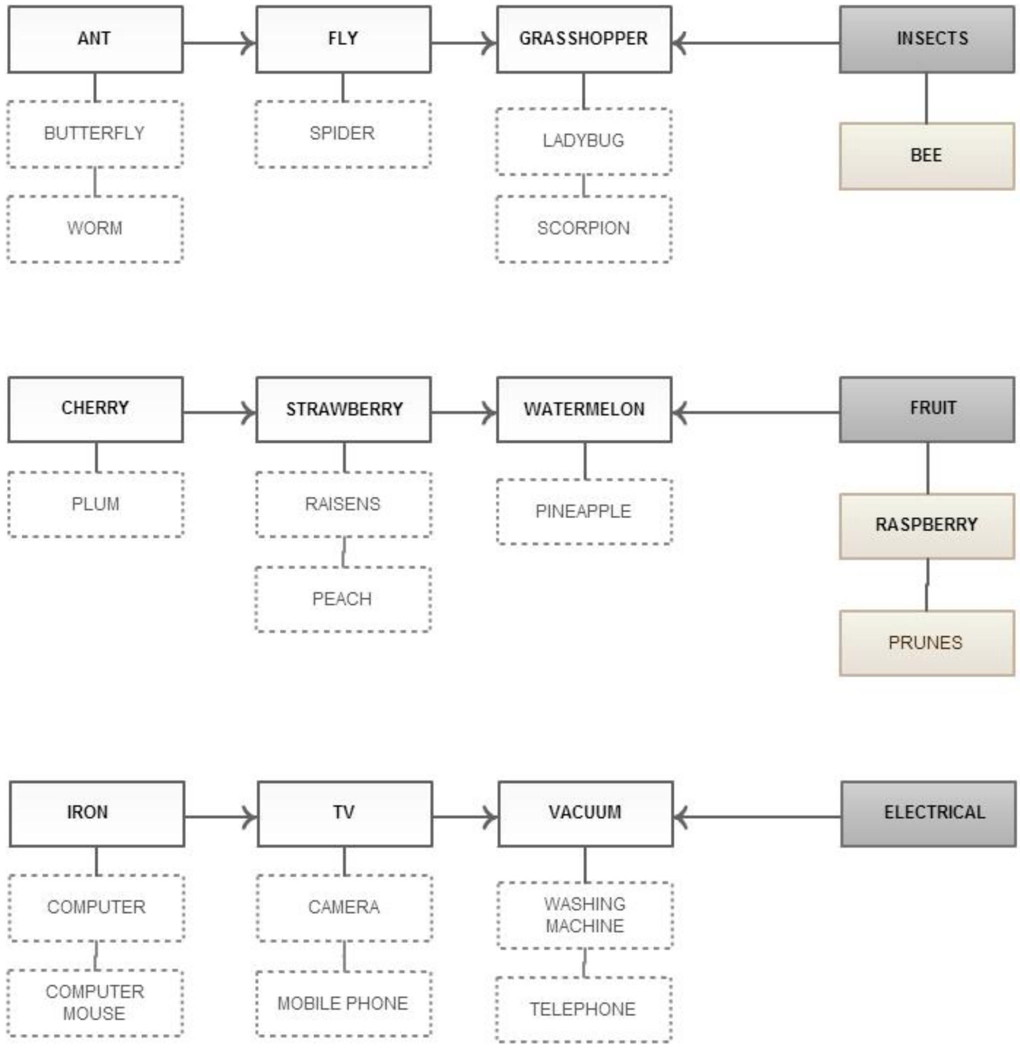


Figure 2.4. Pre-experimental category sort test for Participant 1. Category label on right shaded in a dark grey, stimuli correctly sorted at pre and post-experimental testing in light grey. White boxes with solid grey border to the left of the category show the stimuli chosen for training. Below are the stimuli which were pre-experimentally paired at sort testing, light grey dashed box.

Pre-experimentally, the stimulus ‘butterfly’ was miscategorised into the clothing set paired with the trained A1 stimulus ‘ant’. The stimuli ‘ladybug’ was paired with the trained C1 stimulus ‘Grasshopper’ in the electrical set. Post-experimentally, the stimulus ‘butterfly’ and ‘ladybug’ were miscategorised into the category set electrical. The stimulus ‘camera’ was pre-experimentally miscategorised with the trained stimulus ‘TV’ in the category set fruit. At post-testing, the stimulus camera was miscategorised into the category clothing. This would seem to suggest that that the three stimuli miscategorised post-experimentally were not generalised to the control of the trained stimulus function.

The results of the sort test for all participants can be seen in Figure 2.5. The three categories chosen for Participant 2 were accessories, utensils and fruit. The results of the category sort test showed that Participant 2 was able to correctly sort all nine stimulus pictures that had participated in the MTS training. This indicated a transfer of the category function from the three C stimuli to the B and A stimuli. As expected, the participant also correctly sorted stimuli that had been successfully categorised during pre-experimental testing, one in the accessories category and two in the fruit category. An additional four stimuli in the accessories category, six stimuli in utensils, and four stimuli the fruit category, were also correctly categorised despite no pre-experimental knowledge or subsequent training. From accessories one stimulus ‘scrunchie’ (fabric hair tie) was miscategorised at post-testing. The stimulus was not pre-experimentally miscategorised with a stimulus that was chosen for use during MTS training. Pre-experimentally, the stimulus ‘scrunchie’ was miscategorised into the fruit set paired with another member of the same category ‘bracelet’. Post-experimentally the stimulus ‘scrunchie’ was miscategorised into the same category set fruit. However the previously paired stimulus ‘bracelet’ was correctly sorted in the category accessories.

The three categories chosen for Participant 3 were dairy, vegetables and furniture. Results of the category sort test (Figure 2.5) showed that Participant 3 was able to correctly sort all nine stimulus pictures that had participated in the MTS training and all stimuli that had been successfully categorised during pre-experimental testing (two from each category set). Three stimuli in the dairy, four in the vegetables and four in the furniture category were additionally correctly sorted. One stimulus from the dairy category ‘margarine’ was miscategorised at post-testing. This stimulus was pre-experimentally miscategorised into the animal category, paired with the trained B1 stimulus 'Swiss cheese'. Post-experimentally the stimulus 'margarine' was miscategorised into category set furniture.

For Participant 4, the three categories chosen were sweets (candy), vegetables and furniture. Nine stimuli were trained and tested for each of the three categories. Three stimuli that had been trained and tested in the MTS procedure and an additional six stimuli that had been tested in the pre-experimental category sort test. The category sort test results (Figure 2.5) showed that Participant 4 was able to correctly sort all nine stimulus pictures that had participated in the MTS training. This indicated a transfer of the category function from the three C stimuli to the B and A stimuli. Participant 4 also correctly sorted one stimulus from sweets and one stimulus from furniture that had been successfully categorised during pre-experimental testing. An additional five stimuli in the sweets category set, five in the vegetables category and five in the category set furniture. Only one stimulus from the vegetable category 'sweet corn' was miscategorised at post-testing. The stimulus was pre-experimentally miscategorised with a stimulus that was chosen for use during MTS training. The untrained stimulus 'sweet corn' was miscategorised pre-experimentally into the sweets category set, along with the trained B2 stimulus 'peas'. Post-experimentally the untrained stimulus 'sweet corn' was miscategorised into category set furniture.

The three categories tested for Participants 5 were body parts, musical instruments and furniture. Nine stimuli were post-experimentally tested for each of the three categories consisting of the three for each category which had been trained and tested in the MTS procedure. An additional six stimuli for each category were those used in the pre-experimental category sort test. Post- experimentally correct categorisation could therefore be divided into three types; learned through the MTS training, known pre-experimentally and additional untrained stimuli from the category pre-testing. Participant 5 sorted all stimuli correctly at post-testing as can be seen in Figure 2.5. She was able to correctly sort all nine stimulus pictures that had participated in the MTS training; this again indicated a transfer of the category function from the three C stimuli to the B and A stimuli. As expected, she also correctly sorted two stimuli that had been successfully categorised during pre-experimental testing, one each in the body parts and furniture categories. In the sweets category an additional five stimuli were correctly sorted, five more in the vegetables category and five in the category set furniture.

As can be seen from Figure 2.5 all participants demonstrated categorisation for the individualised real world categories that had been pre-experimentally identified as unknown to each individual. During match-to-sample pre-training the participants acquired the skills to operate the touch screen device with relative ease and only two participants required a second block of training. All participants passed the computerised training and testing phases, the largest number of training trials to criterion for all training and test phases required were for Participant 1 (396 trials) the least was for Participant 2 (156 trials). Participant 3 and 4 required exactly the same amount of trials to criterion across training and testing phases (204 trials) and Participant 5 required 300 trials.

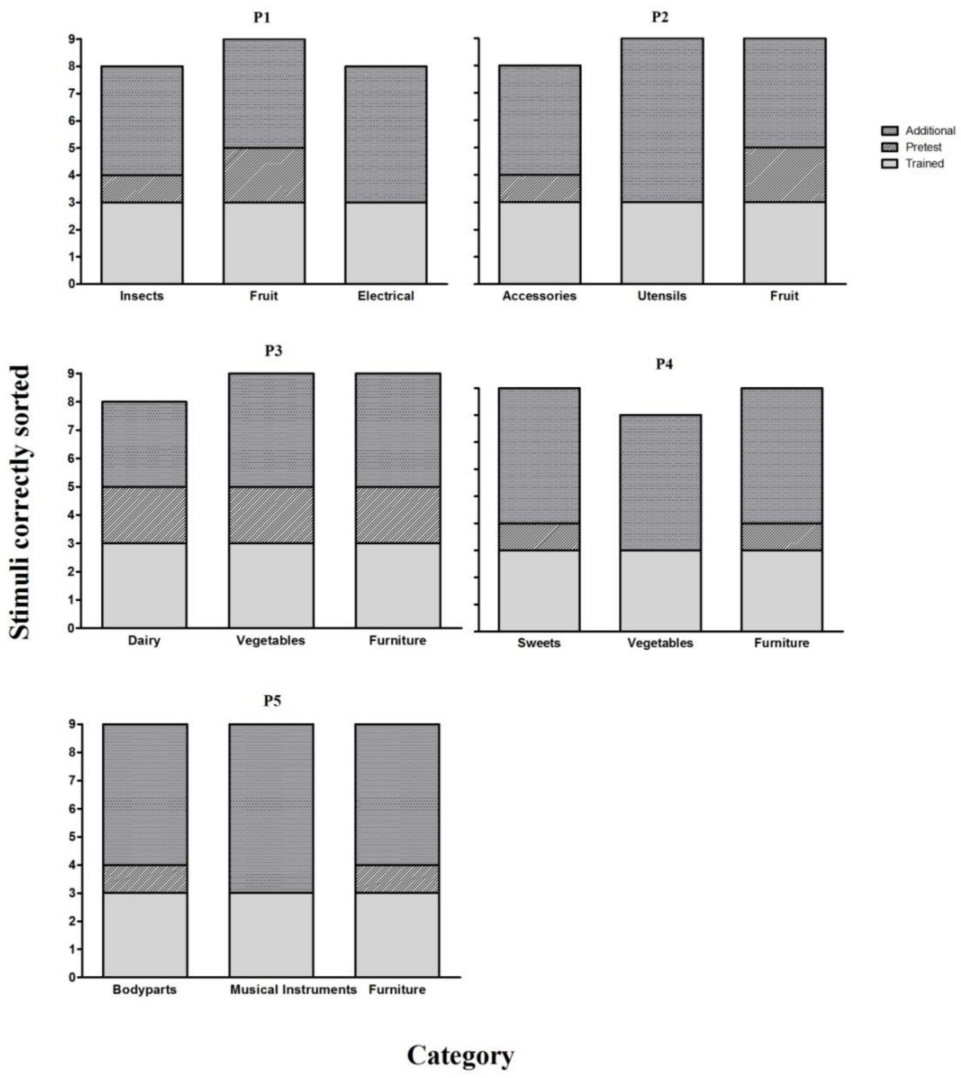


Figure 2.5. Category sort test results for all participants showing the stimuli correctly sorted out of nine for each set that had been chosen for training. Results show the three stimuli chosen for training, the stimuli that were pre-experimental correctly sorted and additional untrained relations which were sorted correctly at post-testing.

The category training which followed trained the corresponding category labels (e.g., animals) to each of the three C stimuli (e.g., C1 dog). All participant passed this training phase, the highest trials to criterion being required by Participant 5 (102 trials) and the lowest Participant 4 (60 trials). Upon returning to the category sort test which again tested the nine pre-experimentally tested stimuli a transfer of category function from the C stimuli to the A and B stimulus was demonstrated. This was the case for all three equivalence classes for each participant. At post-testing, additional untrained stimuli were also correctly sorted, one suggestion for this is provided for by Galizio et al. (2004), the transfer of category membership may have generalised to the other pre-experimental unknown and untrained stimuli.

Language Assessment: PLS-4

This test involved the reintroduction of the same pre-experimental language assessment allowing a comparison of language scores pre and post-experimentally. The purpose of the follow up test was to determine if the children made gains outside of those normatively expected which may indicate a correlation between the EBI procedure and language ability. Such a finding may have implications for future research directions to specifically explore a language correlation with EBI procedures. However it must be noted that for validity purposes a minimum of six months should be allowed between testing. Due to time constraints regarding access to participants these tests were re-introduced at three months during Experiment 1 only and therefore and any findings in the post-experimental language assessment in Experiment 1 do not meet the validity guidelines due to practice effects. Additionally the children were engaged in education programs and therefore it is not claimed that any effects seen are of a direct result of the program. The age normative scores for all participants at pre and post-testing can be seen in Table 2.3. Interestingly, Participants 3 and 5 demonstrated a lower score in the receptive subsection raw scoring at post-testing. Participant 2 showed the highest gains across raw and standard scores. Increases were additionally found for Participants 1 and 4. The participant who made the least gain was Participant 5 who showed no change in the total raw and standard scores at post-experimental testing. Results of the language assessment for all participants are represented in Table 2.3.

Table 2. 4. Experiment 1, Results of Pre and Post-Experimental Language Assessment for Participant 1-5.

		Pre-experimental Language Assessment				Post-experimental Language Assessment			
Composite	Participant	Age	Raw Score	Standard Score	Age Equivalent	Age	Raw Score	Standard Score	Age Equivalent
Total Language	1	4:3	108	103	4:2	4:6	117	104	4:10
Receptive		-	53	104		-	57	106	
Expressive		-	55	102			60	102	
Total Language	2	4:6	109	195	4:3	4:9	125	123	5:9
Receptive		-	53	93		-	61	124	
Expressive		-	56	91			64	118	
Total Language	3	4:2	103	93	3:10	4:5	104	94	3:11
Receptive		-	54	95		-	50	92	
Expressive		-	52	92			54	98	
Total Language	4	4:8	106	194	4.0	4:10	119	205	5.0
Receptive		-	52	106		-	57	106	
Expressive		-	54	86			59	99	
Total Language	5	4:2	103	93	3:10	4:5	104	94	3:11
Receptive		-	54	95		-	50	92	
Expressive		-	52	92			54	98	

Figure 2.6 displays the mean standard scores (+/− 1 SD) on the subscales of the PLS-4. As expected with a neurotypical population, performance was within the normative sample range for receptive and expressive standard scoring: PLS Auditory Comprehension (M = 98) at pre-experimental testing and (M=104) at Post-experimental testing. PLS Expressive Communication (M = 92.6) at pre-experimental testing and (M=103) at Post-experimental testing. The PLS Total Language (M = 135.6) at pre-experimental testing and (M=124) at Post-experimental testing. In other words, as a group, the children in this sample did not present with clinically significant delays in language development.

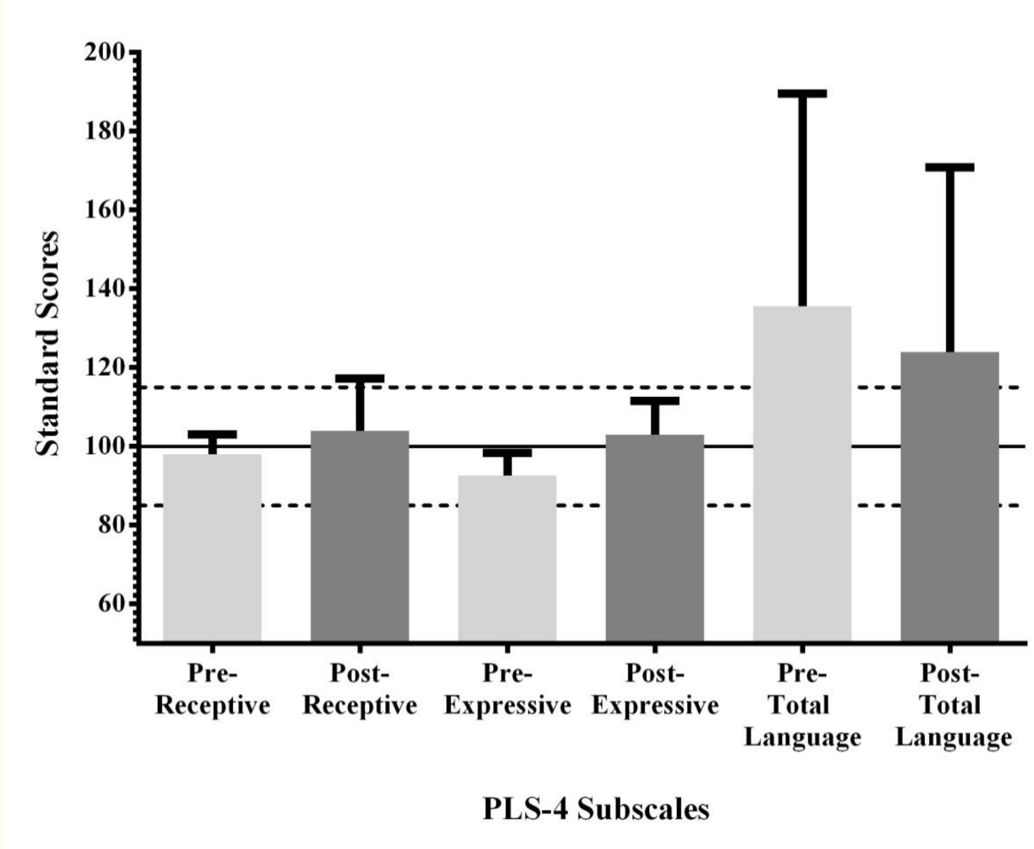


Figure 2.6. Mean standard scores (+ 1 standard deviation) on the language measures. The solid line indicates normative language scores of typically developing children; the dashed lines indicate the boundaries of clinical significance.

Summary Experiment 1

The data suggest that this procedure may offer a quick way to effectively target skills that are individualised to address skill deficits in children or to bring skills that are splintered together. A key marker of children with ASD is that spoken language is often delayed or absent, therefore a procedure such as the one discussed here could be used as an effective teaching procedure for such a population. In addition the findings extend investigation of derived responding through the use of training an auditory category label to the C stimulus which then demonstrated transfer to additional class member that were not directly trained or derived through the computerised MTS procedure. The use of the touch screen which was easily trained in a normative population removes the need to additionally train responding skills such as, mouse or keyboard movements. This is an important factor when considering the application to developmentally delayed populations such as those with ASD whom often present with fine and gross motor delays. Experiment 2 was therefore conducted to investigate the effectiveness of the current procedure in young children with ASD.

Experiment 2

Research examining equivalence class formation in children with a diagnosis with ASD has produced a surprisingly small body of work. Indeed, few experiments have compared the emergence of untaught equivalence relations with people with ASD with that of neurotypical children (Maguire, Stromer, Mackay & Demis, 1994; McLay et al, 2014; O'Connor, Barnes-Holmes, Barnes-Holmes, 2011; O'Connor, Rafferty, Barnes-Holmes, Barnes-Holmes, 2009). Researchers have generally reported while neurotypical children demonstrated the formation of equivalence classes with relative ease, there is by contrast variability in the ability of those with ASD to demonstrate the emergence of untaught equivalence relations. O'Connor et al. (2009) provided evidence that when participants with ASD had high levels of verbal competence there was little difference between performances with neurotypical counterparts. However, when participants with ASD did not demonstrate advanced language abilities additional instruction was required for equivalence class formation to occur. In a later study O'Connor et al. (2011) these variable performance levels were remediated through multiple exemplar training and explicit teaching of correct and incorrect responses. The methodology used in the current study was designed in a manner which meant that verbal responding was not a pre-requisite skill for the children to take part. Experiment 2 therefore examined the efficacy of the program in young children with a diagnosis of autism.

Method

Participants

Three Participants with a diagnosis of ASD were recruited from a specialised early intervention preschool. One participant was excluded prior to commencing pre-experimental tasks following consult with the parent and school staff as the inclusion criteria was not met. The inclusion criteria for participation included good receptive language, no major visual or motor problems and no pre-existing knowledge of the categories to be trained. Two participants took part in the study, Participant 1 was a male aged 4 years 7 months presented with no behavioural problems, he used three to five word sentences in his spoken communication. Participant 2 was also male aged 3 years 11 months, used the picture exchange communication system at a one picture level to communicate his wants and needs, he also used pre-verbal behaviour such as gestures and guidance towards requested items. He presented with some self-stimulatory behaviours such as repetitive vocalizations of sounds and hand mouthing. Both participants had attended the preschool service for approximately one year.

Settings and Materials

All experimental sessions took place twice weekly within the early intervention preschool. For each participant the session duration was a maximum of 30 minutes inclusive of breaks. All experimental sessions took place in a quiet area located beside the participants' classroom. The area was large and bright with windows to one side; no furniture was present other than a small table and two chairs. The setting differed to Experiment 1 which took place within the participants' classroom.

The materials used were the same as for Experiment 1 with the exception of the pictures which were once again, tailored to each participant (see Table 2.5). Nonetheless, the stimuli were the same size as in Experiment 1 and were sourced from the same software.

Table 2.5. Experiment 2, Category sets and stimuli for Participant 1 and 2.

		Set 1	Set 2	Set 3
Participant	Stimuli	Insects	Transport	Body parts
Participant 1	A	Bee	Plane	Teeth
	B	Ant	Lorry	Toes
	C	Worm	Motorbike	Hand
		Toys	Clothes	Animals
Participant 2	A	Puzzle	Coat	Cat
	B	Slinky	Socks	Cow
	C	Slide	T-shirt	Hen

Procedure

All experimental phases were exactly the same as for Experiment 1 with the exception that a six month gap was left between language assessments. The intervention began with two pre-experimental tests consisting of an assessment of language ability PLS-4 and a category sort test. Seven computerised phases were employed and these were followed by a table top category training procedure. Post-experimental tests consisted of the re administration of the language assessment and category sort test.

Results

MTS Pre-training

Participant performance in all MTS phases of the experiment can be seen in Figure 2.7. Participant 1 required two exposures to the MTS pre-training before meeting criterion to move on to the experimental sessions. Participant 2 required three exposures.

MTS Training and Testing

Participant 1 required 124 trials (12 blocks) in order to meet the A-B training criterion of correct responding on 11 out of 12 trials in a block. This participant failed the B-A test for the emergence of symmetry relations (score of 8 /12). Following a second exposure to training (36 trials), he passed the B-A test with a score of 11 out of 12 trials correct. The criterion for B-C training was met after exposure to 180 trials (15 blocks); he subsequently passed the C-B test for the emergence of symmetry relations at the first exposure. Participant 1 required 108 trials (9 blocks) at A-B, B-C mixed training before passing the mixed test on the first attempt with a score of 11 out of 12 trials correct. The participant went on to pass the A-C and C-A test for derived relations.

Participant 2 required 240 trials (20 blocks) of A-B training in order to meet the criterion of correct responding at 12 out of 12 trials correct. He subsequently passed the B-A symmetry test at 11 out of 12 trials correct. B-C training required 312 trials (26 blocks) to meet criterion to progress to the test which he failed on the first attempt with a score of 9/12 trials correct. Following an additional 36 trials (3 blocks) at B-C training the participant passed the C-B test on the second attempt. The participant required 96 trials (8 blocks) at A-B, B-C mixed training to meet criterion with a score of 11 out of 12 trials correct. He failed the mixed test with a score of 10/11 trials correct and returned to training. A further 36 trials (3 blocks) were required before the participant returned to Mixed testing which he passed with a score of 11 out of 12 trials correct. He then passed the A-C and C-A test for derived relations with a score of 11 out of 12 trials correct.

Overall, Participant 2 required the greatest amount of training for any one type of relation, 348 trials over two exposures to B-C training. The lowest number of training trials required was 108 for Participant 1 in the mixed training and testing. The relations tested in the mixed test had been trained and tested in the preceding phases.

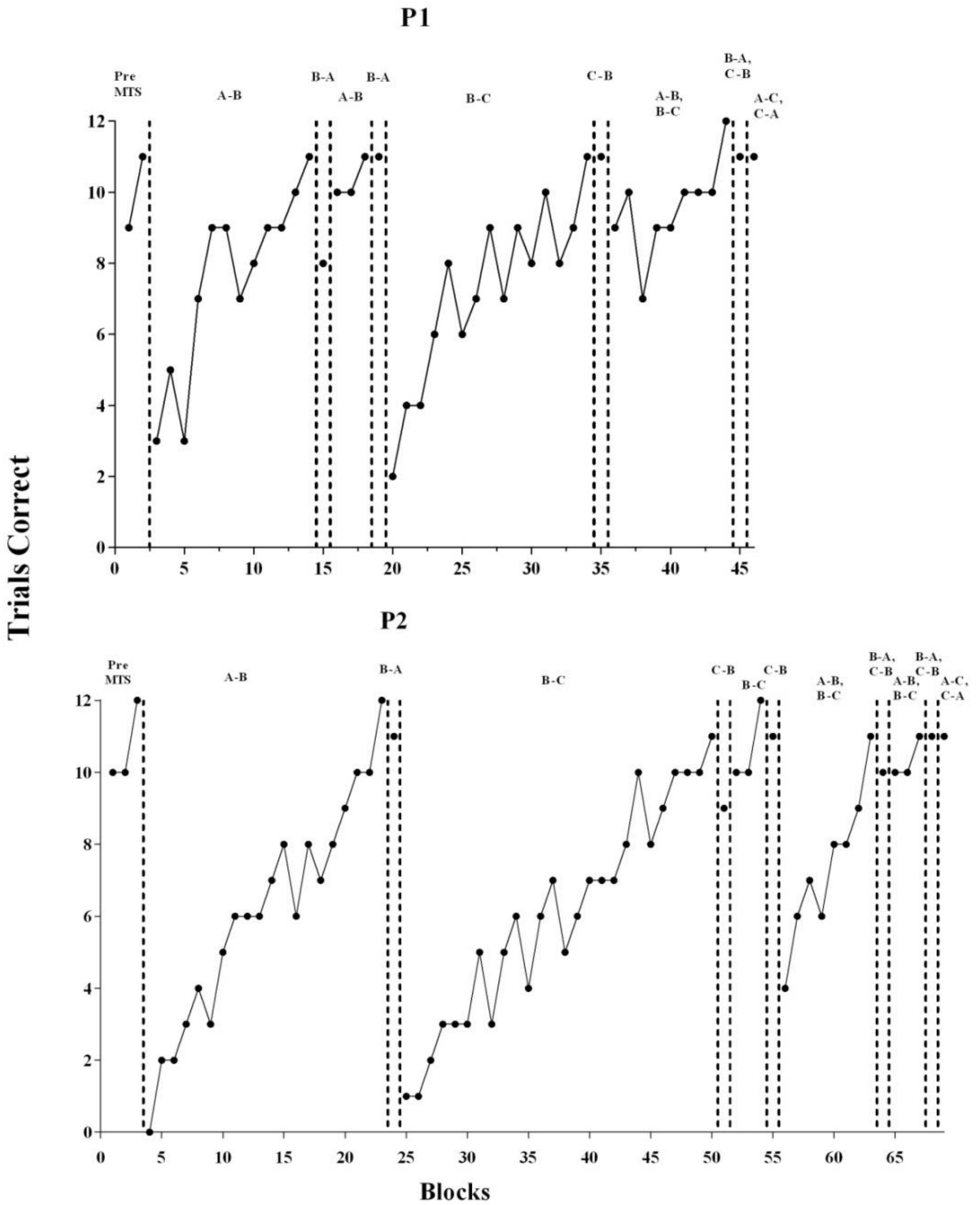


Figure 2. 7. Participant 1 and 2 results for MTS Pre-training, A-B Training, B-A Testing, B-C Training, C-B Testing, Mixed A-B, B-C Training, Mixed B-A, C-B Testing and A-C, C-A Symmetry Transitivity Testing.

Category Training

From Table 2.6 it can be seen that the largest number of trials to criterion were 408 for Participant 2. Participant 1 required 276 training trials. Participants required the most training blocks at the gestural and independent prompt stages of the hierarchy.

Table 2.6. Experiment 2 Total Trials Correct to Criterion Category Training for Participant 1 and 2.

Participant	Full Physical	Light Physical	Gestural	Independent	Total Correct
1	12	11	102	70	195/276
2	12	12	32	11	261/408

Category Sort Testing

The three categories chosen for Participant 1 were insects, transport and body parts (see Table 2.4 for exact stimuli). Nine stimuli were tested for each of the three categories (27 stimuli in total). These consisted of the three stimuli in each category that had been trained and tested in the MTS procedure and an additional six category members that had not been used in the intervention but that had been tested in the pre-experimental category sort test. Correct categorisation on the post-experimental category sort test could therefore be divided into three types; learned through the MTS training, known pre-experimentally and additional category members (see Figure 2.8).

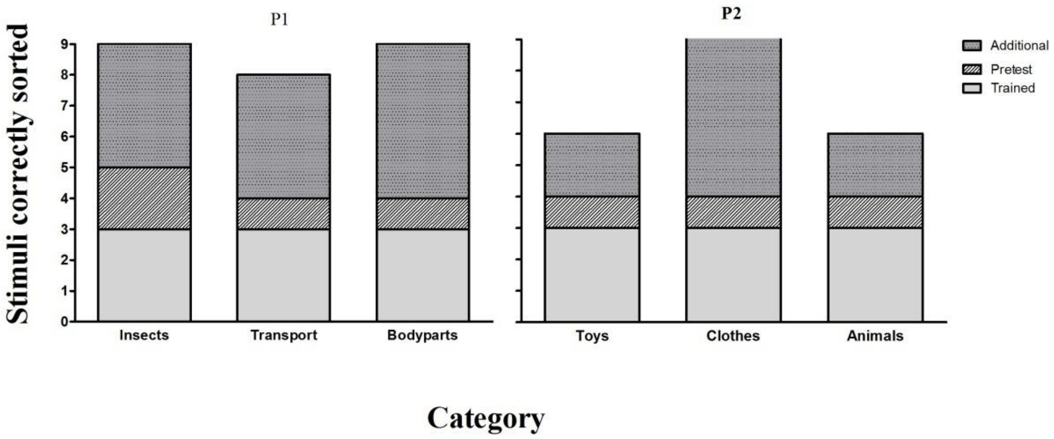


Figure 2.8. Category sort test results for all participants showing the stimuli correctly sorted out of nine for each set that had been chosen for training. Results show the three stimuli chosen for training, the stimuli that were pre-experimental correctly sorted and additional untrained relations which were sorted correctly at post-testing.

The results of the category sort test showed that Participant 1 was able to correctly sort all nine stimuli that had participated in the MTS training (3 for each of the three categories). This indicated a transfer of the category function from the three C stimuli to their respective B and A stimuli. As expected, the participant also correctly sorted stimuli that had been successfully categorised during pre-experimental testing; two from the category insects and one from transport and one from the body parts category. In addition, he correctly sorted four further stimuli in the insect category, four in transport and five in the body parts category. Participant 1 incorrectly sorted just one of the 27 stimuli at post-testing. The stimulus (boat from the category transport) was one which had not been pre-experimentally paired with any stimuli chosen for training. Pre-experimentally the stimulus 'boat' had been placed in the insect category and post-experimentally it was placed in the category fruit.

The three categories chosen for Participant 2 were toys, clothes and animals. Participant 2 was able to correctly sort all nine stimulus pictures that had participated in the MTS training at post-category sort testing. This indicated a transfer of the category function from the three C stimuli to the B and A stimuli. As expected, he correctly sorted stimuli that had been successfully categorised during pre-experimental testing; one in each category, toys, clothes and animals. An additional two stimuli in the toys, five stimuli in clothes, and two stimuli the animals category were also correctly categorised despite no pre-experimental knowledge or subsequent training. Three stimuli from both the toys and animal category sets were miscategorised at post-testing. The three stimuli were pre-experimentally miscategorised with a stimulus that was chosen for use during MTS training. For the category toys, two stimuli pre-experimentally were placed in the food category. Two stimuli 'ring stacker' and 'shape sorter' were paired with the trained C1 stimulus 'slide'. At post-testing they were again miscategorised together into the fruit category however the trained stimulus 'slide' was correctly categorised. An additional stimulus 'doll' had pre-experimentally been placed with the trained B1 stimuli 'slinky' and another additional stimulus 'spinning top', both were miscategorised in the category animals. At post-testing the stimulus 'doll' was again miscategorised into the animal category, however the trained B1 stimulus 'slinky' and the additional stimulus 'spinning top' were correctly categorised into toys.

The three stimuli from the animals' category miscategorised at post-testing were 'pig', 'mouse' and 'bunny'. At pre-experimental testing 'pig' and 'mouse' were paired with the trained C3 stimuli ‘hen’ in the category food. The stimuli ‘bunny’ was paired with the trained B1 stimulus ‘cow’ and an additional stimulus from the animals’ category ‘sheep’, these were miscategorised in the clothing category. Post-experimentally, ‘pig’ and ‘mouse’ were once again miscategorised in to the category food, the trained C3 stimulus ‘hen’ was correctly categorised in animals. The stimulus ‘bunny’ was miscategorised into the category food at post-testing, however the trained B3 stimulus ‘cow’ and the additional ‘sheep’ were correctly categorised in animals.

Both participants demonstrated categorisation for the trained and pre-experimentally known stimuli. In addition Participant 1 correctly categorised an additional 13 untrained stimuli and Participant 2 correctly categorised an additional ten untrained stimuli. It is most likely that these additional untrained stimuli were sorted based on their pre-experimental association with trained stimuli. Both participants in Experiment 2 demonstrated the formation of equivalence classes for real world individualised categories through the use of the modified matching-to-sample procedure. Both participants additionally demonstrated a transfer of category function from the C stimulus to the A and B stimulus. In the post categorisation testing additional stimuli were correctly sorted for all three categories. For Participant 1, a greater number of additional stimuli were sorted correctly at post-testing suggesting generalisation of the category function to previously miscategorised paired stimuli. While Participant 2 did demonstrate categorisation of additional stimuli, there was a significantly lower number for two of the categories tested.

Language Assessment

Age normative scores of the language assessment (PLS-4) for Participant 1 and 2 can be seen in Table 2.7. Post-experimental testing was conducted following a six month interval and both participants demonstrated increases in both receptive and expressive subsection raw scoring. Overall, the results support previous research that demonstrated the formation equivalence classes through the use of visual or auditory-visual stimuli in individuals with minimal verbal skills (Barnes et al., 1990; Grozkreutz, 2010; LeBlanc et al., 2003). Figure 2.9 displays the mean standard scores (+/− 1 SD) on the subscales of the PLS-4. As is typical in samples with children with a diagnosis of ASD, performance was variable across children and language abilities were both significantly lower than the normative sample mean and outside the average range: PLS Auditory Comprehension (M = 55) at pre-experimental testing and

(M=54.5) at Post-experimental testing. PLS Expressive Communication (M = 54.5) at pre-experimental testing and (M=55.5) at Post-experimental testing. The PLS Total Language (M = 82) at pre-experimental testing and (M=83) at Post-experimental testing. In other words, as a group the children in this sample had clinically significant delays in language development.

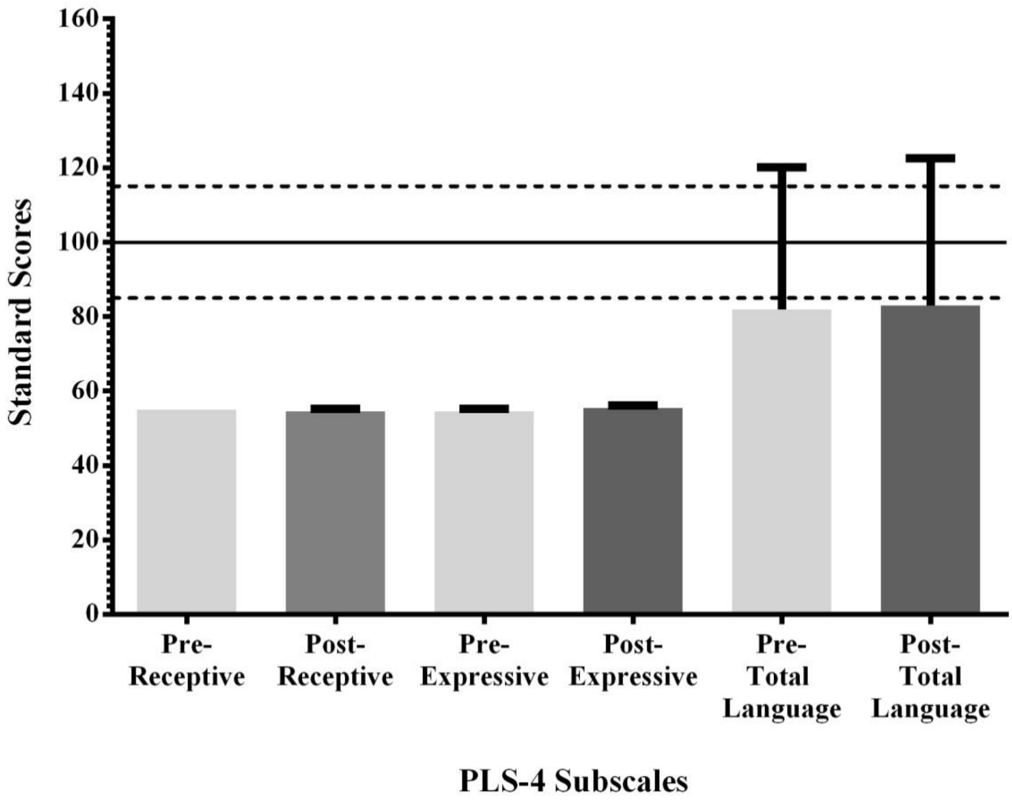


Figure 2.9. Mean standard scores (+/- 1 standard deviation) on the language measures. The solid line indicates normative language scores of typically developing children; the dashed lines indicate the boundaries of clinical significance.

Table 2.7. Experiment 2, Results of Pre and Post-Experimental Language Assessment for Participant 1 and 2.

		Pre-experimental Language Assessment				Post-experimental Language Assessment			
Composite	Participant	Age	Raw Score	Standard Score	Age Equivalent	Age	Raw Score	Standard Score	Age Equivalent
Total Language	1	4:7	79	109	2:7	5:1	90	111	3:1
Receptive		-	39	55		-	44	55	
Expressive		-	40	54		-	46	56	
Total Language	2	3:11	41	55	1:2	4:6	46	55	1:4
Receptive		-	32	55		-	34	54	
Expressive		-	9	55		-	12	55	

General Discussion

The current research expanded on the existing EBI literature by tailoring category skills to each individual participant rather than teaching generic skills across participants. The current methodology was successful in teaching previously unknown, real world categories that were functionally relevant to participants. In both experiments, all participants successfully passed all training and testing phases without any need for remedial action. This is particularly interesting given that participants in Experiment 2 all had a diagnosis of ASD and language abilities below the age norm. Furthermore, all participants categorised the stimuli that were pre-experimentally known, targeted for training during match-to-sample phases and also additional untrained stimuli at post-testing.

The use of portable touch screen devices, such as the one employed in the current study, is increasing among preschool populations and there are many touch screen educational applications aimed at these ages groups. While the use of fixed touch-screens have been documented within the literature (Arntzen & Holtz, 1997; Saunders et al., 1999) the current study has however, added to the limited published research (Still et al., 2015) demonstrating the effectiveness of portable devices. Indeed similarly to Still et al. all participants in the current study had previous exposure to touch screen technology with the exception of P4 in Experiment 1. This meant that training participants in the response mode was very quick. Comparable studies using fixed computers and a computer mouse as a response device have reported considerable difficulties with point and click responses and duration of training required by young children with and without developmental delays (Hourcade et al., 2008; Shimizuet al., 2010). The current study provides an important step in disseminating research on evidence based teaching protocols using methodologies which incorporate portable touch screen technology. Future programs need not be confined to experimental or educational settings as such technology provides a platform for across setting such as in the home or perhaps within group activities.

Although participants across both studies demonstrated emergence of equivalence classes, there were clear differences in the number of trials required to meet mastery criterion for both match-to-sample and category training phases. In the computerised match-to-sample training the maximum number of trials required in Experiment 1, with the neurotypical population, was by Participant 1 (126 trials), however in Experiment 2, with children with ASD, Participant 2 required 780 trials to complete all match-to-sample phases. The high level of trials required by those participants with ASD was expected, based on findings reported in studies using similar populations (LeBlanc et al, 2003). In Experiment 1, Participant 5 required the highest level of 90 trials, while in Experiment 2 Participant 2 required 408 trials. The data from the A-B, B-C mixed training and testing phases show that only Participants 2 and 4 in Experiment 1 passed this phase on the first attempt. Even though the participants were being trained and tested on previously trained relations A-B and B-C, all other participants from both experiments required additional training blocks. This failure to pass these phases on the first attempt does provide some evidence that performance must be established using more stringent mastery criterion before tests for equivalence take place (Arntzen & Holth., 2011; Devany et al., 1986). The difference in the maximum number of training trials required across experiments was also noted in the table top category training phase.

The children who participated in the current study may have had a pre-experimental history of encountering many of the experimental stimuli in their day to day life. Thus the use of the pre-experimental category testing to identify individualised previously unknown categories for each participant was an important experimental control in the current study. Strict exclusion criteria were employed in the pre-test. Due to the type of stimuli and the age of the participants this was of particular importance as the children may have sorted the stimuli correctly together as a category but under an incorrect name. For both experiments, knowledge acquisition demonstrated during match-to-sample and category training phases showed that the stimuli chosen for each participant were indeed not associated pre-experimentally. Specifically, no participant passed Phase 1 the first time and all demonstrated clear progression of knowledge following each training phase.

Although the category sort test appeared to be successful in identifying categories unknown to the participants, it also meant that two stimuli from a given category could be paired within the same container – either the correct category container or an incorrect one. If this was the case, then only one of those stimuli was chosen for inclusion in the trained conditional discriminations. As a result of this pre-experimental pairing, it was expected that category membership would generalise from the stimuli chosen for training to those that had been paired pre-experimentally but not trained. Indeed, at post-experimental testing all participants did correctly sort additional category members which had been tested pre-experimentally but had not participated in the equivalence classes. Occasionally, generalisation to untrained category members was expected but not seen; one explanation for this is the generalisation of the category function based upon commonality of perceptual features. Additionally, these generalisation effects and errors demonstrated within the current study are reflective of those which have been demonstrated in young populations across disciplines (Murphy, 2002).

One other aspect to consider is that the sort test was closed in that the names and containers were given to the participants, they did not have a means to sort stimuli which the participants may have grouped as a different type of sub category (Fields, 1991). However it should be noted that the structure of the test did employ strict exclusionary criteria which accounted for the possibility of the children sorting the cards as they may in an open test. Other means such as a mixed test for conditional discriminations could be examined in future research as a means to identify unknown stimuli. The current study has demonstrated that EBI is an effective way to establish real world categories to young children with and without ASD. The ability to tailor the programme to target individualised skills in these populations means that the skills taught are functional for the learner. As emphasised by Still et al., (2015) the ease of training the response system is of particular interest, and offers further opportunity to examine very young children and children with a variety of disabilities.

Chapter 3 (Study 2): A Preliminary Evaluation of a Computerised Matching-to-Sample Programme for Teaching Real World Categories to Typically Developing Young Children

Research has demonstrated the effectiveness of Equivalence Based instruction (EBI) as an ecologically valid method, in terms of learning outcomes it is nevertheless important to compare the efficacy of such EBI procedures with long standing existing teaching methodologies. For any teaching methodology to have true transfer to real world educational settings additional questions must be answered. These questions relate to the level of time and effort on the part of the educator, outcomes in terms of learning for students in comparison to teaching mythologies which are currently favoured. Currently no known published research has attempted to compare EBI with an existing applied teaching methodology. The main aim of the current study was therefore to compare EBI with one such alternative; the Montessori Method. The Montessori Method is one of the oldest and most recognised evidence based educational methods in early childhood education. Development of the Montessori Method research, originally examined the intellectual development of children with intellectual delay before extending its application to neurotypical children. Today the method is applied across all populations (Lillard, 2012; Montessori, 1964). Estimates indicate that approximately 4,000 private Montessori schools operate within the United States (Lillard; Cossentino, 2005); however, this data does not disclose the age range of children. There are around 700 Montessori schools and nurseries in the UK, all of which are members of the Montessori Schools Association (Montessori.org.uk, 2015). The number of Montessori schools worldwide is estimated at 20,000 (Montessori-namta.org, 2015) however, this figure should be taken tentatively.

In 2005 it was estimated that approximately 500 Montessori Schools were in operation in the Republic of Ireland ('Leading early years education', 2005). Current figures taken from the State Child and Family Agency (TULSA) registry indicated that 10 years later, in 2015, there are approximately 1039 Montessori preschools catering for children up to six years of age currently in operation across 26 counties (Tusla.ie, 2015). There are an additional 12 schools which cater for children up until age 12 currently listed (Montessorialliance.ie, 2015). No information could be retrieved on Montessori based school placements for children over the age 12 in the Republic of Ireland. The increases in Montessori provision in the Republic of Ireland indicate a growing popularity of this as an educational environment for young children. This popularity appears to be supported by studies of efficacy. Lillard and Else-Quest (2006) provided evidence that a Montessori education when strictly implemented promotes equal or superior social and academic skills to those promoted by another traditional form of education. The authors compared two age groups totalling 53 controls and 59 Montessori students across two age groups 5 years old and 12 year old, the control children attended a variety of non-Montessori schools. It was found that the children who attended the Montessori setting performed better on standardised testing across reading and mathematics. Additionally, the children were also found to engage more in positive social interaction in play situations and showed advanced social cognition and executive control (Lillard & Else-Quest).

The figures available within the Republic of Ireland, however, do not do not differentiate if a school uses a mixed methods approach which incorporates some aspect of the Montessori methodology versus solely a Montessori approach. Lillard (2012) attempted to account for research inconsistencies that are found regarding Montessori outcomes. One possible explanation which Lillard discussed is variation in Montessori implementation fidelity. Within this context, fidelity of implementation refers to how well a program is implemented relative to the original or the ideal. In this study Lillard compared three programs for preschool-age children (N = 172). The three programs examined were high fidelity (Montessori only program), lower fidelity (Montessori used as a supplementary program with conventional programs) and conventional education programs alone. The children were tested across a variety of social and academic skills. The results found that the children in high fidelity Montessori programs showed significantly greater school-year gains on outcome measures of executive function, reading, mathematics, vocabulary, and social problem-solving, as compared with children in lower fidelity and conventional programs. The results of this study suggest that high fidelity Montessori implementation is associated with better outcomes than lower fidelity Montessori programs or conventional programs. What is evident from the body of research is a focus on outcomes over long periods of time (Lopata, Wallace and Finn, 2005; Cox & Rowlands, 2000; Krafft & Berk, 1998; He, Yan, Zuo, Liu & Zhang, 2009).

Similarly to Applied Behaviour Analysis, the Montessori Method has a strong emphasis on the environment, stressing the adaptation of this environment to the learners' individual developmental level. The role of physical activity in learning is emphasized across both academic and physical skills (Johnson & Nelson, 2009). Unlike behavioural teaching methods, which rely upon data based decisions and adaptations within educational programs, the Montessori Method relies upon teachers (known as a “director”, “directress”, or “guide”; Lillard, 2012) to support the learners' self-directed activity through clinical observation. A key characteristic of the Montessori Method is a focus on self-directed activity. Particularly within the preschool-age setting, self-directed learning on the part of the child is a distinguishing feature. Following the introduction of the learning materials, the teacher subsequently remains a ‘silent presence’ in the environment, allowing for self-directed learning on the part of the child. Types of learning activities cover a variety of domains which include, fine and gross motor development through what is known as Practical Life, Sensorial (sensory and brain development), Language, Mathematics, Geography, Science and Art. The held premise is that children learn through discovery and therefore didactic materials which facilitate self-correcting are favoured for use (Montessori, 1964).

While outcome measurements over long durations are essential, it is also imperative to establish the direct and immediate effect or none-effect that any teaching method has on learning. The purpose of this study is to compare a behaviour analytic teaching methodology with a Montessori methodology which undoubtedly will result in challenges arising. One key challenge that presents in such a comparison lies within measurement. In direct contrast to behaviour analytic methodologies, interim traditional measurements of achievements such as grades or tests do not fit within the Montessori approach of self-directed learning. That is not to say that feedback on performance is not provided, it however, tends to take the form of qualitative analysis usually as a list of skills, activities and critical points. In some cases a reporting structure is provided giving a narrative of the child’s achievements, strengths and weakness with an emphasis on improvements regarding areas of weakness. An additional difficulty regarding measurement arises in relation to when a child should progress with a task. Within the Montessori Method, progress is monitored through observation and is open to subjective interpretation. Also no set criterion of measurement is available which would enable remedial action or progression, the skill is repeated over time until the child demonstrates the whole skill.

Vargas (2013) recently discussed how the similarities between the structures of the Montessori teaching steps “periods” are comparable to the format of discrete trial teaching (p. 196). Indeed even more importantly every skill required is directly taught to the children. A key characteristic of stimulus equivalence is that by teaching just a few relations, derived or untrained relations emerge. Prior to their published work on statistical inferences (Critchfield & Fienup, 2010; Fienup, & Critchfield, 2011; Fienup, Covey & Critchfield, 2009) a brief examination which described factors outside of an experimental design (e.g. taking part in the on a Friday versus Monday) which resulted in systematic variance occurred, Critchfield and Fienup (2013). Worthy of note this study examined the differences between groups of undergraduate students (n54) who were assigned to one of two groups, the emergence expected and the taught everything group. This study although conducted with an adult population is of interest as within the Montessori Method, children are taught everything. Similar to later translational work exclusion criterion was set at scoring over 70% correct on a pre-test. Training and testing consisted of a match-to-sample procedure conducted at individual computer workstations in a classroom. The stimuli employed were printed text based on the concepts of inferential statistics and hypothesis testing.

Three lessons were conducted, each lesson consisted of several phases and students were required to meet a mastery criterion before moving to the next task and as such no student could complete the lessons without mastering the content. In the taught everything procedure students directly practiced all of the relations that the other group was expected to show. In the emergent relations procedure students practiced selected conditional relations that were expected to result in emergent ones. Critchfield and Fienup (2013) emphasise that “this comparison was selected because it is widely assumed that emergent relations procedures create the same repertoires as teaching everything, but with a substantial savings of training investment” (p. 3). The authors furthermore stress that limited research to verify such claims exists (Critchfield and Fienup; Taylor & O'Reilly, 2011). The results of this brief experiment found that collectively, students in the emergent relations group scored near chance on the conditional relations, this is of particular interest as during training only two comparisons were presented which meant that they had 50% change of correct responding. Critchfield and Fienup discuss how systematic variance occurred only under the emergent relations procedure which suggests that the taught everything procedure built repertoires that were more stable. Due to the level of chance responding seen in the data, the authors could not make any conclusion as to whether one procedure was more efficient that the other.

The MTS methodology used within the current study has already shown to be effective at establishing functional real world categories across two different populations of young children in Chapter 2. The Montessori teaching protocol used within the current research program has therefore been modified to attempt to control for measurement difficulties while still attempting to account for and being respectful of the philosophical underpinnings of the approach. This modification employed effects data measurement only which will enable us to compare the behaviour analytic method with the Montessori Method to ascertain if the program has application in mainstream educational settings. Firstly, the present study will focus on a specific teaching protocol from each method in order to determine if differences in terms of speed of concept acquisition could be found, secondly, by examining differences in the number of newly gained skills found for each participant.

Method

Participants

Eleven typically developing preschool-age children were recruited to part in the study. Two participants did not complete the study, one dropped out following Pre-experimental test 1 and a second was excluded at Phase 1 in Teaching protocol 1: Phase 1 due to exhibiting distress following consultation with the research team, school and parent. Nine children (see Table 3.1 for detailed participant information.) who attended a day and afterschool service took part in the study. The inclusion criteria for participation included good receptive language, no major visual or motor problems and no pre-existing knowledge of the categories to be trained determined through pre-experimental testing. All participants had attended the preschool service for at least one year. All the participants spoke English as their first language.

Table 3.1. Participant demographics.

Participant Number	Gender Male/Female	Commencement Age
1	M	3 years 2 months
2	F	3 years 3 months
3	F	4 years 4 months
4	F	4 years 3 months
5	M	4 years 5 months
6	M	3 years 1 month
7	M	4 years 1 month
8	F	3 years 6 months
9	M	3 years 6 months

Ethics

All ethical information was identical to the ethical information in Chapter 2 and a copy of the approved ethical application can be found in Appendix C. Duplicates information contained in the ethical application appendices such as PLS information and visual textual boards have not been included as they are provided in Appendix A.

Settings and Materials

All participants were trained and tested individually across two teaching protocols. Teaching Protocol 1 was the computerised match-to-sample (as outlined in Chapter 2) and Protocol 2 was the Montessori Method. Experimental sessions took place three times a week and session duration was set at a maximum of 30 minutes inclusive of breaks. All experimental sessions took place in the preschool class room in a small quiet area located in the corner used for individual work sessions. The other children and two teachers were present in the room engaging in daily activities.

All materials as described in Chapter 2 were again used for Protocol 1. In addition the same picture card (5x5cm) representing the experiment was shown directly to participants as one was not used in the school. The picture showed a computer with the word work written underneath. The same yellow ‘break’ card (8x5cm) was used so participants had an additional means of communicating any discomfort. The same token economy system was additionally used. A standard countdown timer was also used to record teaching time and to ensure consistent time with reinforcers.

A two choice preference assessment was conducted using a variety of developmentally appropriate toys. Access to highly preferred reinforcers was contingent upon performance during training, each token earned equated to 30s of play. However, secondary reinforcers identified as having low to medium value were presented for one minute if no tokens had been earned. Pictures of the reinforcers were affixed to a board later presented as choices of reinforcers to participants following an experimental training block. A visual and textual story board as in Chapter 2 was used to explain the process of the each Teaching Protocol and the token system to each participant at the beginning of each session.

General Procedure

The general procedure used during the experiment consisted of two pre-experimental tests, exposure to the two Teaching Protocols, followed by two post-experimental tests. This was a within participants design and all children were exposed to both Teaching Protocols. Specifically, half of the categories were trained using Teaching Protocol 1 (TP1) and the other half using Teaching Protocol 2 (TP2). However the order of exposure to the teaching protocols was counterbalanced across participants. For ease of communication, the procedure will be outlined as Teaching Protocol 1 first, followed by Teaching Protocol 2.

Language Assessment

As in Chapter 2, the standardised and norm referenced assessment of language used for Pre and Post-Test 1 was the Preschool Language Scale – Fourth Edition (PLS – 4; Zimmerman, Steiner, & Pond, 2005).

Pre-experimental Category Sort Test

The second pre-experimental test was a category sort test. The purpose of this test was to identify, for each participant, three categories of which they had little or no knowledge for each Teaching Protocol. This ensured that the programme was tailored to each participant's individual needs and that categories did not overlap across Teaching Protocols. During the category sort task, the participant was required to sort 27 picture cards once into three corresponding categories (9 cards per category). A forth container was presented and given a category label although no stimuli from this category were tested. This was introduced as an additional means of controlling for pre-experimental known stimuli and to reduce the number of stimuli from anyone category being paired together in the same container. Participants were tested across a number of categories until six sets had been identified as meeting criteria. Those categories identified were finally tested as a set of three to ensure that they still met criteria and ensure minimal overlap in topography of images.

During the category sort task, the participant sat at a table upon which four containers were placed. The researcher sat out of view behind to the right or left side of the participant. Participants were given the following instructions, “I want you to sort these pictures into these containers.” The researcher then pointed to each container and named what category was to be placed in each container. For example, “Animals” (pointing at Container 1), “Fruit” (pointing at Container 2) “Transport” (Pointing at Container 3) and “Toys” (Pointing at Container 4). The labels were repeated a second time again pointing to each container. After instruction, the researcher shuffled the picture cards. Each picture card was handed to the participant individually while he/she was simultaneously asked to ‘sort’.

Correct responding was defined as the participant placing the picture card in the corresponding (matching) category container and self –corrected errors were accepted as a correct response. Incorrect responses were defined as placing the picture card in a non-corresponding container, at any other location on the table/floor or, making no attempt to place the card within 10 s. No feedback was given to the participants at any stage during testing and no corrective actions were undertaken by the researcher. If the participant did not respond within 10 s the researcher removed the picture card and immediately placed the next picture in the participant’s hand issuing the instruction ‘sort’. The non-placed card was then recorded as an incorrect response. Categories for the computerised stages of the study were chosen based on the results of the pre-experimental category sort test. Category exclusion occurred when a participant placed four or more pictures from the same category set into the same container, regardless of the container’s category label. See Table 3.2 and 3.3 for the stimuli chosen for each participant for Protocols 1 and 2.

Table 3.2. Category sets and stimuli for Participants 1-4 for teaching Protocol 1 and 2.

Participant	Stimuli	Teaching Protocol 1			Teaching Protocol 2		
		Set 1	Set 2	Set 3	Set 1	Set 2	Set 3
		Reptile	Fruit	Money	Musical	Dairy	Zoo Animals
	A	Leaf frog	Blueberry	10 Euro	Tambourine	Cream	Tiger
1	B	Chameleon	Peach	2 Euro	Guitar	Cheese	Zebra
	C	Alligator	Lemon	20 cent	Trumpet	Yogurt	Giraffe
		Farm Animals	Transport	Furniture	Vegetables	Money	Birds
	A	Goat	Bus	Armchair	Broccoli	5 Euro	Crow
2	B	Duck	Motorbike	Desk	Beans	1Euro	Robin
	C	Sheep	Boat	Table	Parsnip	50 cent	Parrot
		Tools	Sports	Musical	Accessories	Big Cats	Planets
	A	Hammer	Football	Violin	Gloves	Cheetah	Jupiter
3	B	Saw	Tennis Racket	Trumpet	Belt	Snow Leopard	Mars
	C	Screwdriver	Helmet	Saxophone	Cap	Panther	Moon
		Sea Animals	Tools	Berries	Birds	Reptiles	Vegetables
	A	Squid	Wrench	Grape	Vulture	Alligator	Carrots
4	B	Lobster	Hammer	Cranberry	Macaw	Terrapin	Sweet Potato
	C	Sea Turtle	Drill	Raspberry	Eagle	Gecko	Turnip

Table 3.3. Category sets and stimuli for Participants 5-9 for teaching Protocol 1 and 2.

Participant	Stimuli	Teaching Protocol 1			Teaching Protocol 2		
		Set 1	Set 2	Set 3	Set 1	Set 2	Set 3
		Planets	Instruments	Insects	Electrics	Tools	Sports Equipment
5	A	Saturn	Flute	Dragonfly	Fridge	Grips	Hurley
	B	Neptune	Organ	Cricket	Oven	Screwdriver	Baseball Bat
	C	Uranus	Trombone	Wasp	Vacuum	Level	Hockey stick
		Zoo Animals	Fruit	Money	Furniture	Reptiles	Instruments
6	A	Hippo	Peach	10 cent	Lamp	Crocodile	Violin
	B	Zebra	Plum	5 Euro	Bed	Frog	Guitar
	C	Tiger	Grapes	1 Euro	Table	Terrapin	Drums
		Sports	Planets	Tools	Berries	Electrics	Instruments
7	A	Shin pads	Moon	Drill	Strawberry	TV	Saxophone
	B	Rugby Ball	Sun	Screw	Blueberry	Microwave	Flute
	C	Racket	Earth	Hammer	Blackcurrant	Dishwasher	Piano
		Birds	Fruit	Transport	Instrument	Sea Animals	Vegetables
8	A	Blackbird	Pineapple	Helicopter	Xylophone	Whale	Cauliflower
	B	Robin	Kiwi	Bike	Trumpet	Crab	Peas
	C	Seagull	Watermelon	Train	Tin Whistle	Sting Ray	Mushrooms
		Insects	Accessories	Dairy	Birds	Fruit	Transport
9	A	Worm	Watch	Butter	Crow	Mango	Bus
	B	Bee	Necklace	Cream	Owl	Apricot	Car
	C	Butterfly	Bracelet	Milk	Swan	Cherry	Airplane

Teaching Protocol 1: Match-to-Sample Training

The procedure for Teaching Protocol 1 was identical to that of Chapter 2 with two exceptions. First, the stimuli were once again individualised for each participant and so were different to those employed in Chapter 2. Second, an additional pre and post-experimental tact test was administered during this Protocol in order to provide balance with Teaching Protocol 2 which involves directly training and testing the stimuli names during Phase 2, Period 3 which will be outlined afterwards (see Figure 3.1 for a schematic of Teaching Protocol 1).

Duration recoding began as soon as the researcher gave the instruction ‘match’ during the computerised phases and the timer was stopped upon completion of the trials when the word ‘finished’ appeared. In the table top aspect the timer was started upon completion of the instruction ‘Give me…’ and stopped when the card was placed in the researchers hand as per the methodology outlined in Chapter 1. If a break was requested the timer was stopped however, no one participant ever showed distress or requested a break.

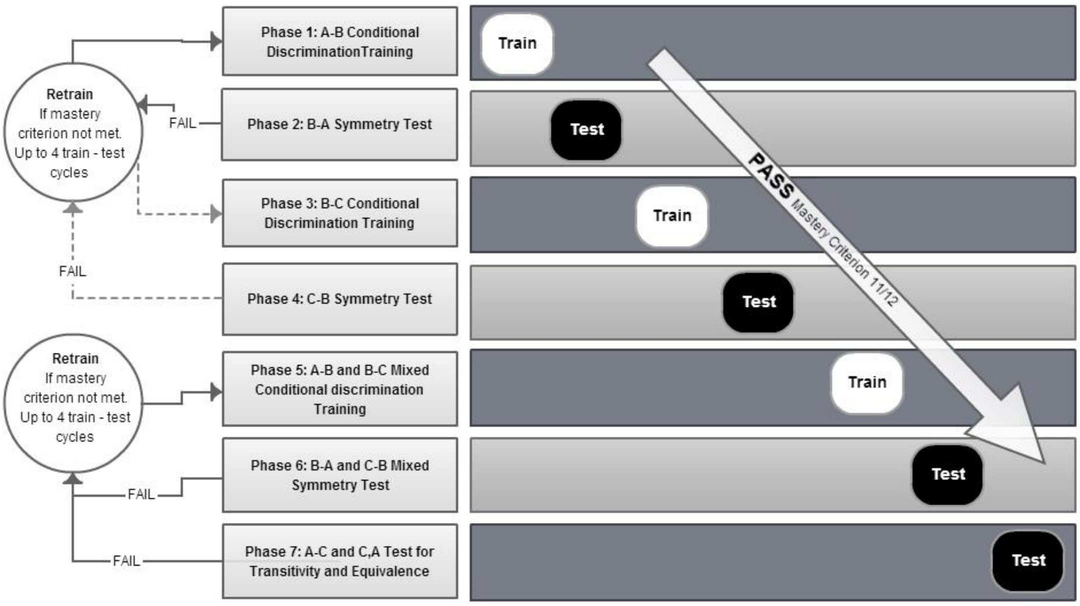


Figure 3.1. Schematic representative of computerised experimental Phases 1-7 used in Teaching Protocol 1.

Teaching Protocol 1: Pre-experimental Tact Test

Once three 9-member category sets had been identified a stimulus tact test was conducted to establish if the participant could label the stimuli. The 27 stimuli were shuffled together, placed in a pile on the table to the right of the researcher. One stimulus was presented to the participant at a time, by the researcher placing the picture card on the table facing the participant. In order to avoid confusion the researcher gave the child a working example to establish if the child could understand what was required in the tact test.

The researcher asked the child "tell me some things you like to eat"? Using the responses given by the child for example chips, apples and fish. The researcher then asked the child "Chips, apples and fish are a group, what group do they belong to"? If the child responded with the correct response "food" then testing began.

The researcher stated, "I am going to show you some pictures, I want you to tell me what group they belong to". The researcher placed the first card on the table, pointed to the picture and stated "Tell me what group this belongs to". The response was recorded and the next stimulus was presented. For the purpose of this test, correct responding was defined as the child responding with the category label e.g. fruit.

No feedback was given for incorrectly labelled the stimulus, or additionally if no response was made. Where no response was made following five seconds after the researcher instruction "Tell me what group this belongs to" the stimulus was removed and the next stimulus in the pile was presented however all children made attempts to tact each stimulus. Approximations and use of age appropriate labels (e.g. sweeties) were accepted as correct responses. In addition diction may not have been exacting for example, musical instrument may have been approximated as Music-Moosic, Instrument. Duration recording began following the practice session immediately following the researcher issuing the question "Tell me what group this belongs to"? The timer was not stopped unless a break was requested (this did not occur for any one participant). The timer was stopped following the participants responses to the last picture or following 5s of the instruction being given.

Teaching Protocol 2: The Montessori Method.

Teaching Protocol 2 consisted of four phases. The first phase naturally exposed the children to the new vocabulary. In the second phase the children practiced the vocabulary within the context of a three period lesson. The third phase consisted of identity matching and the final, fourth phase consisted of matching the picture cards. Each phase will be described in detail subsequently, for a schematic representative of Teaching Protocol 2 see Figure 3.2.

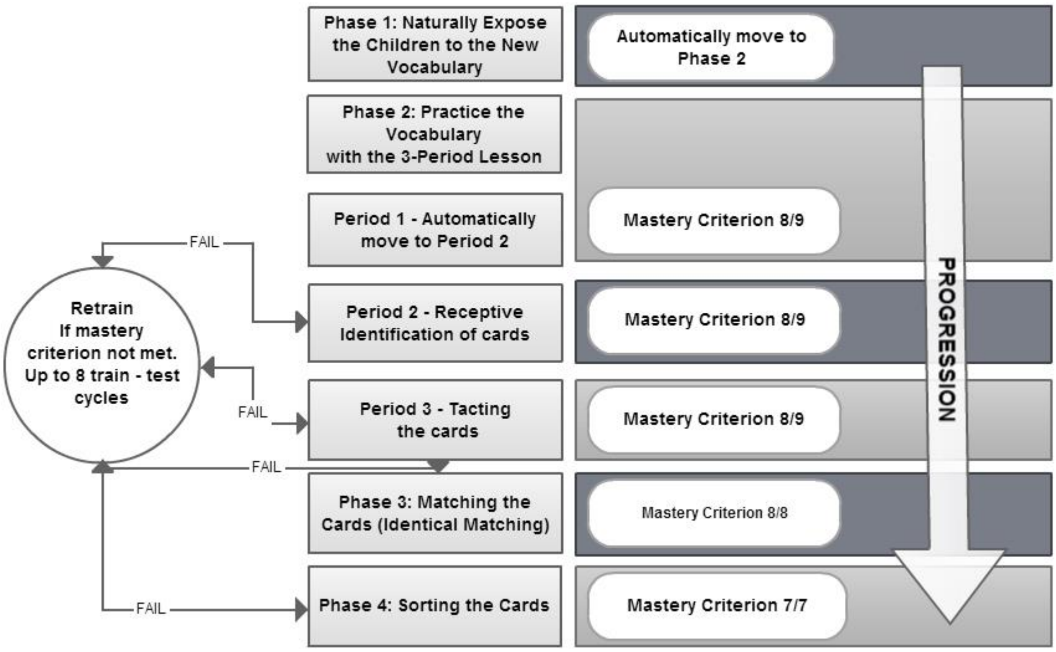


Figure 3.2. Schematic representative of Phases used in Teaching Protocol 2.

The token economy system was not used in Teaching Protocol 2 in keeping with the Montessori Method. Children were given verbal praise at the end which was specific to each phase for example, 'that was great telling me what those cards are'. No corrective verbal feedback was given at any stage when errors were made. Following each phase, a short break was encouraged and the children could go back and engage with other teaching activities in their class or play with the toys in the classroom if it was during free play times. Remedial action is not a feature of the Montessori Method but for the purpose of the research a criteria was allocated to allow measurement balance across both protocols. During Phase 2 and 3, eight training and test cycles would occur before remedial action would be considered although no remedial action was required for any participant during this Protocol, however no one participant required remedial action during the study.

Teaching Protocol 2, Phase 1: Naturally Expose the Children to the New Vocabulary

Before using the cards themselves (each card was representative of the stimuli identified for each participant at pre-testing), the participants were naturally exposed to the new vocabulary. Exposure was conducted by regularly using the stimuli (pictorial and textual representations) in conversations related to reading a book (a children's picture dictionary) that featured the objects. During this phase the researcher and child examined a book and the researcher read aloud the name of the item and pointed to the pictures and gave a feature or function of the item. For example, this is an apple, it's red and you eat it. Depending on the item/object the child may have responded, 'I like apples' or acknowledged the item by shaking head or repeating the name. Duration recording began during this phase following the researcher stating 'we are going to look at pictures and talk about them'. The timer was not stopped until all the stimuli had been presented with exception if any one participant requesting a break or the session was terminated due to distress however this did not occur for any one participant. After all the pictures had been identified a statement of class and function for each item was made, the timer was then stopped. The participants automatically moved to Phase 2.

Teaching Protocol 2, Phase 2: Practice the Vocabulary with the 3-Period Lesson

Period 1: Nine picture cards, three from each category set (e.g. ambulance, car & bus) were placed on the table, three to the left, centre and middle. The researcher touched the first card, on the left and said to the participant, "*This is* an ambulance." The process was repeated for all nine cards. The participant was not required to make any response at this stage. Duration was recorded when the researcher touched the first card and stopped when the researcher had named the last card. Upon completion the participant moved directly to the next period. The timer was not stopped during this period with exception if any one participant requesting a break or the session was terminated due to distress however this did not occur for any one participant.

Period 2: The researcher then moved away from the cards and asked the participant to, "*Show me* the ambulance." If the participant did not respond or pointed to the wrong card, the researcher returned to Period 1. Duration was recorded from when the researcher gave the first instruction of "*Show me the…"* until an error was made or upon completion of the task with the last card placed in the researcher's hand. The process was repeated for all nine picture cards and the criterion for mastery was set at eight out of nine trials correct to move to Period 3. If an error was made the participant stepped back to the previous Period in Phase 2 training (see Figure 3.2).

Period 3: The researcher pointed to each corresponding card (matching) for each of the same nine stimuli and asked the participant, "*What is* this?" If the participant did not correctly name the card, the researcher moved back to Period 2. The criterion for mastery was set at eight out of nine trials correct at Period 3 to move to the next phase in the Teaching Protocol. Duration was recorded when the researcher first stated *"What is this"* and was stopped when an error was made or upon completion of the participant naming the final ninth picture card.

Teaching Protocol 2, Phase 3: Matching the Cards (Identical Matching)

Each of the three pictures for each category (nine stimuli) was laid out in columns of three starting on the left side of the table. A second set of identical stimuli were shuffled in a pile and placed to the right side of the columns on the table.

The researcher took the card from the top of the second set and said to the participant, "Let's see if these cards look the same as any of the ones here. Let's see if they match." The researcher then began to find the match with the participant beginning at the top of the left column. The card was placed directly on top of the matching card. It is important to note in the Montessori Method that typically the card would be placed just to the right, however as more stimuli were used in this phase, the card was placed directly on top.

The child was then asked to continue, during this teaching phase the researcher said to the child, 'will you find the matches for these cards' and pointed to the remaining cards in the second set. Duration recording began at this point and was stopped when the last picture card had been placed down with another. When cleaning up the cards, the researcher repeated the name of each object pair as it was returned to a container. The criterion to move to the next phase was set at eight out of eight trials correct. In this phase an example was provided by the researcher and therefore the participant could only independently match eight out of nine stimuli used.

Teaching Protocol 2, Phase 4: Sorting the Cards

All nine picture cards were mixed together in one pile and placed face up on the table directly in front of the participant to the right side. The researcher took the first card and placed it in a column on the left side of the workspace. The researcher then took the next card and asked the participant, "What is this?" The card was then placed on the table in the column directly below the first card if part of that category set or to the right in a new column. The researcher then asked the child to take the next card, name it and place it in the proper column. Duration recording began on trial three following the two samples, when the researcher said, 'will you take the next one, tell me what it is and put it with the cards it belongs with'. The researcher then asked the child, ‘will you do the same again for these cards’, and pointed to the remaining set of cards. Participants were given a sample which incorporated two of the nine stimuli at the beginning of the Phase and the timer was not started until after trial two as these provided the children with the correct answers. Therefore criterion for mastery was set at seven out of seven correctly sorted. For Teaching Protocol 2, eight training and testing cycles would occur before remedial action would be considered. No feedback or corrections were given and if the child failed to meet the criterion they returned to the previous phase as outlined in Figure 3.2.

Post-experimental Category Sort Test.

This phase involved the participants assigning each of the nine stimuli for each set to one of the three categories established for the C stimuli in Protocol 1 and for Protocol 2 the directly trained category members. The procedure used was the same as in the pre-experimental category sort test.

Post-experimental Language Assessment

The language assessment was re-administered at the end of the study, six months after the first administration.

Results

Teaching Protocol 1: Match-to-Sample (MTS) Pre-training

Participant performances in all MTS phases of the experiment can be seen in Figure 3.3 and 3.4. All participants only required one exposure to the MTS pre-training before meeting the criterion to move on to the experimental sessions.

Teaching Protocol 1: MTS Training and Testing

Participant 1 required 72 trials (6 blocks) to meet the A-B training criterion of correct responding on 11 out of 12 trials in a block. He failed the subsequent B-A test for the emergence of symmetry relations (score of 9 /12). Following a second exposure to training 24 trials (2 blocks), the B-A test was passed with a score of 11 out of 12 trials correct. Criterion for B-C training was met after exposure to 72 trials (6 blocks) and Participant 1 then passed the C-B test for the emergence of symmetry relations at the first exposure. One exposure to A-B, B-C mixed training and testing was required, 12 training trials (1 block) before he passed the mixed test. He then went on to pass the A-C and C-A equivalence test.

Participant 2 required 60 trials (5 blocks) of A-B training in order to meet the criterion of correct responding at 11 out of 12 trials correct. The B-A symmetry test that followed was passed at 12 out of 12 trials correct. After 48 B-C training trials (4 blocks) she met criterion to progress to the test which she also passed. The participant passed A-B, B-C mixed training in just 11 trials and went on to pass the B-A, C-B test with a score of 11 out of 12 trials correct. She passed the subsequent A-C and C-A equivalence test with a score of 11 out of 12 trials correct.

Participant 3 required 48 trials (4 blocks) to meet the meet the criterion for A-B training. She passed the B-A symmetry test on the first attempt with a score of 12 out of 12 trials correct. Participant 3 required 60 B-C trials (5 blocks) to meet criterion and subsequently passed the C-B symmetry test first time. Participants 3 required just one exposure to A-B, B-C mixed training 12 trials (1 block) before passing the B-A, C-B test. She then passed the A-C and C-A equivalence test with a score of 11 out of 12 trials correct.

Participant 4 required 60 trials (5 blocks) at A-B training to meet the criterion to move to the subsequent B-A symmetry test which was passed on the first attempt with a score of 11 out of 12 trials correct. A total of 36 B-C training trials (3 blocks) were required to meet criterion, and the C-B symmetry test was subsequently passed first time. Participant 4 required just one exposure to A-B, B-C mixed training 12 trials (1 block) before passing the B-A, C-B test. The subsequent A-C and C-A equivalence test was then passed with a score of 11 out of 12 trials correct.

Participant 5 required 60 A-B training trials (5 blocks) before passing the B-A symmetry test first time. He required 48 B-C training trials (4 blocks) before passing the C-B symmetry test. Participant 5 only required just 12 A-B, B-C mixed training trials (1 block) to score 11 out 12 trials correct and passed the B-A, C-B test with a score of 11 out of 12 trials correct. The A-C and C-A equivalence test was passed with a score of 11 out of 12 trials correct.

Participant 6 required 72 A-B training trials (6 blocks) before passing the B-A symmetry test on the first exposure. He required 48 training trials (4 blocks) at B-C training and passed the C-B symmetry test on the first attempt. Participant 6 only required 12 trials (1 block) at A-B, B-C mixed training before passing the test on the first attempt with a score of 11 out of 12 trials correct. He subsequently passed the A-C and C-A equivalence test with a score of 11 out of 12 trials correct.

Participant 7 required 60 trials (5 blocks) at A-B training before passing the B-A test on the first attempt. He required 48 trials at B-C training (4 blocks) before passing the subsequent C-B test on the first attempt with a score of 11 out of 12 trials correct. This participant only required 12 trials to meet the criterion to move to the B-A, B-B mixed test which he passed with a score of 12 out of 12 trials correct. He passed the equivalence test which followed with a score of 11 out of 12 trials correct.

Participant 8 required 72 trials at A-B training (6 blocks) before passing the subsequent B-A test with a score of 11 out of 12 trials correct. She required 48 trials (4 blocks) on the next B-C training phase she then passed the C-B test which followed on the first attempt with a score of 12 out of 12 trials correct. She required just 12 trials (1 block) at A-B, B-C mixed training to move to the mixed test which she passed at 12 out of 12 trials correct. She subsequently passed the A-C and C-A equivalence test with a score of 11 out of 12 trials correct.

Overall, the maximum amount of training required for any one type of relation was 96 trials over two exposures to A-B training for Participant 1. For all other phases, Participant 1 required just one exposure to the train-test cycle. The smallest number of training trials required was 12 for all participants in mixed training and testing. These relations had been trained and tested in the previous phases. The trials to criterion for Teaching Protocol 1 for all participants can be found in Table 3.4.

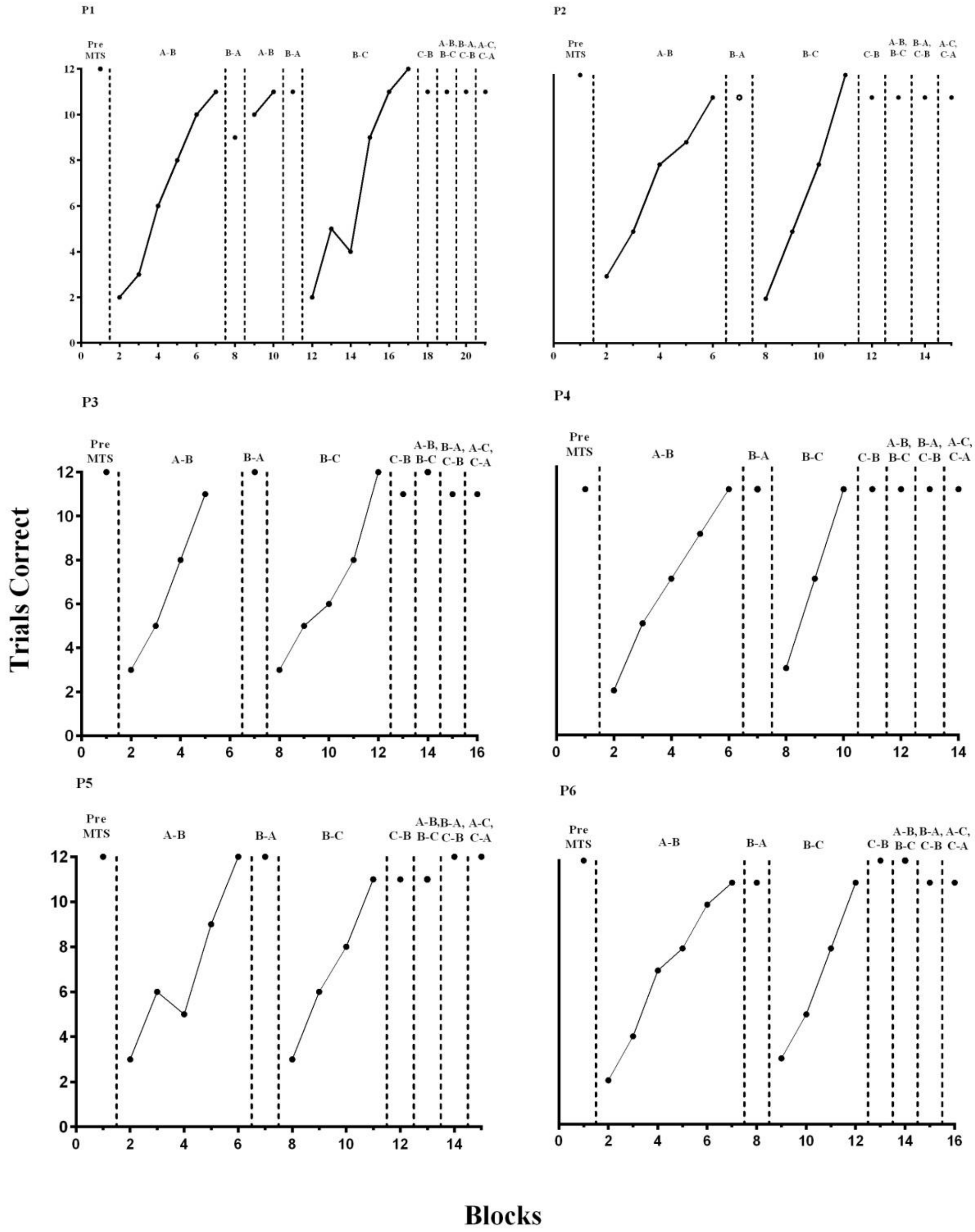


Figure 3.3. Participant 1 to 6 results for MTS Pre-training, A-B Training, B-A Testing, B-C Training, C-B Testing, Mixed A-B, B-C Training, and Mixed B-A, C-B Testing and A-C, C-A Symmetry Transitivity Testing.

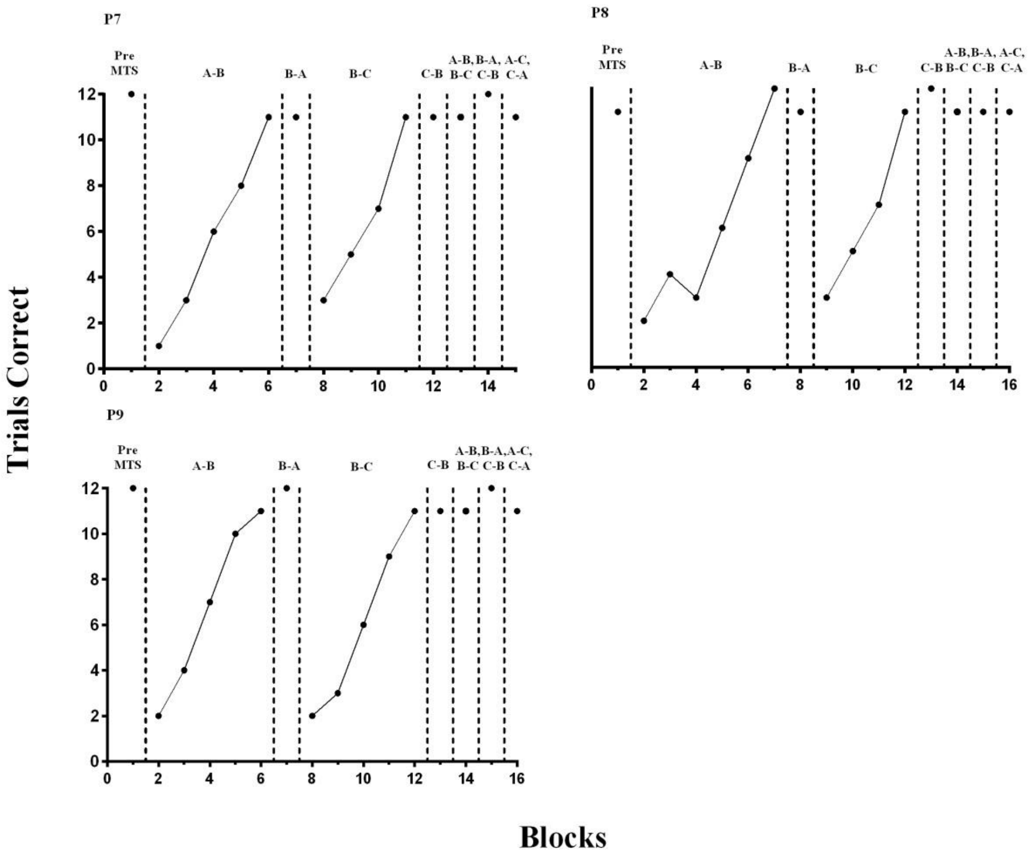


Figure 3.4. Participant 7 to 9 results for MTS Pre-training, A-B Training, B-A Testing, B-C Training, C-B Testing, Mixed A-B, B-C Training, Mixed B-A, C-B Testing and A-C, C-A Symmetry Transitivity Testing.

Teaching Protocol 1: Category Training

From Table 3.4 it can be seen that the largest number of trials to criterion was 72 by Participant 1. Participants 3, 5, 6, 7, 8 and 9 only required 48 trials to reach criterion.

Table 3.4. Total Trials to Criterion for Teaching Protocol 1, Participants 1 to 9.

Participant	AA-B	BB-A	BB-C	CC-B	AA-B, B-C	BB-A, C-B	AA-C, C-A	Category Training	Total Trials
1	996	224	660	112	112	112	112	72	300
2	660	112	448	112	112	112	112	60	228
3	448	112	660	224	112	112	112	48	228
4	660	112	336	112	112	112	112	60	216
5	660	112	448	112	112	112	112	48	216
6	772	112	448	112	112	112	112	48	228
7	660	112	448	112	112	112	112	48	216
8	772	112	448	112	112	112	112	48	228
9	660	112	660	112	112	112	112	48	228

Teaching Protocol 1: Tact Testing

The result of the pre and post-experimental tact test can be seen in Figure 3.5. Pre-experimentally two participants successfully labelled all stimulus by the given category name. Participant 2 and 6 identified one stimulus from their categories fruit. For Participant 2 apple which was also correctly sorted pre-experimentally was labelled fruit. For Participant 6 banana was labelled correctly as fruit and was also corrected sorted pre-experimentally. Post-experimentally five of the nine participants could correctly tact all 27 stimuli by the correct category label. Participant 2 did not correctly labelled two of the stimuli and Participants 4, 6 and 7 failed to correctly label one stimuli.

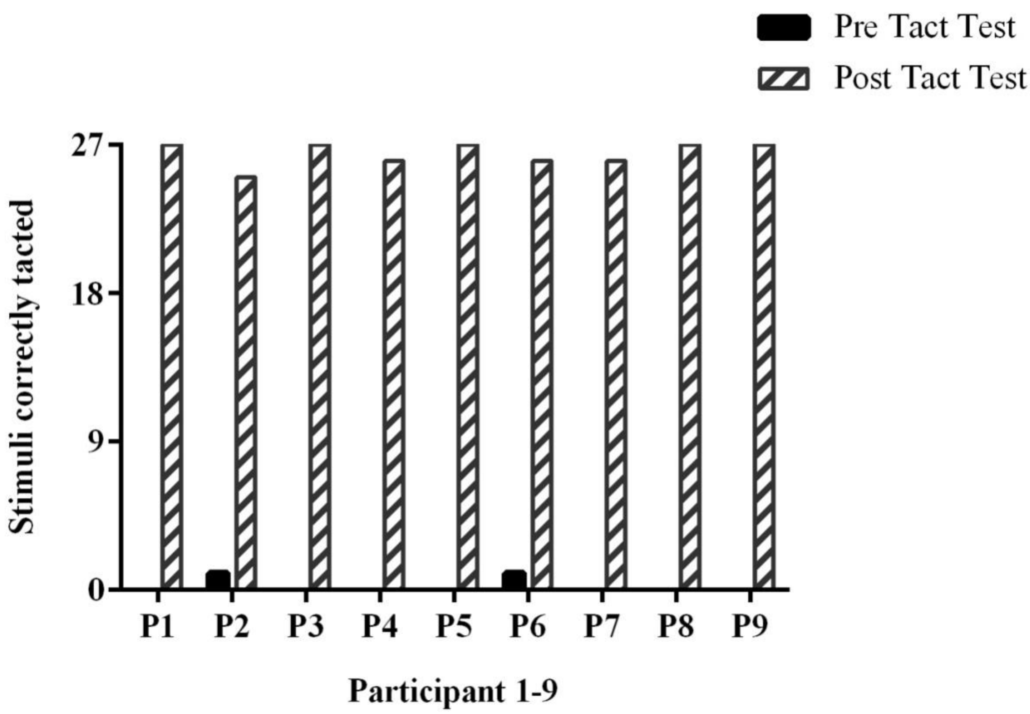


Figure 3.5. Pre and post-experimental tact test for Teaching Protocol 1.

Teaching Protocol 2: Montessori Method

All participants were only exposed to one block at Phase 1 which naturally exposed the children to the stimuli via books and discussion. As specified in the Montessori Method only one exposure to this Phase occurred. Phase 2: *Practice the Vocabulary with the 3-Period Lesson* of the Teaching Protocol consisted of three periods that will be referred to as Period 1, 2 and 3. As is standard within the

Montessori approach participants only additionally required 1 block at Phase 2, Period 1. Trials to criterion for all participants for Teaching Protocol 2 can be seen in Table 3.5.

The largest number of trials for any one participant for all phases was Participant 1 who required 232 trials. The lowest number of trials required for all teaching phases were for Participant 4, 187 trials and Participant 2, 188 trials. For Phase 2, Period 2 which required the participants to receptively identify the cards both Participant 1 and 8 required the highest level of trials (63trials) before meeting criterion. The lowest number of trials to criterion was 45 trials for Phase 2, Period 2 for Participants 2, 3, 5, 6 and 9. For Phase 2, Period 3 which required the children to name the cards, Participant 2 and 3 required the highest number of trials to criterion (45 trials). All other participant (Participants 3-9) met criteria following 18 trials. Participant 7 required the highest number of trials (64 trials) to criterion in Phase 3 identical card matching. The lowest number of trials required at Phase 3 was for Participant 1, 32 trials. In Phase 4 which consisted of the children sorting the cards Participant 1 required the highest number of trials to meet criterion (56 trials). Participants 3, 7 and 8 required the lowest number of trials to meet criterion at 42 trials.

Table 3.5. Total Trials to Criterion for Teaching Protocol 2, Participant 1- 9.

Participant	Phase 1	Phase 2 Period 1	Phase 2 Period 2	Phase2, Period 3	Phase 3	Phase 4	Total Trials
1	9	27	63	45	32	56	232
2	9	18	45	27	40	49	188
3	9	36	45	18	48	42	198
4	9	27	36	18	48	49	187
5	9	36	45	18	48	49	205
6	9	27	45	18	56	49	204
7	9	27	36	18	64	42	196
8	9	36	63	18	48	42	216
9	9	27	45	18	56	56	211

Duration

The total duration of teaching time for both protocols can be seen in Figure 3.6. For all participants the duration in Teaching Protocol 1 was shorter than in Teaching Protocol 2. The shortest duration for Teaching Protocol 1 was 45 m for Participant 4 and the longest duration was for Participant 1 at 54 m. The shortest duration for Teaching Protocol 2 was 59m for Participant 4 while the longest was 66m for Participant 3.

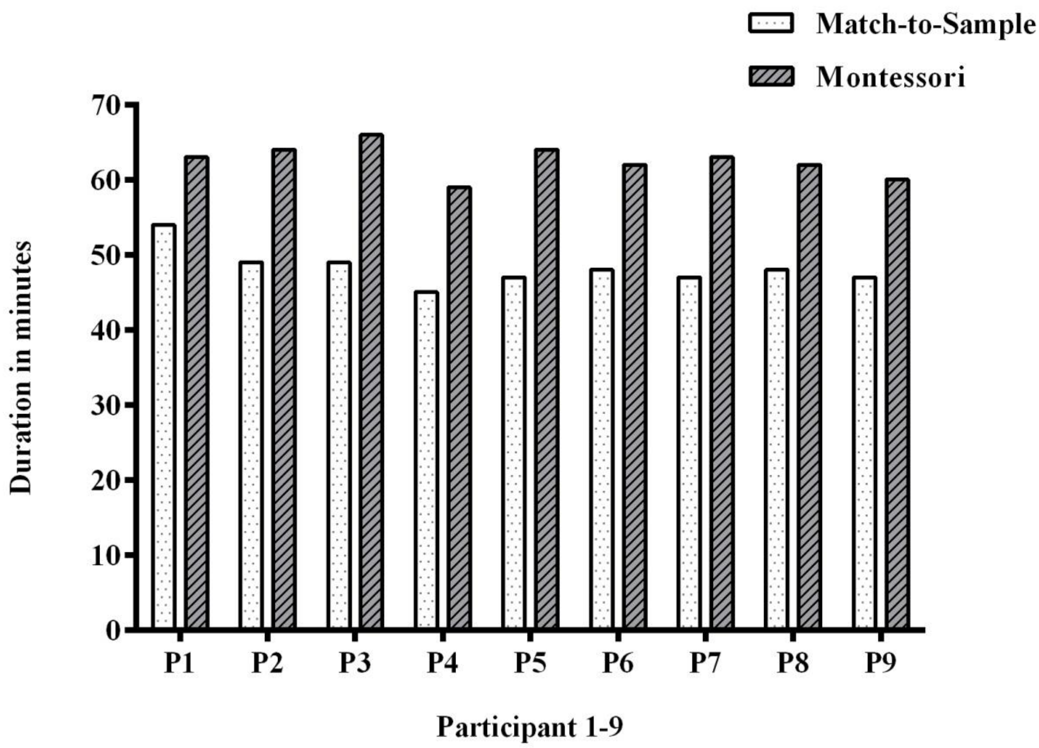


Figure 3.6.Total duration of teaching time for all participants across Teaching Protocol 1 and 2.

Category Sort Testing

The results of category sort testing for all participants can be seen in Figure 3.7 and 3.8. For Teaching Protocol 1 the three categories chosen for Participant 1 were reptile, fruit and money and in Teaching Protocol 2, musical instruments, dairy and zoo animals (see Table 3.2 for exact stimuli). Nine stimuli were tested for each of the three categories for each Protocol (27 stimuli per Protocol). These consisted of the three stimuli in each category that had been trained and tested in the Teaching Protocol, and an additional six category members that were not used in the intervention but that had been tested in the pre-experimental category sort test. Correct categorisation on the post-experimental category sort test could therefore be divided into three types; learned through the Protocol, known pre-experimentally and additional category members.

The results of the Category Sort Test showed that in Teaching Protocol 1, Participant 1 was able to correctly sort eight stimuli in the reptile category, nine in the fruit and eight in the money category. The stimuli that had participated in the MTS training (3 for each of the three categories) were sorted correctly, indicating a transfer of the category function from the three C stimuli to their respective B and A stimuli. As expected, the participant also correctly sorted stimuli that had been successfully categorised during pre-experimental testing; two from the reptile category, two from the fruit category and one from the money category. There were 13 additional stimuli this participant could have sorted correctly at post-testing and a total of 11 were correctly sorted; three in the reptile category, four in the fruit category and four in the money category. In the second Protocol there were 15 additional stimuli other than those trained or pre-experimentally known for which the participant correctly sorted 13. Five stimuli were correctly sorted in the musical instruments category, three stimuli in the dairy category and five more in the zoo animal category.

For Participant 2 the three categories chosen for Teaching Protocol 1 were farm animals, transport and furniture. In Protocol 2 the categories chosen were vegetables, money and birds. In both Protocols this participant correctly sorted the stimuli trained in the Teaching Protocols and the pre-experimentally known stimuli. In Protocol 1 there were four stimuli pre-experimentally sorted correctly; two in farm animals, one in transport and one in the furniture category. In the second Protocol there were three pre-experimentally correctly sorted; one in vegetable and two in the bird category. For Participant 2 in Teaching Protocol 1 there were 14 additional stimuli which could have been sorted correctly at post-testing. The participant sorted all the stimuli for each category; four in farm animals, five in transport and five in furniture. In Protocol 2 there were 15 additional stimuli other than those trained or pre-experimentally known for which the participant correctly sorted 11. She correctly sorted three stimuli in the vegetables category, five stimuli in the money category and three more in the bird category.

The categories chosen for Participant 3 in Protocol 1 were tools, sports equipment and musical instruments. In Protocol 2 the categories chosen were, accessories, big cats and planets. This participant correctly sorted the stimuli that were trained and those demonstrated pre-experimentally across both Protocols at post-testing. Pre-experimentally, Participant 3 correct sorted three stimuli in Protocol 1, one stimulus in the tools category and two stimuli in the sports equipment category. In Protocol 2 she pre-experimentally correctly sorted three stimuli; one in the big cat category and two in the planets category. Post-experimentally, there were 15 additional untrained stimuli in Protocol 1; the participant correctly sorted all 15 stimuli. Five stimuli in the tools category, four stimuli in the sports equipment category and six in the musical instruments category were correctly sorted. In the second Protocol there were also 15 additional untrained stimuli which the participant could have sorted correctly, she correctly sorted 12 stimuli. Five stimuli were correctly sorted in the accessories, three in the big cat category and four in the planets category.

For Participant 4, the categories chosen for Protocol 1 were sea animals, tools and berries and for Protocol 2 birds, reptiles and vegetables. Pre-experimentally two stimuli were correctly sorted in total at Protocol 1, one in the sea animal category and one in the berries category. In Protocol 2 two stimuli were sorted in total pre-experimentally; one in the birds' category and one in the reptiles' category. At post-testing, these pre-experimentally correctly sorted stimuli were again correctly sorted in addition to the three stimuli trained for each category set. For Protocol 1, Participant 4 had 16 stimuli that were untrained in addition to those targeted for training and pre-experimentally known; 15 of which were sorted correctly. In the sea animals category five untrained stimuli were sorted correctly, five in the tools category and five in the berries category. In the second Protocol the participant had a total of 16 untrained stimuli tested, of which, 11 stimuli were correctly sorted. Three stimuli in the bird category, four in the reptile category and four in the vegetables category were correctly sorted.

The categories chosen for Protocol 1 for Participant 5 were planets, musical instruments and insects. In Teaching Protocol 2 the categories chosen were electrics, tools and sports equipment. At the pre-experimental test this participant correctly sorted a total of four stimuli for Protocol 1; two in planets, one in musical instruments and one in insects. He correctly sorted a total of three stimuli in Protocol 2; one in electrics, one in tools and one in the insect category. At post-testing he demonstrated categorisation for the pre-experimentally known stimuli and those directly trained in both Protocols. In the first Protocol there were a total of 14 untrained stimuli that could be tested, in addition to the trained and pre-experimentally known. This participant correctly sorted all the stimuli in Protocol 1; in the planets category four stimuli, in musical instruments five stimuli and in insects five stimuli were correctly sorted. For Protocol 2 there were 15 untrained stimuli that were tested in addition those pre-experimentally know and those trained. He correctly sorted 12 of these stimuli, four in electrics, four in tools and four in the sports equipment category.

For Participant 6, the six categories for Teaching Protocol 1 were zoo animals, fruit and money and for Protocol 2 were furniture, reptiles and musical instruments. Pre-experimentally, Participant 6 correctly sorted only one stimulus in the fruit category in the first Protocol, and two in the second Protocol; one in furniture and one in reptiles. In addition to the directly trained and those pre-experimentally known, there were an additional 16 untrained stimuli tested for Protocol 1 at post-experimental testing. He correctly sorted a total of 13 stimuli, five in zoo animals, two in fruit and six in the money category. In Protocol 2, 16 untrained stimuli were also tested and he correctly sorted 15 stimuli. He correctly sorted five stimuli in furniture, four in reptiles and six in musical instruments.

The categories chosen for Participant 7 in Teaching Protocol 1 were sports equipment, planets and tools. In Protocol 2 the categories chosen were berries, electrics and musical instruments. During Protocol 1 pre-experimental category sort test he correctly sorted one stimulus in the sports equipment category and one in the tools category, a total of two stimuli. In Protocol 2 three stimuli in total were correctly sorted, one in the electrics category and two in the musical instruments category. Post-experimentally for Protocol 1 there were a total of 16 untrained stimuli which he correctly sorted in addition to the trained and pre-experimentally known stimuli. There were five sorted in the sports equipment category, six in the planets and five in the tools category. In the second Protocol there were 15 untrained stimuli tested of which he correctly sorted 13; five in the berries category, four in electrics and four in the musical instruments category.

For Participant 8 in Teaching Protocol 1 the categories chosen were birds, fruit and transport and for the Protocol 2, musical instruments, sea animals and vegetables. Pre-experimentally she correctly sorted a total of four stimuli in Teaching Protocol 1; two in birds, one in fruit and one in transport. In Protocol 2 she correctly sorted three stimuli, one from each category set. Post-experimentally Participant 8 correctly sorted the directly trained and pre-experimental known stimuli for both Protocols. In Protocol

1, 14 untrained stimuli were tested of which she correctly sorted 13; three in the bird category and five in both the fruit and transport categories. In Protocol 2, 15 untrained stimuli were tested of which she correctly sorted 11; three in the category musical instruments and four in both the sea animals and vegetables category.

For the final participant the categories chosen for Protocol 1 were insects, accessories and dairy and in Protocol 2, birds, fruit and transport. Participant 9 correctly sorted one stimulus from the accessories category and two in the dairy category, a total of three stimuli. In the second Protocol he correctly sorted a total of four stimuli, two in the bird category and one in both the fruit and transport categories. He correctly sorted the pre-experimentally known and trained stimuli for both Protocols at Post-category Sort Test. In addition for Protocol 1, 15 untrained stimuli were tested of which he correctly sorted 12 stimuli; five in insects, four in accessories and three in the dairy category. In Protocol 2 there were 14 untrained stimuli which were tested and this participant correctly sorted all of the stimuli at post-testing, four in the bird category and five in both fruit and transport categories.

For Participant 1 and 9 more untrained stimuli were correctly sorted at post-experimental testing in the second Teaching Protocol, the Montessori Method. However, for all of the other seven participants more untrained stimuli were correctly sorted at post-testing following the MTS procedure, Protocol 1.

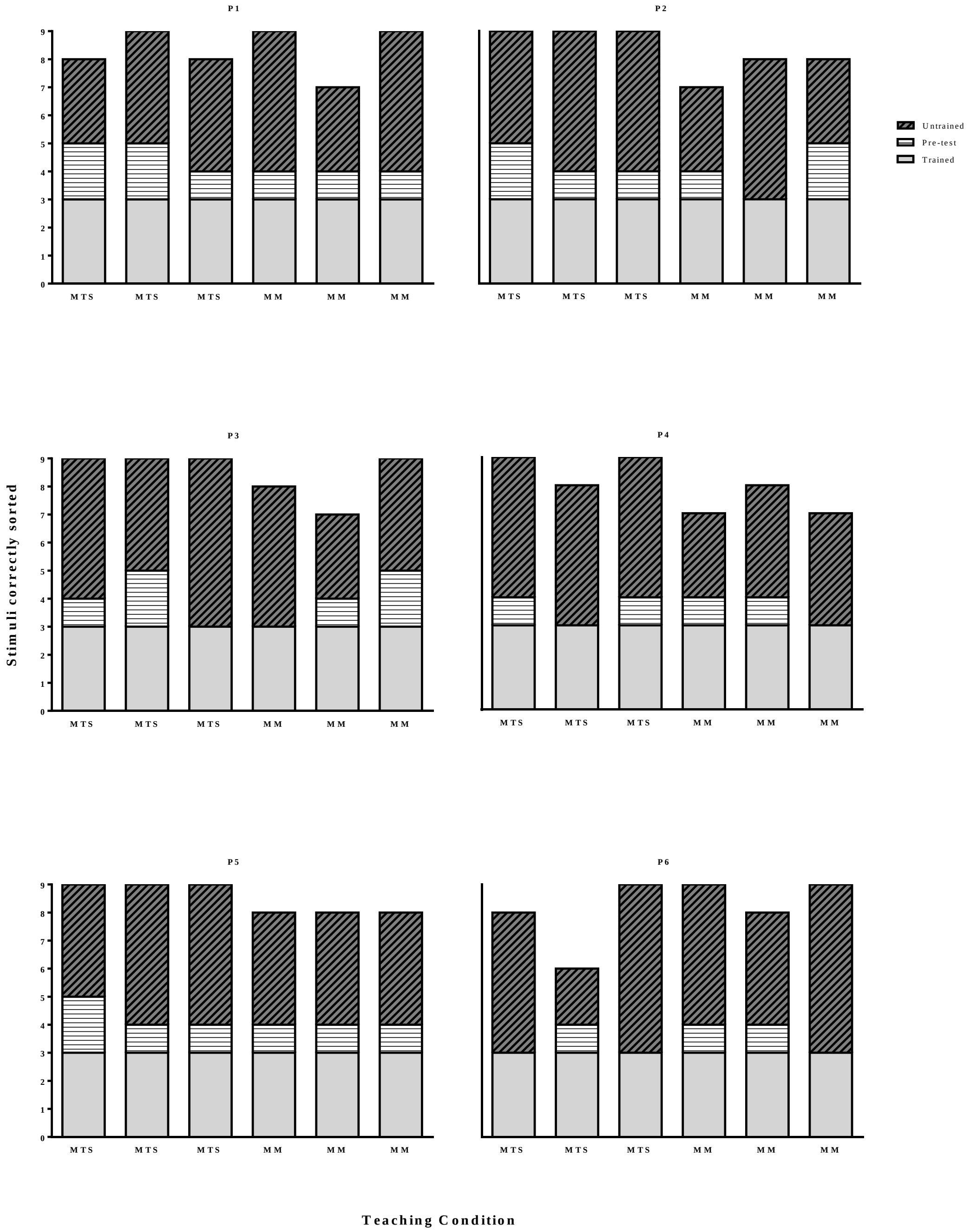


Figure 3.7. Pre and post-experimental category sort test for Teaching Protocol 1 and 2 for Participant 1-6.

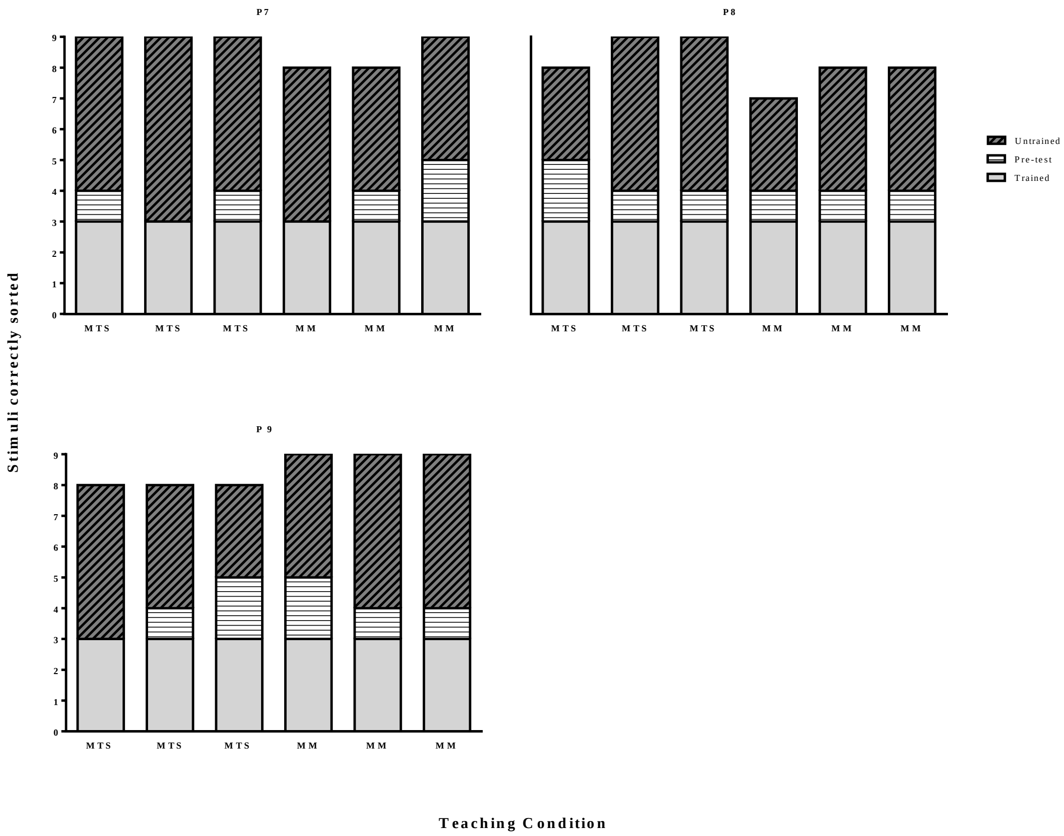


Figure 3.8. Pre and post-experimental category sort test for Teaching Protocol 1 and 2 for Participant 1-6.

Language Assessment: PLS-4

Results of the language assessment are represented in Tables 3.6 and 3.7 for all participants. Figure 3.9 displays the individual standard scores (+/− 1 Standard Deviation) on the subscales of the PLS-4. As expected with a typically developing population, performance was within the normative sample range for receptive and expressive standard scoring. Participant 2, scored just below -1 standard deviation (SD), however, both expressive and total language scores were within normative ranges. The score in receptive language was not significant enough to consider language delay or disorder. Overall, none of the children presented with clinically significant delays in language development.

Table 3.6. Results of Pre and Post-Experimental Language Assessment for Participants 1-5.

		Pre-experimental Language Assessment				Post-experimental Language Assessment			
Composite	Participant	Age	Raw Score	Standard Score	Age Equivalent	Age	Raw Score	Standard Score	Age Equivalent
Total Language	1	3:2	95	108	3:4	3:8	102	98	3:9
Receptive		-	48	111			51	104	
Expressive		-	47	104			51	93	
Total Language	2	3:3	80	86	2:11	3:9	94	86	3.4
Receptive		-	36	82			47	92	
Expressive		-	44	91			47	82	
Total Language	3	4:4	111	108	4:4	4:9	117	105	4:10
Receptive		-	53	104			58	111	
Expressive		-	58	113			59	99	
Total Language	4	4:3	110	107	4.3	4:9	113	97	4.6
Receptive		-	53	104			55	98	
Expressive		-	57	110			58	96	
Total Language	5	4:5	120	118	5:2	4:11	127	129	6:1-6:3
Receptive		-	57	114			62	127	
Expressive		-	62	120			65	125	

Table 3.7. Results of Pre and Post-Experimental Language Assessment for Participants 6-9.

		Pre-experimental Language Assessment				Post-experimental Language Assessment			
Composite	Participant	Age	Raw Score	Standard Score	Age Equivalent	Age	Raw Score	Standard Score	Age Equivalent
Total Language	6	3:1	91	99	3:2	3:7	101	98	3:8
Receptive		-	45	103			51	104	
Expressive		-	46	95			50	91	
Total Language	7	4:1	113	111	4:6	4:7	120	111	5.2
Receptive		-	55	109			59	116	
Expressive		-	53	113			61	106	
Total Language	8	3:6	108	108	4:2	4:1	116	115	4:9
Receptive		-	48	95			54	107	
Expressive		-	59	121			62	120	
Total Language	9	3:6	104	103	3.11	4:0	108	102	4.2
Receptive		-	49	99			52	99	
Expressive		-	55	107			56	106	

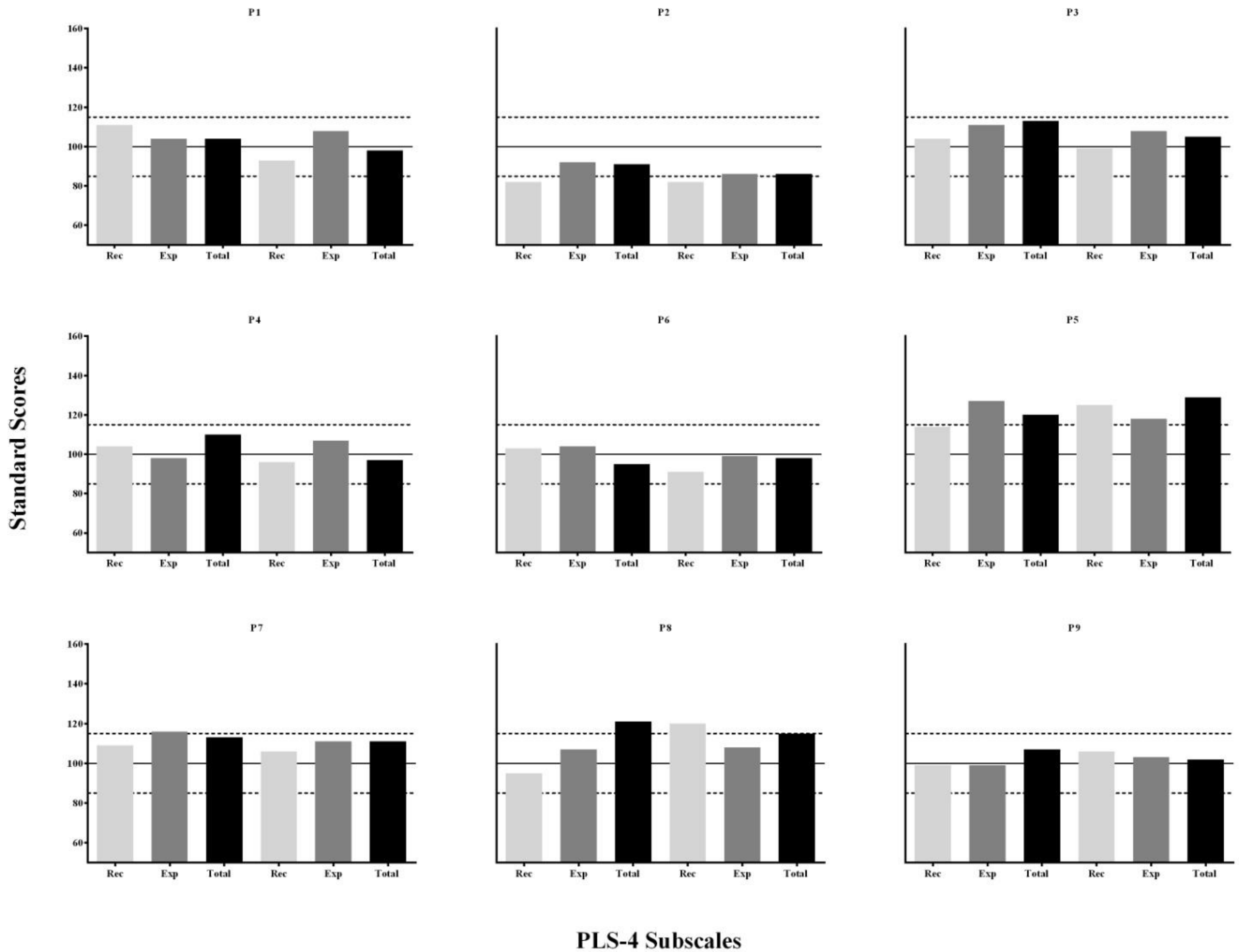


Figure 3.9. Participant 1-9 standard scores (+/- 1 standard deviation) on the language measures. The solid line indicates normative language scores of neurotypical children; the dashed lines indicate the boundaries of clinical significance.

Figure 3.10 displays the group mean standard scores (+/− 1 SD) on the subscales of the PLS-4. As expected with a typically developing population performance was within the normative sample range for receptive and expressive standard scoring: PLS Auditory Comprehension (M = 102.3) at pre-experimental testing and (M=106.4) at Post-experimental testing. PLS Expressive Communication (M = 108.2) at pre-experimental testing and (M=102) at Post-experimental testing. The PLS Total Language (M = 105.3) at pre-experimental testing and (M=104.5) at Post-experimental testing. In other words, as a group the children in this sample did not present with clinically significant delays in language development.

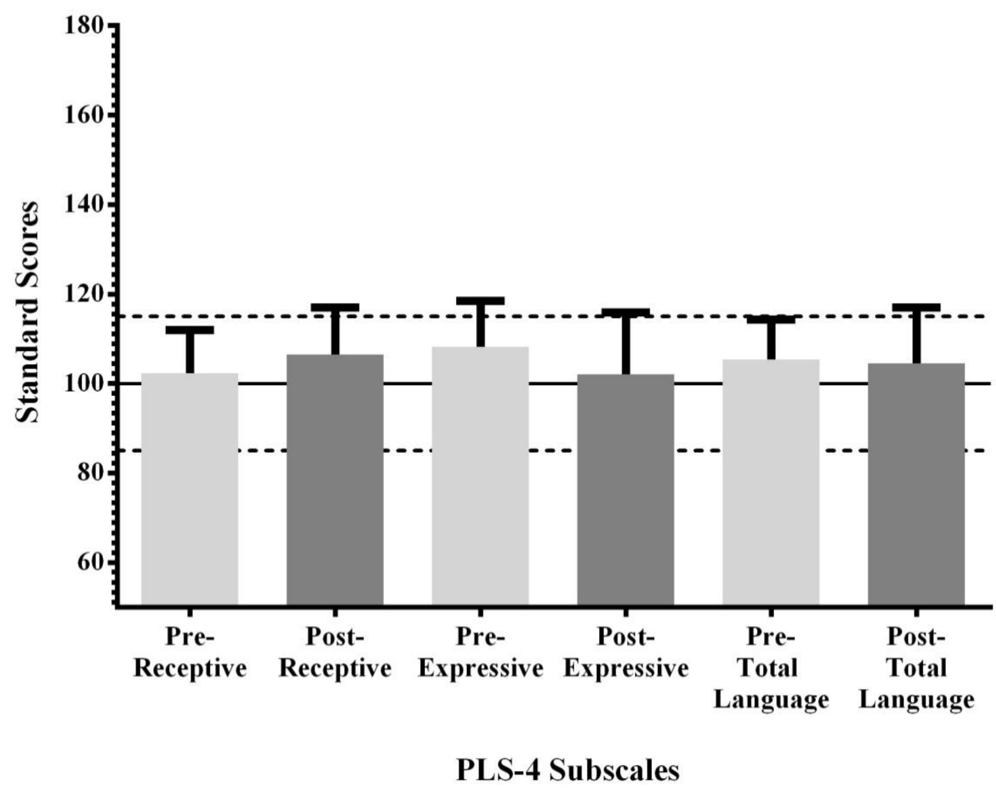


Figure 3.10. Group mean standard scores (+/- 1 standard deviation) on the language measures. The solid line indicates normative language scores of neurotypical children; the dashed lines indicate the boundaries of clinical significance.

General Discussion

A within-participants design was used to investigate the effectiveness of two different teaching protocols to teach non-overlapping, functional and individualised categories. The order of exposure to the teaching protocols was counterbalanced across participants. Following two pre-experimental tests, formal language assessment and category sort testing, half of the category sets identified were trained using Teaching Protocol 1 and the other half using Teaching Protocol 2. Teaching Protocol 1 was a behaviour analytic protocol which used a modified three, three member matching-to-sample procedure. Teaching protocol 2 was a protocol taken from an aspect of the Montessori Method. Re-exposure to the language assessment and sort testing was conducted post-experimentally. All participants successfully passed all teaching phases in both protocols and no one participant required additional modification to either protocol. The assumption that emergent relations procedures create the same repertoires as when teaching everything is supported by the findings of the current study (Critchfield & Fienup, 2013). In terms of direct teaching, for both protocol no significant durational difference was found. The shortest duration for Teaching Protocol 1 was 45 m for Participant 4 while in comparison in Teaching Protocol 2 the shortest was 59m for Participant 4. These finding add to the shortage of research that has directly investigated efficacy in terms training investment, the time that participants require to learn skills (Critchfield & Fienup; Taylor & O'Reilly, 2011). Where clear differences can be found is in the number of derived (untrained) relations which the children acquired via the teaching methodologies.

In Teaching Protocol 1 the children only received training on three stimuli for each of three category sets (nine stimuli in total) including the additional receptive training of the category label to the C stimuli. In contrast, the three stimuli for each of the three categories taught in Teaching Protocol 2 had all been directly trained to one another. Interestingly the training trials to criteria in relation to the number of training opportunities revealed that while the overall duration for Teaching Protocol 1 was less than that required in Teaching Protocol 2. All the participants had a greater number of learning opportunities in Teaching Protocol 1 the largest amount of trials to criteria being 300 for Participant 1 and the lowest 216 for Participants 4, 5 and 7. What must be noted is that in Teaching Protocol 2 where each stimulus were directly trained to each other, the trials to criteria reveal a lower number of learning opportunities were provided. The largest number of trials to criterion was 232 for Participant 1 and the lowest 187 for Participant 4, suggesting a greater exposure to learning opportunities were provided for participants in Teaching Protocol 1. This is further evidenced by the tact testing conducted during Teaching Protocol 1, the transfer of the receptively taught category name was shown to transfer not only to other stimuli which were previously unknown, but additionally to other stimuli which were unknown and not targeted for training.

In terms of teacher interaction, both protocols require a minimal level of teacher instruction. Even with the modifications which were made in order to allow measurement within the Montessori Protocol, these measurements could be accomplished with relative ease. Post-experimental category sort testing consisted of the three stimuli in each category that had been trained and tested in the Teaching Protocol and an additional six category members that were not used in the intervention, but that had been tested in the pre-experimental category sort test. Three types of correct categorisation could therefore be identified; those learned through the Protocol, known pre-experimentally and additional category members. With the exception of Participant 1 and 9, more untrained stimuli were found to be related at post-experimental testing in the first Teaching Protocol, the MTS procedure.

Participant 1 demonstrated the exact same level of responding at category sort testing across both protocols and did not demonstrate correct sorting for two stimuli in Teaching Protocol 1 and two in Teaching Protocol 2. Critically, the stimuli incorrectly sorted were not those which had been directly trained, or pre-experimentally known. Participant 9 on the other hand, demonstrated more correctly sorted stimuli following Teaching Protocol 2 sorting an additional one stimulus for each set (three extra in total), but for both Teaching Protocols all directly trained and pre-experimentally known stimuli were sorted correctly. The results of the pre and post experimental language assessments found that no significant increases in language scores were found for either individual or group standard scoring than would be expected within normal language development. All of the participants fell within the normal distribution expected. Therefore it could be argued that neither Teaching Protocol had any direct effect on language outcomes seen in the post-experimental test.

The present study has added to both the EBI and Montessori literature, to date no known published research has attempted to directly compare an EBI procedure with a specific teaching element such as the Montessori Method in young children. The results of the current study additionally give support to the effectiveness of the Montessori Method as previously published research (Cox & Rowlands, 2000; Krafft & Berk, 1998; Lillard, 2012; Lillard & Else-Quest, 2006) have focused on long term achievements versus specific teaching aspects. This should no way take away the importance of the findings for the EBI literature but an important finding to discuss. Indeed, within the EBI literature the findings of the current study for Teaching Protocol 1 are in direct contrast to results reported by Critchfield and Fienup (2013) in the emergent relations group. In the present study outcomes in terms of pre and post category sort test scores are comparable across both Teaching Protocols. One reason for the conflicting findings between those reported in Chapter 3 and Critchfield and Fienup may be attributed to the methodological procedure, in the present study three three-member classes were established using a quasirandom match-to-sample procedure before the category label was directly trained to the C stimuli. In contrast, the emergent relations group in Critchfield and Fienup's study only received training on two comparisons and participants in this group responded at chance levels at testing (Critchfield and Fienup). The findings in the present study would strengthen the argument that more trained relations are required to build in stable response repertoires.

While the current study has demonstrated positive results for the relative effectiveness of EBI, there are many questions which have arisen in relation to the transferability of this technology to educational settings. The use of touch screen responding is one which is affordable and easy to use, nonetheless the available technology is lacking in terms of ease of use, particularly programming of software. Future research could indeed examine human factors and ergonomics (HF&E) within the context of EBI application to identify barriers within natural settings. Such investigations and developments may in turn allow for a generality of EBI procedures that could be used effectively within society across a variety of settings. It is important to note, a key difference of any such comparison, lies in the presentation of materials. In the match-to-sample phases in Protocol 1, delivery of the protocol was computerised while in Protocol 2 everything was delivered via table top procedures using tactile printed materials. Future research could explore whether differences exist when teaching methods are more exactly matched, for example a table top based approached of the computerised MTS procedure. Within in the current study the procedures although modified to allow measurement differed vastly in structure and therefore these variables should be explored in future research. In addition of areas that warrant investigation include level of instructor engagement in terms of instructions given, preparation and teaching time.

Chapter 4 (Study 3): A Preliminary Investigation of Equivalence Based Instruction in the Mainstream Classroom.

Chapter 4 Study 3

In recent years a growing body of EBI literature has begun to emerge, in particular with adult populations, to address the validity and ecological value of such procedures within more naturalistic group settings (Critchfield &Fienup, 2010; Fields et al., 2009; Fienup et al., 2010; Ninnes et al., 2006; 2009; Pytte & Fienup, 2012). Published research to date has nonetheless, focused upon individual contingences and responding as a means of measurement. One area that has received no attention in the equivalence literature is the examination of group contingencies and responding. Active student responding can take many different forms and positive results have been found across a variety of activities such as choral responding, response cards, personal whiteboards, reading out loud and fill in the blank supplements to lectures (Colbert, 2005). These response forms are representative of the literature in that they typically employ low technology methods such as hand raising or response cards.

Advances in technology over recent decades have seen the growth of high tech alternatives to the traditional low tech methods which were favoured in the past. These technologies can take various forms, for example interactive whiteboards, tablets and student response systems. The availability and use of such high tech response systems have become more prevalent and cost-effective in recent years. According to Lowery (2006) one type of system, the student-polling system has grown in popularity. Within the literature there exists no standardised terminology and a variety of descriptions currently exist: student-response system (SRS) or Clickers, audience-paced feedback systems (APF), classroom performance systems (CPS), electronic response systems (ERS), hyper-active teaching technology (H-ITT), interactive engagement (IE), interactive audience response systems (IRIS), interactive learning systems (ILS), interactive student-response systems (ISRS), personal response systems (PRS), group response systems (GRS), and wireless response systems (WRS). For the purpose of the current thesis and ease of communication the term student-response system (SRS) will be used throughout.

Currently these systems work via infrared (IR), radio frequency (RF), or Wireless Fidelity, wireless internet (Wi-Fi). A computer (standalone or laptop) is a requirement to the associated software and additionally if results are to be displayed to students a projector is required. The use of SRS allows students to respond quickly and anonymously to questions presented in class and results are immediately presented individually on the device or summarized and presented on screen or later as a report. In direct contrast to stimulus equivalence research, much of the research regarding SRS use has been conducted in applied settings and researchers have addressed that the verification of results found in applied studies need to be transferred to and examined under more controlled laboratory settings (Draper & Brown, 2004). As discussed previously, the emergence of new technologies within educational settings offer an opportunity for reform (Twyman, 2011). EBI provides behavioural researchers with the opportunity to merge scientifically empirical EBI procedures with incorporate a host of behaviour analytic principals (reinforcement through feedback, token systems) and techniques such as prompting and individual and group contingencies. The use of a single-subject-design (as discussed in Chapter 1) is traditionally found within the applied behavioural literature and includes research methods which allow for the examination of individual, pairs and small groups of individuals.

Published EBI research to date has been conducted using Single Subject Research Design (SCRD) or Small (n) group designs as outlined in Chapter 1. A recently published paper (Zinn, Newland & Ritchie, 2015) examined an EBI protocol under an alternative technique, a randomized controlled trial (RCT). RCT is a type of scientific (often medical) experimental design in which participants are randomly allocated to one or another of different treatments (IV) under study. RCT is often considered the gold standard for a clinical trial and more often used to test the efficacy or effectiveness of various types of medical intervention. Random assignment of participants to either the intervention or Control-group takes place once participants have been recruited and assessed for eligibility (Chalmers, Smith, Blackburn, Silverman, Schroeder, Reitman & Ambroz, 1981). Zinn et al. conducted a study using an RCT design with 61 college students. In their experiment participants were required to attempt to learn 32 pairs of proprietary and generic drug names using computer-based match-to-sample presentations of auditory and written drug names. The participants who received EBI experienced pairings based on stimulus equivalence theory demonstrated mastery criteria quickly. Participants in the Control-group practiced relations selected at random from those that the EBI group learned via training or emergence. The results found that participants in the criterion-control group required many more trials to achieve the same accuracy as the EBI group. In the third trial-control group participants were yoked to participants in the EBI-group and received the same number of trials but achieved poorer levels of accuracy and not all participants met mastery. Overall the findings of the Zinn et al. study support that EBI was more efficient and effective than unstructured training procedures.

No known published research has attempted to establish if an EBI protocol including group contingencies (mastery and token system) is an effective means of teaching young children within a small (n) group design. The current program of research employed a four member one- to-many (OTM) arrangement (3 classes); single- sample multiple- comparison and sample- as- node (SaN) (Fields, Hobbie-Reeve, Adams & Reeve, 1999). The purpose of the current study was to extend upon previous work as discussed in the previous chapters, by including slightly older participants and employed a small (n) group design to examine and EBI procedure and group contingencies for mastery of materials. This design allows the measurement of both the individual and small group data which was an important consideration given the young age of the participants involved who do not have as sophisticated learning history as adults. The first aim of the current study was therefore to explore the use of SRS as a response mechanism in an OTM protocol. The second aim was to examine small group responding through group contingencies during the teaching protocol and to determine if the protocol is effective with an older population. The final aim was to examine individual responding during the protocol and investigate categorisation skill development from pre to post testing phases.

Experiment 1

Method

Ethics

All ethical information was similar to the ethical information in Chapter 1 and 2 and a copy of the approved ethical application can be found in Appendix D. Key differences in the ethical implications arose due to the small (n) group design. The children in this experiment were older and had sophisticated language abilities. Each child in addition to informed parental consent gave assent to take part in the study. Each child was given a visual and textual instruction sheet similar to that used in Chapters 1 and 2. The researcher had a copy of the instructions and went through point with the class as a whole, pointing to the corresponding picture while holding the sheet for the children to see. At the end of the instructions the children completed either did or did not give assent to take part, no one child chose not to take part in the study.

The children were instructed that if any child needed a break or help to raise their hand. If any one child requested a break the experiment was stopped for all participants and a general break was taken. However breaks were built into the experiment and no one child actually requested a break. Throughout the study the children were reminded by the researcher and research assistant that their own results were not to be disclosed to anyone else in the classroom and not to provide others with an answers. This was implemented to ensure that privacy was maintained and reduce the possibility of any child feeling that they had made a mistake. The criterion for a trial to be correct was set at >50% in Experiment 1. As this research is preliminary in nature it was considered essential to ensure that the children remained engaged and that the session length not be excessive to cause boredom or frustration. The criterion level was changed in the subsequent experiment as this was not found to effect the children's motivation or create frustration.

Participants

Two small (n) groups of typically developing primary school-age children from two classes in a mainstream national school were recruited to take part in the study. Group 1 consisted of ten children, three girls and seven boys aged between 5 and 7 years. Both Participant 6 and 7 were bilingual and English was not the primary language spoken at home. In Group 2, 16 children, 10 girls and six boys aged between 6 and 7 took part in the study. In this group Participants 8, 9, 10, 14 and 15 were bilingual with English not the primary language spoken at home.

Settings and Materials

All experimental sessions took place in the children's own class room each located directly beside each other. The main classroom was a large square space, the children sat at group tables (a maximum of four per table) and six tables were present in each room. To the front of the group tables in each classroom there were two large whiteboards, one of which was an interactive whiteboard connected to an overhead projector. A pull down laptop stand was fixed to in the centre of the wall between the two boards. During the study, three people were present in each of the classrooms in addition to the participants. These were the children’s teacher, the researcher (the author) and a research assistant. The role of the research assistant included distribution and collection of materials, technical issues and in addition participated in data collection. During experimental session the classroom teacher remained to the rear of the class.

Experimental sessions were delivered via a laptop connected to the overhead projector. Actionpoint (Qwizdom.com, 2015) polling software for native PowerPoint ® files was used for the creation and delivery of the training and testing slides. The software provides an interactive delivery system, whereby responses to questions are made and scored instantly via an app or keypad. Participant responses were made via wireless SRS, Q4 response system. The Q4 handset is a lightweight handheld device, dimensions of 5.2 x 11.5 x 1.6 (cm) and can be seen in Figure 4.1. It supports a variety of different question types such as multiple choice questions and is suitable for use with all ages (See Appendix E for equipment specifications).

Figure 4.1. The student response system Q4 handset which was used by each participant to respond individually during the experiments.

The same stimuli (three sets) were employed for both participant groups. For ease of communication stimuli will be referred to using alphanumerics (e.g. A1, A2). The textual stimuli, the category name (A1, A2 and 3) were typed words created directly in the PowerPoint ® slides. All picture stimuli (B, C and D) were obtained from a variety of sources (see Appendix F for a list). The stimuli chosen can be seen in Table 4.1 were reflective of the Irish Primary School Curriculum: Social, Environmental and Scientific Education (SESE) (NCCA, 1999). The same text and images were used for pre and post-experimental testing and computerised phases. Pre and post-experimental sessions were conducted via paper and pencil tests which differed in presentation layout, four layouts were created (see Appendix G for a sample of the pre and post-test used during the experiment).

Table 4. 1. List of stimuli used during the experiment with reference to the Irish Primary Curriculum.

Relation	Irish Primary Curriculum Relation	Actual Stimuli
A1	Fungi	Printed Word Fungi
B1	Does not move	Picture of roots
C1	Absorb nutrients from other organisms	Picture of Compost
D1	Example Mushroom	Picture Mushroom
A2	Plantae	Printed Word Plantae
B2	Structure	Picture Roots, Stem and leaves
C2	Autotroph (absorb nutrients from sun)	Picture sun beams on tree
D2	Example Plants	Picture of flowering plants
A3	Animalia	Printed Word Animalia
B3	Get energy by consuming other organisms	Picture Meat, Fish, Fruit and Veg
C3	Movement	Picture Man running with dog
D3	Example Animalia	Picture animal groups

Pre-training was conducted prior to the lesson and all participants received an instruction sheet a picture of the SRS, a black box indicated to the power on/off button located at the top left of the clicker. The participants were asked to press this button and turn on their clicker then press the arrow button to send. When all the SRS devices had been turned on, the second instruction indicated a black outlined box under the A, B and C buttons located on the centre of the clicker was given. The researcher explained that the children would be asked to pick an answer using either A, B or C. The children were then asked if they were ready to practice using the SRS (see Appendix H). A glass jar (18 x 4) had a red taped band across the middle was used during training sessions and this jar differed to that shown in the instruction sheet. During training sessions a white polystyrene ball with gold stars (10 & 12 cm) was placed in the jar for each correct group response.

General Procedure

Pre-experimental Test

The purpose of the first test was to identify if the participants had pre-experimental knowledge of the categories chosen for use in the study. No participant exclusionary criteria were placed on this test, however, if the responses of the group demonstrated an overall knowledge of the stimuli for example, more than half of the group responded at over 50% responding then new stimuli sets would be tested. This was a pencil and paper test during which participants were required to draw a line from nine picture cards, to one of three boxes, each containing a printed category name (see Appendix G). These nine stimuli were those chosen for use in the experiment, three from each of the three corresponding categories. This type of test is similar to those typically used in educational settings.

Prior to the participants being given the test, the researcher explained what was required and used a sample test to demonstrate. This sample was laid out in the same manner but the stimuli differed, the printed words were circle, triangle and square and the pictures stimuli consisted of corresponding shapes (circle, triangle & square) which differed only in colour (red, black & blue). The researcher read the instructions aloud to the classroom and subsequently demonstrated for two images on the sample what the children were required to do with their own test. Once the demonstration had been completed each participant received a printed test and a pencil which had an eraser top. Participants' were instructed not to begin the until the researcher said 'start' and were instructed to raise their hand if they needed help or once they had completed the sheet. During the pre-experimental test the researcher stood at the front of the classroom observing. The research assistant walked around the rear of the room observing the students. Where any observation of any participant offering help to another in the group was observed the entire group were reminded of the rules by either the researcher or the research assistant.

Correct responding was defined as the participant drawing a line connecting the picture card to the corresponding category box. Self - corrected errors were accepted as a correct response such as erasing the line and redrawing a line to the correct box. No feedback was given to the participants at any stage during testing and no corrective actions were undertaken by either the researcher or the research assistant.

Computerised OTM Training and Testing

Pre-training

In order to familiarise the participants with the SRS a pre-training phase was conducted. The researcher held up one of the SRS devices and demonstrated how to turn on and use the device, additionally the instruction sheet which the participants received also showed the images (see Appendix H).

Once participants had mastered turning on the clickers and knew where to locate the specific response buttons being used, they were exposed to a sample trial in the same format as the experimental trials. This trial was programmed in PowerPoint ® and projected onto a screen in the classroom. A printed word appeared at the top of the screen to the centre of the slide. The experimenter read the word aloud (e.g. Bart Simpson) and left the word on the screen for approximately three seconds. The sample stimulus was then removed and the three comparisons stimuli immediately appeared on the screen. Comparisons were listed horizontally to the left of the screen, each of the pictures were prefixed as A), B) and C).

The researcher stated “If you think the answer is A press the A button on your clicker, B press the B button or C press the C button, then the arrow button”. Each block consisted of nine trials whereby each stimulus (3 per category) was presented in a pre-determined randomised order across each block. The criterion for correct responding per trail was set at the total group response being greater than chance level. For Group 1, six out of ten participants or 60% or greater and for Group 2, nine out of 16 participants 56% participants must have selected the correct answer. Only four trials were provided during pre-training and the participants were only required to master one trial, as this phase was designed to familiarise the children with the SRS.

Phase 1: Mixed Conditional Discrimination

During Phase 1 participants were directly trained to pair the A stimuli to the corresponding B, C and D stimuli using the same procedure as described for pre-training. For a visual representation of a training phase see Appendix I. For example, choosing B1 from an array (B1, B2, & B3) was reinforced following the presentation of A1. Correct responding on trials was reinforced by the researcher placing a ball into the jar. The criteria for trial mastery was set as in pre-training > 50% correct over one trial, for Group 1, six out of ten participants or 60% or greater and for Group 2, nine out of 16 participants, 56% of participants must have selected the correct answer. The criterion to move forward to the next phase of the experiment was set at seven out 9 trials correct (78%) over one block. For a schematic representing the computerised phases see Figure 4.2.

Phase 2: Mixed Symmetry Testing

This phase tested for derived symmetry of the B, C and D stimuli to the respective A stimuli. Criterion performance was set as in Phase 1: Mixed Conditional Training. If the participants did not meet criteria, Phase 1 training restarted for a maximum of four train-test cycles. The instructions for testing phases differed from training because no reinforcement was provided.

The participants were informed that this time the questions would look different and that we would not be placing the balls in the jar.

1) *We are going to answer some more questions.*

2) *This time a picture will appear on the top and you will choose the word that matches.*

3) *This is a test so we will not be putting balls in the jar this time.*

The criteria for trial mastery was > 50% correct over one trial, for Group 1, six out of ten participants or 60% or greater and for Group 2, nine out of 16 participants or 56% of participants must have selected the correct answer. The criterion to move forward to the next phase of the experiment was set at seven out 9 trials correct (78%) over one block. If either group failed the test a return to Phase 1 was implemented.

Phase 3: Equivalence Testing.

The procedure for Phase 3 was the same as in Phase 2 with the exception that participants were tested on the six previously untested B-C, B-D, C-D, C-B, D-C & D-B relations for each of the three category sets (for all tested relations see Figure 4.2). This trial test block exposure consisted of 18 trials in which each stimulus pair was presented once across the block. The criterion to move on to the next Phase in the study was at 14 out of 18 trials correct. Remedial action would be taken had any group failed to meet criterion for this phase.

Post- Experimental Category Test

The purpose of this test was to determine if the participants demonstrated generalisation of the trained category members that were not demonstrated during pre-experimental testing. The protocol for this phase was identical to that used in the pre-experimental category test, but differed only in that the layout of the stimuli varied to the test sheets used previously.

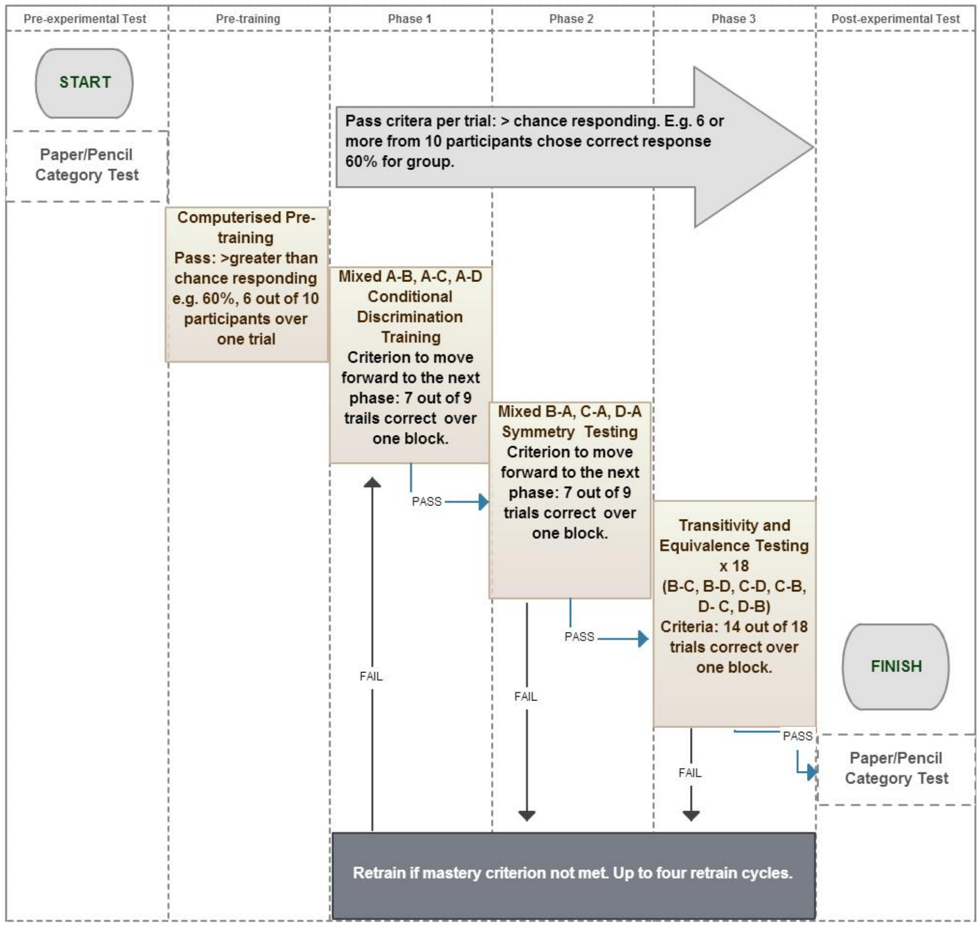


Figure 4.2. Schematic of all training and testing phases for both groups in Experiment 1.

Results and Discussion

OTM Training and Testing

Group Performances

The number of blocks required for each group to meet criteria can be seen in Table 4.2. For Group 1, three blocks were required at Phase 1 before meeting criteria to move to test for mixed symmetrical relations in Phase 2 which was passed on the first attempt. Phase 3 equivalence testing was passed on the first attempt.

For Group 2, four training blocks were required in Phase 1 before passing the test in Phase 2 in the first instance. Phase 3 test was then passed on the first attempt for Group 2.

Table 4.2. Experiment 1: Blocks required for each group to meet criteria across all OTM training and testing phases.

OTM Phase	Group 1 Blocks to Criteria	Group 2 Blocks to Criteria
Mixed Conditional Discrimination	3	4
Mixed Symmetry Testing	1	1
Equivalence Testing	1	1

Statistical Analysis

Group 1 test scores were used in the analysis between the Pre and Post-Category Sort Phases (see Figure 4.3). The mean score in the Pre-category Sort Test was notably lower (M = 1.10, SD = 1.10) than at Post-category Sort Test (M = 6.80, SD = 1.31).

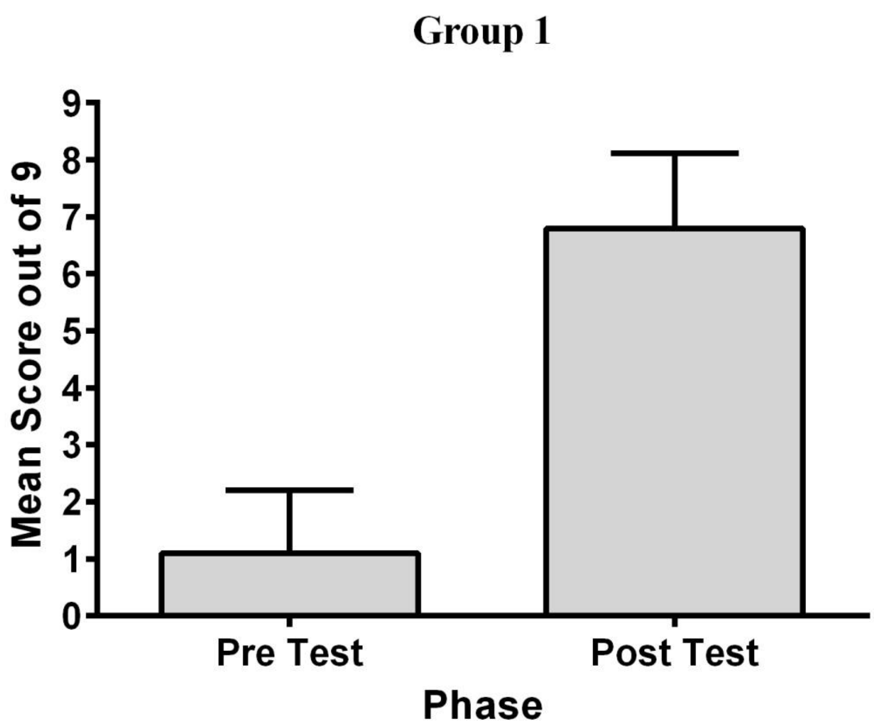


Figure 4.3. Experiment 1: Mean score out of nine for Group 1: Senior Infant for Pre and Post-Category Sort Testing.

For Group 1 a paired sample t-test was conducted to evaluate students' scores on the pre and post-experimental category sort test. There was a statistically significant increase in test scores from pre -test (M=1.10, SD = 1.10) to Post -test (M=6.80, SD = 1.31), t (9) = -10.58, p <0.0005 (two-tailed). The mean increase in the test scores was from -6.91 to -4.48. Cohen's d statistic (0.96) indicated a large effect size.

Group 2 test scores were used in the analysis between the Pre and Post-Category Sort Phases (see Figure 4.4). The mean score in the Pre-category Sort Test was notably lower (M = 0.81, SD = 0.75) than at Post-category Sort Test (M = 7.56, SD = 0.81).

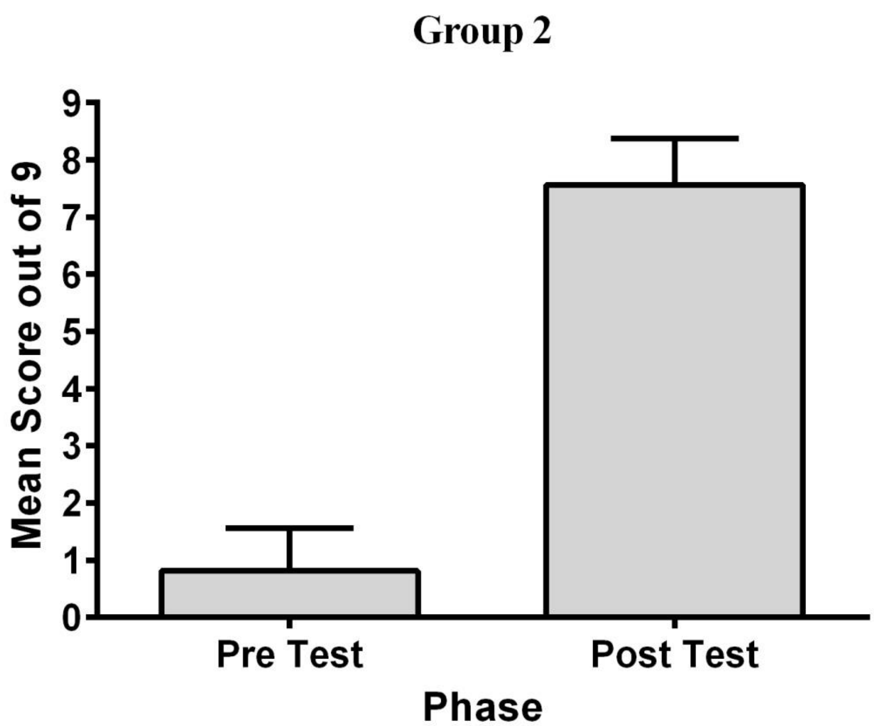


Figure 4.4. Experiment 1: Mean score out of nine for Group 2: First Class for Pre and Post-Category Sort Testing.

For Group 2 a paired sample t-test was conducted to evaluate students' scores on the pre and post-experimental category sort test. There was a statistically significant increase in test scores from pre -test (M=.81, SD =.75) to Post -test (M=7.56, SD =.81.), t (15) = -27.00, p <0.0005 (two-tailed). The mean increase in the test scores was from 7.28 to -6.21. Cohen's d statistic (0.99) indicated a large effect size.

Group 1: Pre and Post-Experimental Testing

The raw data for the current experiment consisted of the pre and post-test scores for each participant in each group. As can be seen in Figure 4.5, the results for all participants in Group 1 showed a larger increase from pre-test scoring. The greatest increase in post-test scoring was seen for Participant 4, all nine stimuli were correctly matched. Participant 3 and 7, who had scored zero at pre-testing increased to seven stimuli corrected matched at post-testing. In addition Participant 6 who had scored one out of nine in pre-testing, increased their score by seven in the post-test and a total of eight were correctly matched. Participant 1 and 2 increased their post-test scores by an additional three stimuli matched. Participant 5, who had a score of zero increased to five at post-testing. Participants 8, 9 and 10 all had an increase of six in the post-test. Participant 8, 9 and 10 scored eight out of nine correctly at post-testing.

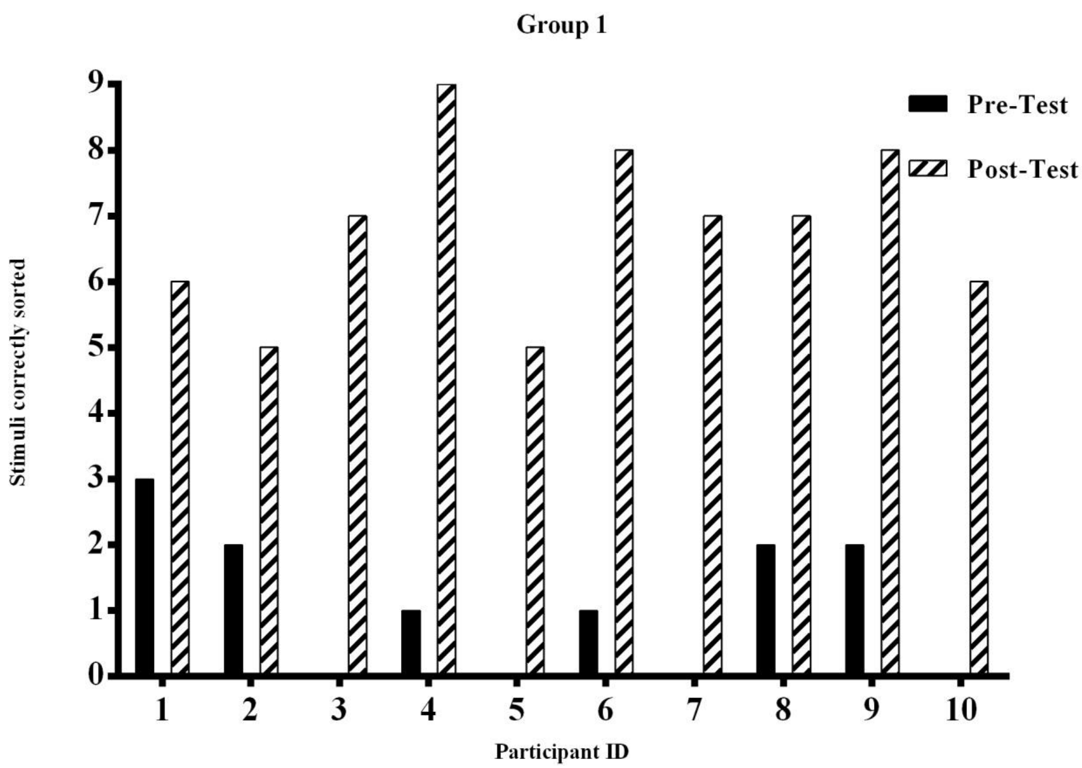


Figure 4.5. Experiment 1: Pre and Post-test scoring for Participants 1-10 in Group 1: Senior Infants.

Group 2: Pre and Post-Category Testing

The results of the pre and post-category test for all participants in Group 2 can be seen in Figure 4.6. In this group, Participants 2, 7 and 12 showed the least amount of gains in terms of post-test scoring with an increase of five additional stimuli correctly matched. The highest gains in this group were seen in Participants 6, 10, 13 and 15, all of these participants correctly matched an additional eight stimuli at post-testing. Three children, Participants 4, 8 and 9 increased in scoring by an additional six stimuli correctly matched at post-testing. Six children, Participants 1, 3, 5, 11, 14 and 16 sorted an additional seven stimuli at post-testing. None of the participants in this group correctly matched all nine stimuli at post-testing.

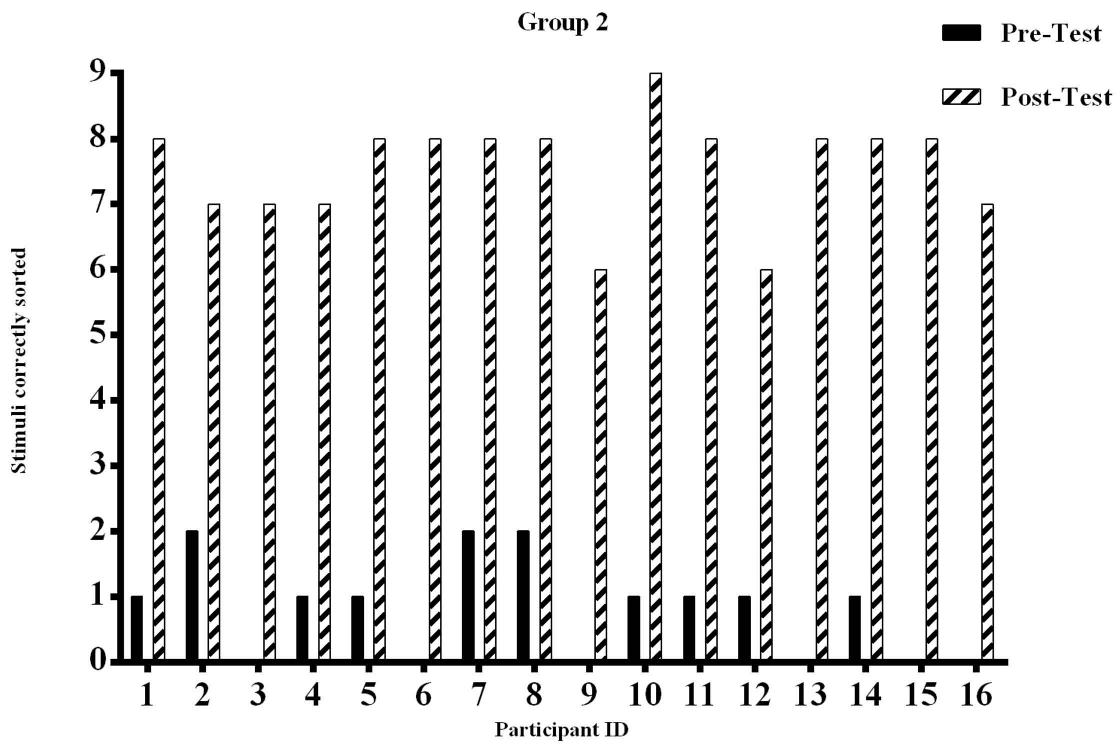


Figure 4.6. Experiment 1: Pre and Post-test scoring for Participants 1-16 in Group 2.

Group 1: Individual Performance

Individual performance across training and testing phases for Group 1 can be seen in Table 4.3. While not an aim of the current study the data warrants investigation. During training phases there were vast differences in individual performance scores. Scoring over chance responding is marked by an (*) in Table 4.3. At Phase 1, Block 3, only two participants (Participant 3 and 9) scored nine out of nine trials correct. Participant 5 and 6 scored at levels below chance responding during this training block, Participant 5 scored two and Participant 6 scored three out of nine trials correct. All other participants scored at over chance levels during this phase. Interestingly the highest score recorded for Phase 2 mixed symmetry testing was for Participant 3 who scored seven out of nine trials correct. With the exception of Participants 1 and 5 who scored at the same level, all other participants scores decreased from those seen in the last training Block 3 in Phase 1. In the final test Phase 3, five of the Participants 1, 2, 3, 7 and 8 scored at or under chance levels. The highest score recorded in the test for equivalence was for Participant 5 who scored 17 out of 18 trials correct.

Table 4.3. Experiment 1: Group 1, OTM training and testing phases for Participants 1-10.

Participant ID	Phase 1 Block 1	Phase 1 Block 2	Phase 1 Block 3	Phase 2	Phase 3
1	4/9	3/9	6/9*	6/9*	8/18
2	6/9*	6/9*	7/9*	5/9*	9/18
3	4/9	5/9*	9/9*	7/9*	7/18
4	5/9*	5/9*	7/9*	4/9	14/18*
5	1/9	7/9*	3/9	3/9	17/18*
6	2/9	4/9	2/9	4/9	10/18*
7	4/9	3/9	6/9*	5/9*	7/18
8	4/9	6/9*	6/9*	5/9*	7/18
9	5/9*	7/9*	9/9*	5/9*	12/18*
10	3/9	6/9*	6/9*	5/9*	11/18*

Group 2 Individual Performance

For Group 2, four training blocks were required at Phase 1 Mixed Conditional Discrimination training. As can be seen in Table 4.4 the lowest scores recorded in Block 4, Phase 1 were for Participants 10 and 15 who scored three out of nine trials correct.

Scores above chance responding are indicated by an (*) in Table 4.4. The highest score recorded was for Participant 1 with nine out of nine correct. All other participants scored at above chance levels during this block. In the following Phase 2 which tested for the symmetrical relations only two participants showed an increase in scoring, Participant 10 scored five out of nine trials correct and Participant 15 scored six out of nine trials correctly. The highest score recorded was for Participant 1 with a score of eight out of nine trials correct. In Phase 3 test for equivalence relations the highest score recorded was for Participant 1, who scored 15 out 18 correct. Six of the participants in Group 2 scored at or below chance responding.

Table 4.4. Experiment 1: Individual scores for Participant 1-16 in Group 2, OTM training and testing phases.

Participant ID	Phase 1 Block 1	Phase 1 Block 2	Phase 1 Block 3	Phase 1 Block 4	Phase 2	Phase 3
1	5/9	7/9*	7/9*	9/9*	8/9*	12/18*
2	3/9	5/9	7/9*	8/9*	7/9*	11/18*
3	1/9	9/9*	8/9*	7/9*	6/9*	8/18
4	6/9*	6/9*	6/9*	7/9*	5/9*	11/18*
5	3/9	6/9*	5/9*	7/9*	6/9*	8/18
6	4/9	2/9	6/9*	7/9*	6/9*	10/18*
7	7/9*	3/9	3/9	7/9*	5/9*	9/18
8	7/9*	5/9	7/9*	8/9*	8/9*	14/18*
9	5/9	7/9*	6/9*	6/9*	3/9	9/18
10	5/9	7/9*	8/9*	3/9	5/9*	6/18
11	7/9*	3/9	7/9*	6/9*	7/9*	11/18*
12	5/9	6/9*	5/9*	7/9*	6/9*	15/18*
13	7/9*	6/9*	6/9*	7/9*	6/9*	12/18*
14	6/9*	6/9*	7/9*	8/9*	4/9	13/18*
15	3/9	3/9	3/9	3/9	6/9*	14/18*
16	5/9	4/9	6/9*	7/9*	5/9*	9/18

Summary of Experiment 1

In Experiment 1 two groups were taught the same educational goals using individual SRS to respond to an OTM protocol. During Experiment 1 the criteria for mastery during trials was lower than that seen in the previous empirical Chapters (Chapter 2-4). As this study was examining group responding versus individual responding, criterion for mastery was set per trial and per block. The criterion for trail mastery differed for each group depending on the number of participants. For Group 1, six out of ten participants or 60% or greater, and for Group 2, nine out of 16 participants, 56% or greater must have selected the correct answer. While these criteria meant that the groups met criterion for mastery when examined at an individual level, none of the participants individually would have passed all training and testing phases. Additionally, in Experiment 1, feedback differed to that typically seen as participants still received individual feedback on their clicker per trial during testing phases. Therefore it is entirely possible that the children were still learning through the reinforced correct responses made during the symmetry test. Both of the methodological issues listed, may account for the variability that can be seen in the individual data for OTM training and testing phases. Indeed the results of the category sort test which saw an increase for all participants in both groups would indicate that learning was still occurring during testing phases.

The results however are interesting from a learning perspective as they highlight that even though a group may be performing, that individually students may not be learning at the same rate. Using the SRS these individual learning differences can be quickly identified through the reports generated which offer many benefits within the traditional classroom structure where learning difficulties may not be identified until individual testing is conducted. Within traditional approaches these tests are often conducted annually. However in order to examine group responding under a stricter methodological approach Experiment 2 was then conducted.

Experiment 2

Method

The general methodology employed in Experiment 2 was exactly the same as Experiment 1 with some slight modifications. The criterion for mastery per trial was increased to greater than 80% of participants in the group making the correct response. The mastery for a block was additionally increased to 80% or greater. In the current study eight out of nine trials correct (88%) over Phase 1 and 2 training and testing blocks and 16 out of 18 trails (88%) for Phase 3. In addition, the SRS programme was modified so that no feedback was given either as a group or individually during Phase 2 and 3 testing.

Due to the increase in criteria it was expected that the duration of the experiment would be greater than that seen in Experiment 1. In order to prevent participant fatigue Experiment 2 was conducted over two sessions. Session 1 saw the administration of the pre-test and pre-training with the SRS. Session 2 was conducted the following day and saw the implementation of experimental phases (Phase 1-3) and the post-experimental test.

Participants

One group of typically developing, school aged children, from a mainstream class in a different national school located in the greater Dublin region were recruited to take part in the study. Experiment 2, Group 1 consisted of six children, four boys and two girls aged 5-6 years. Only Participant 6 were bilingual with English not the primary language spoken at home.

Settings and Materials

During the study, two people were present in each of the classrooms, the children's teacher and the researcher. The research assistant was not present for Experiment 2. During experimental sessions the classroom teacher remained to the rear of the class. All experimental sessions took place in the children's own class room which consisted of a large square space, the children sat at two group tables (three per table) positioned in front of a projector screen to the left of the classroom. All experimental materials were the same as in Experiment 1.

Results

OTM Training and Testing

Group 1

The number of blocks required for Group 1 to meet criteria can be seen in Table 5.5. For Group 1, two exposures were required at Phase1 before criteria was met on the test for mixed symmetrical relations in Phase 2, on the second attempt. Phase 3 equivalence testing was passed on the first instance.

Table 4.5. Experiment 2: Group 1, blocks required to meet criteria across all OTM training and testing phases.

OTM Phase	Group 1 Blocks to Criteria
Mixed Conditional Discrimination	10
Mixed Symmetry Testing	2
Equivalence Testing	1

Statistical Analysis

Group 1 test scores were used in the analysis between the Pre and Post-Category Sort Phases (see Figure 4.7). The mean score in the Pre-category Sort Test was notably lower (M = 1.66, SD = 0.81) than at Post-category Sort Test (M = 8.50, SD = 0.83).

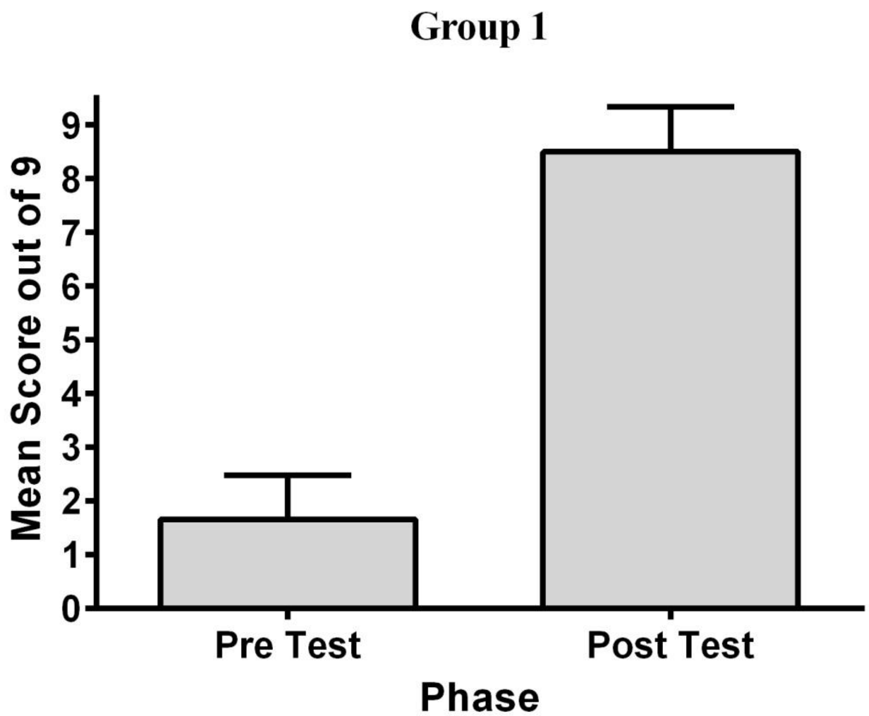


Figure 4.7. Experiment 2: Group 1, mean score out of nine for Pre and Post-experimental tests.

For Group 1, a paired sample t-test was conducted to evaluate students' scores on the pre and post-experimental category sort test. There was a statistically significant increase in test scores from pre -test ($M = 1.66$, $SD = 0.81$) to post-category sort test ($M = 8.50$, $SD = 0.83$), $t\ (5) = -17.02$, $p < 0.0001$ (two-tailed). The mean increase in the test scores was from 0.33 to 0.34. Cohen's d statistic (0.99) indicated a large effect size.

Group 1: Pre and Post-Experimental Testing

The raw data for the Experiment 2 consisted of the pre and post-test scores for each participant in each group. As can be seen in Figure 4.8 the results for all participants in Group 1 showed a larger increase from pre-test scoring. The greatest increase in post-test scoring was seen for Participants 2 and 3, all nine stimuli were correctly matched at post-testing, an increase of eight.

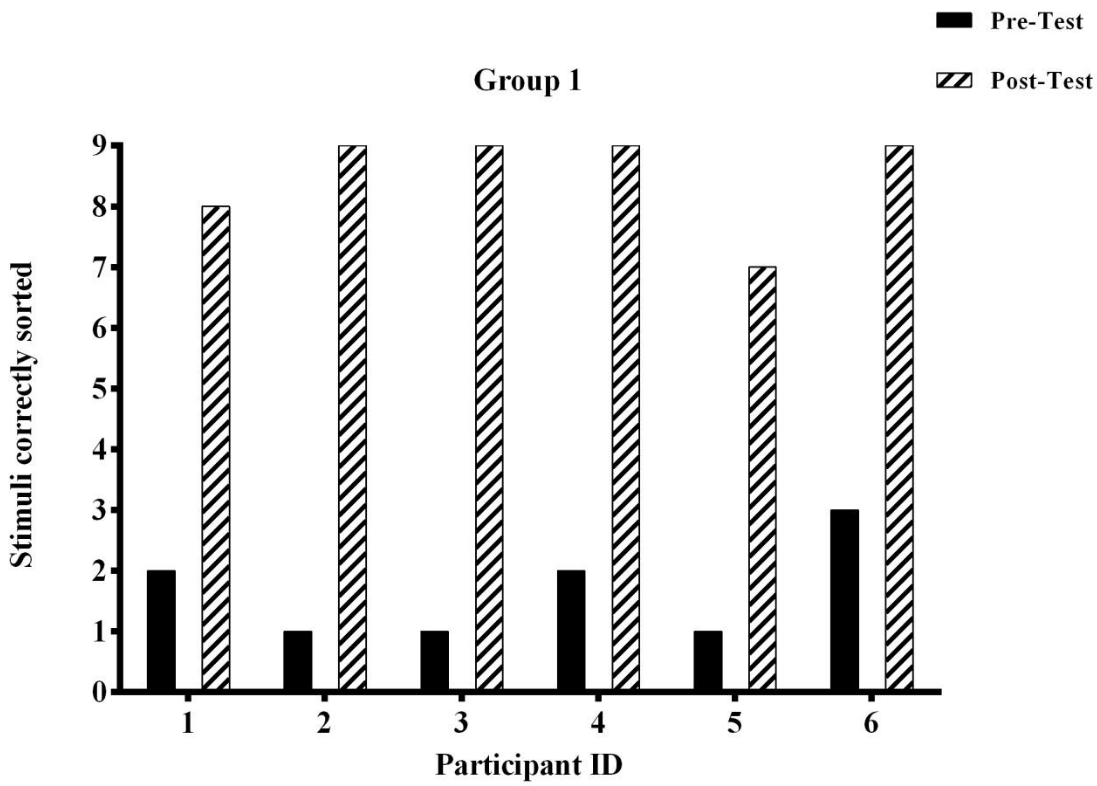


Figure 4.8. Experiment 2: Group 1, pre and post-experimental test scores for Participants 1-6.

Group 1: Individual Performance

Individual performance across training and testing phases for Group 1 can be seen in Table 4.6. While not an aim of the current study as in Experiment 2 the data warrants investigation. During training phases, vast differences in individual performance scores were recorded, as can be seen in Table 4.6. Where a participant would have met the criteria for a block 80% or greater or eight out of nine trials correct Phase 1-2 or 16 out of 18 Phase 3 is indicated by an * after the score. Participant 1, 3 and 6 met the criteria for Phase 1 very quickly at Block 3. Interestingly Participant 6 performance levels dropped off and did not return to criterion level until Block 10. A similar reduction in criterion performance was seen for Participant 2. Participant 3 however maintained performance at or near criterion level until the entire group met criterion. This variability in performance may indicate boredom or frustration in Participant 1 and 6 as performance did not increase until the other group participants began to show performance levels near criterion levels.

It can be seen in Table 4.6 that at Block 9 when the group first met criteria to move to Phase 2 testing, the responding was actually below 80% for half of the participants, but as a group, they had met criterion to move to Phase 2 testing. The scores for Phase 2 test on the first instance reflect the group score, no one participant had scored at 80% criteria on this test. During the second exposure it can be seen that five of the six participants scored at 80%. In the second exposure to Phase 2, symmetry testing all participants scored 100%. While as a group they passed the test for equivalence at Phase 3 only four of the six participants would have individually passed.

Table 4.6. Experiment 2: Group 1 Participant 1-6 individual scores for OTM training and testing phases. * indicates block criteria met.

ID	Phase 1 Block 1	Phase 1 Block 2	Phase 1 Block 3	Phase 1 Block 4	Phase 1 Block 5	Phase 1 Block 6	Phase 1 Block 7	Phase 1 Block 8	Phase 1 Block 9	Phase 2 Block 1	Phase 1 Block 10	Phase 2 Block 2	Phase 3
1	3	1	8*	5	6	8*	8*	7	7	6	8*	9*	15
2	2	3	5	7	8*	8*	8*	7	8*	6	8*	9*	16*
3	2	6	9*	8*	8*	7	8*	7	8*	6	8*	9*	17*
4	2	5	7	5	8*	6	6	7	6	6	7	9*	17*
5	4	5	7	7	7	8*	6	7	8*	7	8*	9*	14
6	2	6	9*	8*	6	7	7	6	6	6	8*	9*	16*

General Discussion

The current research expanded on the existing EBI literature by investigating an EBI procedure to teach generic skills by incorporating group contingencies in a small (n) group design. To date no known published research has examined EBI procedures and small group contingencies in the equivalence literature and the results of the current study provide the first preliminary methodology and data in this research area. The results provide an important step in EBI research as the current methodology was successful in teaching previously unknown generic skills that were functionally relevant to the participants' general education. Two experiments were conducted and as a group, all participants successfully passed all training and testing phases without any need for remedial action. However following examination of individual performances in Experiment 1, it was discovered that performance levels did not reach a criterion that demonstrated significant learning outcomes for all individuals. If the criterion had been set for each individual versus the group overall in Experiment 1 even at chance levels, the number of participants who met all the properties of equivalence were at low levels. From Group 1, Experiment 1 only two of the ten participants passed the training and subsequent tests at chance level, Participant 9 and 10. In Group 2, eight out of 16 participants passed all training and testing phases. However all demonstrated a significant increase in post-test scoring. The methodological flaw whereby feedback was provided individually on the SRS may account for the learning demonstrated at post-test.

While Experiment 1 showed positive evidence that the methodology was easy to implement in a short period of time, the criterion levels and feedback provided were a flaw in the design. Experiment 2 was conducted in order to address these flaws and examine the methodology more stringently. It was anticipated based on the data from Experiment 1 that as a group, participants in Experiment 2, would require significantly more training to meet the increased criterion. In Experiment 2 the overall duration required was slightly longer and was conducted over two sessions in order to prevent participant fatigue and minimize any possible frustration. In Experiment 2 the results demonstrated that not only did the group pass all the training and testing phases, four out of six participants passed all the training and testing phases meeting the criteria for equivalence. While examination of individual responding was not an initial aim of the study it became an obvious area of both concern and interest. The results demonstrated are quite possibly reflective of group learning situations whereby certain individuals are quicker to learn the targeted goals and other participants need additional training. One benefit of the SRS is that it provides both individual and group scores quickly and therefore can be used to identify differences in participant learning outcomes and not just group performance. In particular identification of both rapid learners and those who demonstrate slower learning patterns, that may otherwise go unnoticed in group teaching situations, would be of great benefit within a variety of educational settings. Early identification of deficits may in turn provide students with additional one to one remedial teaching time. Systems such as the SRS can be developed to deliver self-paced lessons which may benefit students who differing rates of learning.

The use of the SRS in conjunction with equivalence based instruction that incorporated group contingencies was successful in teaching generic skills in a small (n) group design. In terms of use, the SRS with a typically developing young population was easy to train, and the SRS was an extremely novel experience for the children. The lesson development is delivered through a well-established and developed medium, PowerPoint ®, which is a widely known and used tool and once familiar with the software, lessons can be quickly developed. Such a delivery offers a wide scope of educational goals which can be targeted for learning, spelling, mathematics, geography, history and science to name but a few. Importantly the incorporation of SRS and EBI as demonstrated within the current study provides a methodology for the future study of group contingencies within equivalence research. Such incorporation may lead to the development of productive and cost effective teaching methods as called for by Crow (2008). Empirically based methodologies may have application, not just within traditional mainstream education, but across a variety of populations.

Indeed there is application for future research to examine the incorporation of low tech systems which are readily available to examine efficacy and under an equivalence paradigm. In addition an RCT design similar to that used by Zinn et al. (2015) could be used to explore the efficacy of EBI in a larger group setting. Such research could incorporate both a control-group and also participants could be assigned to a traditional learn as usual (LAU) lesson; where by children are typically taught everything. However it must be noted that the use of an RCT design with a younger population may not produce the same within and between-subject data that can be examined under SCRD as demonstrated in the current study. A further research direction may then include the incorporation of RCT and SCRD as complimentary designs which may in turn provide a more comprehensive account to examine EBI procedures with incorporate using group contingencies/equivalence to produce derived responding with a classroom population.

Chapter 5: Discussion

The primary aim of the current research programme was to test the effectiveness of computerised equivalence based instruction (EBI) procedures in teaching both individualized, tailored to needs functional categories and generic skills to young children across a variety of educational settings. By nature, EBI procedures focus on teaching functional relations between, objects, concepts or events that children may encounter in the real world. The examination of categorisation has great societal value; arguably it is the ability to categorise, that enables individuals to make sense of the world in which they live (Murphy, 2002). Outside of the behaviour analytic field, it is a held belief that behavioural theorists have little to offer the investigation of categorisation and concept learning (Murphy; Medin & Rips, 2005) and EBI research may begin to counter those misconceptions. Rehfeldt (2011) called for ecologically valid research to investigate the application of EBI to naturalistic educational settings. Research responses to this call may in turn begin to address the misconception held by cognitive theorists and furthermore promote behaviour analytic theory into the wider education practice.

Over the course of three empirical chapters, variations of EBI procedures were thoroughly examined. Across three of the empirical studies (Chapters 2 & 3) the use of individualised and functional categories were focused upon in one-to-one training to address deficits in each participant's knowledge, rather than the generic skills that are often targeted for groups of children. In Chapter 4, the third study, a different EBI procedure was tested in a mainstream classroom setting with a small (n) group, rather than individual, sessions. Overall, the procedures appeared to be effective when applied across different age groups and populations of young children, and also when compared to another, more commonly used teaching method. In Chapter 2, the effectiveness of EBI to teach individualised real-world category membership was demonstrated using a touchscreen three, three member modified MTS procedure. The use of touchscreens is novel and relatively unusual in the literature (Still et al., 2015) and so Chapter 2 provides important data in what can only be a growing area of novel technology application. Furthermore the modified EBI procedure has further expanded the literature by introducing a table top training stage whereby the category name was receptively trained to the C stimulus for each class. This allowed for the testing of the transfer of the trained category name to the C stimulus to the other members (two from each of the three classes).

In addition the category name transfer was then tested post experimentally to examine if transfer occurred for other members that had been pre-experimentally tested but were not chosen for training through the MTS procedure (six stimuli from each of the three classes). The second empirical study (Chapter 3) was extremely novel in its efforts to compare the efficacy of the EBI procedure against a teaching aspect of a widely used methodology (the Montessori Method, MM) to teach categorisation. Such comparisons have been notably absent in the literature, and the preliminary findings that EBI compared favourable to a modified MM procedure, is extremely important in determining the functional ecology of behavioural teaching strategies that have typically been examined in laboratory based studies using arbitrary nonsense stimuli (Critchfield & Fienup, 2013; Taylor & Reilly, 2011).

The third empirical study (Chapter 4) further sought to advance the EBI literature by expanding application to traditional education teaching situations which have not yet been investigated in previous studies, but which are invaluable in examining the ecological validity of EBI procedures in applied settings. The findings support the use of EBI procedures to teach generic categorisation skills with young children, specifically using an OTM paradigm. The results furthermore support the notion that merger of EBI procedures with existing technologies, as called for by Twyman (2011), may provide a means in which to examine group learning. The use of a small (n) group design sheds light on a critical aspect of group learning, that of accounting for and accommodating the diversity of individual learners within a group (Crow, 2008). Uniquely, the EBI procedure implemented provided such a means and this may have greater future application in educational settings. The findings of each empirical chapter were discussed individually and so the current chapter will briefly examine the results in a broader application to current published findings on DRR and EBI more widely. In addition, applied implications and suggested future directions will be discussed.

Chapter 2

Researchers studying Stimulus Equivalence have typically targeted arbitrary stimuli or generic skills for groups of individuals. While the demonstration of DRR under controlled conditions is an essential and necessary investigation, the result yielded may not reflect real world learning environments. EBI offers a means in which to examine functional DRR skill development in naturalistic settings, through the use of DRR procedures which incorporate behavioural principals and techniques. Numerous authors have made calls for the investigation of such phenomenon in real world settings (Hull, 1920; Rehfeldt, 2011; Pytte & Fienup, 2012) and some steps have been taken to address this in adult populations (e.g., Critchfield & Fienup, 2010; Fields et al., 2009; Fienup et al., 2010; Ninness et al., 2009; Ninnes et al., 2006; Pytte & Fienup, 2012; Sella et al., 2014; Taylor & O'Reilly, 2011: Walker & Rehfeldt 2012). However, there remains a limited body of EBI research that has targeted individualised and functional skills for young children. Furthermore, research with children has often relied on table top procedures and has typically been conducted with populations of individuals with developmental delay such as a diagnosis of ASD (Groskreutz et al., 2010; LeBlanc et al., 2003). The current thesis has therefore aimed to address this perceived gap in the literature. Chapter 2 did this by teaching categorisation skills across two populations of young children. In Experiment 1, neurotypical young children, and in Experiment 2 children with Autistic Spectrum Disorder (ASD) were investigated. In addition, Chapter 2 expanded on the existing EBI literature by targeting individually tailored, rather than generic, skills for each participant. Targeting of individual skills involved the development of a category pre-test to establish individual pre-existing knowledge which was a critically important aspect of the methodology.

Typically following training and testing under linear MTS protocols, tests for generalisation are immediately conducted. However, the current methodology uniquely included an additional aspect whereby the category name was receptively trained to the C stimuli. This was purposefully trained to the C stimuli; the last to be trained in the MTS computerised stages and given the participants' ages, was most likely to have been retained. The pre-experimental sort test had identified two aspects of pre-experimental knowledge. Firstly, if the participants were sorting based on the category name or secondly, if sorting was as a result of reliance on perceptual commonalities. One limitation identified is that training of the category name to the C stimuli may not have necessarily been required. The post category sort test was not conducted until after the receptive training and therefore this could be identified as a limitation of the procedure. It could be argued that the children may have demonstrated categorisation for the directly trained or derived relations found directly following the computerised MTS procedure. Many of the additional stimuli had been pre-experimentally paired during the sort test however, these were sorted incorrectly and therefore it can be assumed they were not under the control of the category name. It can be hypothesised that if the receptive category name was not trained to the C stimuli, generalisation effects to these additional class members would not be expected to occur as no relation between the additional members (other than perhaps some perceptual similarity) exists. Future research could indeed test this hypothesis by introducing a sort test prior to training the category name to establish the extent that the directly trained members have on class expansion in terms of perceptual commonality.

The results of both experiments in Chapter 2 add to and extend the literature supporting the use of MTS to develop associative or natural categories. All participants passed all training and testing phases without the need for remedial action and categorised the stimuli that were pre-experimentally known, targeted for trained during match-to-sample phases and also additional untrained stimuli at post-testing. The findings of the study support recent research that such procedures are effective in developing derived skills across populations (McLay et al., 2014). The findings extend the literature by tailoring the programme to target individualised skills in young populations, this means that the skills taught are functional for the learner. Findings for the children with an ASD diagnosis in Experiment 2 are consistent with research that has examined equivalence class formation with this population (LeBlanc et al., 2003; McLay et al, 2014). In keeping with previously published research, Chapter 2 findings support that that procedural changes, such as a reduction in the number of members being taught, may be required when applying MTS training for these populations. Stringent mastery criteria may also facilitate retention of the directly trained members and this has been suggested by researchers previously (Arntzen & Holth., 1997; Devany et al., 1986). However, it must be noted that the current mastery criteria was set at quite a high level (eight out nine correct in Chapters 2-4 which used the MTS procedure to train three conditional discriminations). Therefore, in these young populations criterion level alone may not be responsible for failure on tests for equivalence.

The modified MTS procedure included phases whereby participants were trained and tested for symmetry on A-B and B-C relations separately, before a return to mixed conditional discrimination training (A-B, B-C) and testing (B-A , C-B) phases was made. This modification is not typically found within the literature and extends upon published EBI research with young children. Given the young age of the participants', these phases were included in the procedure as a precaution and as a measure to ensure retention of the previously trained relations (A-B and B-C). Interestingly, the findings would suggest that even though the participants with ASD had already met the criteria at a previous phase (i.e. A-B, B-A training and testing), there was a possibility that failure on the combined transitivity test would have occurred as none of the ASD participants passed the mixed conditional training (A-B, B-C) and testing (B-A, C-B) phases on the first instance even though these relations had been previously demonstrated as having met mastery criteria. Future research conducted with very young children or those with a specific diagnosis could indeed use a similar retrain and test phases in order to establish retention before tests for combined transitivity. Within applied research such procedural rigidity may serve to provide a more accurate description of learning in young children with whom sessions are often conducted over longer periods of time. It could be further argued that the data demonstrate that learning is not occurring for these populations in the time between experimental sessions. If learning or maintenance of the skills were occurring outside of session the expectancy would be for responding levels to increase or at the very least be maintained in the time between experimental sessions.

In Chapter 2 Experiment 2, although all participants had a diagnosis of ASD, none had a language age equivalence of less than one year of age. Participant 2 in Experiment two had the lowest age equivalent language ability across all the empirical Chapters. His Receptive language score was lower than the other participant with ASD and his expressive language was near absent, some babbling and vocal sounds. These results do provide indirect evidence supporting the view that receptive language ability is critical in the formation of categorisation (McLay et al., 2014). Certainly the findings indicate that EBI procedures may offer a quick way to effectively target individual skill deficits in children. Furthermore, such procedures may serve as an effective means to bring together skills that are splintered and may be suitable for use with a much broader range of population than examined in the current thesis. The overall success and seemly ease of use, led to questions regarding efficacy of the procedure and the next empirical study Chapter 3 was conducted to examine if the procedure has application in mainstream educational settings.

Chapter 3

The second empirical study, Chapter 3, was conducted specifically to compare the efficacy of the MTS procedure with a widely used teaching aspect taken from the Montessori Method. A yoked-pairs within participant design, was used to investigate the effectiveness of the modified MTS protocol (Teaching Protocol 1) with an aspect of the Montessori Method (Teaching Protocol 2) to teach non-overlapping, functional and individualised categories. The order of exposure to the teaching protocols was counterbalanced across participants. As in Chapter 2, the MTS procedure, Teaching Protocol 1, was successful and all participants passed all teaching phases. The same level of success was found in Teaching Protocol 2 and no participant required additional modification to either protocol. The findings from across both protocols were comparable indicating the MTS procedure has application in mainstream education settings. Little difference in the length of time needed to teach the categories using either protocol, the shortest duration for Teaching Protocol 1 was 45 m for Participant 4, while in comparison, in Teaching Protocol 2 the shortest was 59m for Participant 4. Interestingly, there were clear differences in the number of learning opportunities across the protocols. For Teaching Protocol 1, the greatest number of trials to criterion was 300 for Participant 1 and the lowest was 216 for Participants 4, 5 and 7. In Teaching Protocol 2, even though each stimulus was directly trained to each other, there was typically a lower number of learning opportunities. The greatest number of trials to criterion was 232 for Participant 1 and the lowest 187 for Participant 4. The transfer of the receptively taught category name was found to transfer not only to other stimuli which were previously unknown but additionally to other stimuli which were unknown and not targeted for training.

The transfer of the receptively trained category name was also seen to transfer to the participants' tacting (vocally naming) the stimuli when tested and these findings are of particular interest in terms of the DRR literature. The tact test was introduced as a measure of balance to Teaching Protocol 2 because the participants underwent training of the category name as standard under the Montessori Method. The tact test was not a key part of the investigation and therefore this test revealed surprising results which warrant further investigation. Within Montessori Method, Teaching Protocol 2, the children were trained both the speaker and listener names. However the name was only receptively trained as listener behaviour in the modified MTS protocol to the three C stimuli. The investigation of training relations as either speaker or listener was not the purpose of the investigation, and there are key procedural differences in the modified MTS protocol and those reported more widely (Miguel et al., 2008; O'Connor et al., 2011). Nonetheless, further investigation of this unexpected transfer is required.

The preliminary findings of Chapter 3 extends both the Montessori and EBI literature. No previously known published research has attempted to make such a comparison with another teaching method in either discipline with a young population. Traditionally the Montessori Method has focused upon on long term achievements versus specific teaching aspects (Cox & Rowlands, 2000; Krafft & Berk, 1998; Lillard, 2012; Lillard & Else-Quest, 2006). These findings not only indicate to the effectiveness of the method, but also offer a new perspective to examining the effectiveness of the methods underlying procedures. Nevertheless the current findings raise an important question when considering the literature on EBI of which the thesis is concerned. In direct contrast to findings reported by Critchfield and Fienup (2013), wherein the taught everything group (whereby all stimuli were directly trained similar to the Montessori approach) performed better than the emergent relations group whom responded at chance levels, few differences were found between either methodologies employed in Chapter 3. As discussed in Chapter 3, the most simplistic explanation for the contrasting results lies in methodological differences. The findings of Chapter 3 would strengthen the view that more trained comparison relations are required in order to establish stable response repertoires (Critchfield & Fienup). One fundamental assumption of EBI is that by training just a few relations that other skills develop without being directly taught. Efficacy of such procedures is therefore a fundamental research area and the findings from Chapter 2 and 3 offer preliminary support for the efficacy of EBI and extend the current body of research by comparing a teaching aspect from a well-known and popular method typically used in educational settings with young children. Efficacy nonetheless takes many forms, and future research could explore other aspects of the efficiency of EBI procedures with those traditionally found across a range of educational settings. Comparisons of teaching procedures that are more closely matched should be the topic of future research. One limitation of Chapter 4 is that the EBI procedure is designed to result in derived/untrained relations to form whereby the Montessori aspect specifically teaches each relation. Other areas of research could focus on instructor engagement in terms of preparation, teaching time and reporting of student development. Moreover, further research is additionally required to investigate whether comparable findings exist when other skill areas are targeted. Future research using or incorporating other research designs such as RCT (Zinn et al., 2015) may provide EBI researchers with a means to explore the validity of EBI, across populations and in a range of educational settings.

Chapter 4

Chapter 4 differed quite significantly from the previous empirical chapters in its reliance on small (n) group design. It incorporated an EBI procedure, specifically an OTM paradigm with a student response system (an existing technology which is widely available, researched and tested for usability). Software development which incorporates validated EBI procedures provides an exciting area for future research development. The growth and availability of technology has marked a turning point in the way in which society communicates and learns. As Twyman (2011) highlighted behaviour analysts have much to offer, and many opportunities to modify existing and emerging technologies currently exist. In terms of true ecological validity of EBI procedures, usability and efficacy of EBI procedures incorporated with technology still required further investigation and Chapter 4 was conducted to explore EBI with an innovative and novel technology, a SRS. The findings seen in Chapter 4 offer an inventive and unique insight into some of the possibilities that are currently available. In Chapter 4 an OTM procedure was successful in teaching category membership which included group contingencies offering new findings to the existing EBI literature. The development of this preliminary investigation require the protocol adjustment to attain high levels of responding across all participants. Following Experiment 1 and 2, an immediate concern was that not all children met the criteria of all three properties of equivalence even though as a group criterion was met. Mastery criterion was identified as a variable that impacted upon individual performance and levels of responding. One concern regarding a high level of mastery criterion centred in ethical concerns. Would the children become frustrated with repeated trials or if one child acquired the skills quickly in comparison to the other children; would boredom or fatigue set in resulting in distress for anyone child? This however was not found to be the case and as a result modification to the criterion was made for Experiment 3. The findings showed an increase in individual and group performance levels and the children all demonstrated increases in post-test scoring.

While generic skills have been targeted frequently there are many potential opportunities for future research to explore the teaching of other generic skills under group responding such as mathematics, history, geography and other generic skills that are targeted for children (e.g. Miguel et al., 2008; Haegele et al., 2011). One limitation of Chapter 4 is that tests for retention were not built into the design and the focus was on short term gains. Future research could indeed incorporate additional tests for generalization and retention of skills over time which is imperative within educational systems. One standout aspect of the procedure used in Chapter 4 is the ability to quickly identify participants who may be struggling to meet educational goals or on the other hand may not be challenged by the skills targeted which are provided to groups of children. Further investigations are required and procedures such as the one used in Chapter 4 may have greater application in educational settings as a means to identify strengths and deficits. Peer modelling and team learning are additional areas which could be incorporated and investigated using similar procedures.

EBI and Young Children

The EBI procedure used across the first three empirical studies (Chapters 2-4) found positive results which expand the EBI literature by tailoring category skills to each individual participant rather than teaching generic skills across young participants. Across all of the empirical studies (Chapter 2-3) the EBI procedure included the same (three, three-member) modified MTS procedure which was successfully passed by all participants without the need for remedial action such a MET. The findings across Chapter 2-4 are contradictory to those reported in Miguel et al. (2008) and O’Connor et al. (2011).

Key differences are nonetheless evident between the methodologies employed and more specifically the type of stimuli applied across these studies. The results of Chapter 2, Experiment 2 which examined DRR in children with a diagnosis of ASD with normative language abilities below their age norm are of interest. Consistent with published research (Maguire et al., 1994; McLay et al., 2014; O'Connor et al., 2011; O'Connor et al., 2009) the children in Experiment 2 required extensively more training and testing blocks before success was met. The typically developing children across the studies conducted (Chapters 2-4) demonstrated the formation of equivalence classes with relative ease in contrast to the variability seen in Experiment 2 with the children with ASD to demonstrate the emergence of DRR. As previously discussed the protocol was purposefully designed to rely on visual and auditory modalities and as such good receptive language ability which was determined through formal language assessment as a requirement for inclusion in the study. However, in terms of children with a specific diagnosis, further research is warranted to investigate the validity of such a procedure in comparison to other methods which are used to teach individuals with ASD. In Chapter 3, Experiment 2, the total trials for mastery in the MTS Phases were 780 trials for one of the children with ASD. Future research with this population is needed to examine the efficacy of EBI procedures when compared to methodologies which are currently used within special educational settings to directly teach class members.

Pre-experimental History

The children who participated in the empirical studies (Chapter 2-4) may have had a pre-experimental history of encountering many of the experimental stimuli in their day to day life. This is a significant challenge faced by applied researchers, it should nonetheless be recognised that by its nature, applied research cannot be held to the same rigours as laboratory based research. Nonetheless, the results demonstrated should be invaluable; results demonstrated in natural settings should endeavour to inform laboratory based research whereby extraneous or unidentified variables can be further investigated under more rigorous conditions (Crow, 2008). Indeed as discussed throughout collaboration and feedback between applied and experimental based research should underpin the manner of all subjects under examination. Across all experimental chapters the use of the pre-experimental category testing to identify individualised previously unknown categories for each participant was an important experimental control and as such strict exclusion criteria were employed in pre-testing. The result for all participants however indicate that knowledge acquisition was demonstrated during match to sample and category training phases indicating that the stimuli chosen for each participant were indeed not associated pre-experimentally.

No participant across the empirical studies (Chapter 2-4) passed any training phase on the first instance and all demonstrated clear progression of knowledge acquisition across the training phases. In the sort test procedure used in the first three empirical studies the vocal label of the category was given and as such the children were required to remember the designated label. As a means to counteract any effects of the children responding by simply visually grouping stimuli together, which often occurs in open sort testing when no category label is given, any tub which contained more than three members sorted together were excluded. Without a doubt other measures could have been implemented such as a visual sample either a sample member or the printed word. Miguel et al. (2008) used a visual sample, during sort testing however it must be noted that the stimuli used were outlines of either Northern or South states in the United States of America and consisted of what could be deemed arbitrary stimuli, the children were still required to engage in meditating remembering responses. More importantly none of the participants in Chapter 2-4 demonstrated initial high levels of correct responding in the MTS phases which would strengthen that argument the category sort test was a successful means of identifying unknown categories. For the participants in Chapter 2, Experiment 2, the exclusion of category sets that were sorted together in any one container was of particularly importance to ensure that the categories identified were indeed unknown and not as a result of not understanding the requirement of the test or a based on a reliance of visual similarity which is common in children with Autism. Indeed open sort testing alone can lead to other problems as reported across the literature and more so when natural categories are used as children may indeed sort stimuli on the basis of other levels such as at super-ordinate level (animals) and may use alternative strategies to categorise, such as similarity or function of an object (Quinn et al., 1997).

Natural Categories

The use of natural categories has produced some interesting findings within the current thesis. There is a consensus that natural categories such as those used in the current study, often consist of fuzzy boundaries and more often contain stimuli which are both perceptual and associative (Zentall et al., 2008; Zentall et al., 2014). Categories at basic level (e.g., dog) can be combined to form super-ordinate level categories (e.g., animals), or can be divided to form subordinate level categories (e.g., Alsatian). Perceptual features or commonality of shape at the basic level are commonly expected and therefore the errors seen in natural categorisation with children can be attributed to reliance on perceptual commonality (Quinn et al., 1997; 2001). Non similarity based classes can often be described as arbitrary as they may be related by other functions than physical similarities. Zentall et al. (1996) discussed how even across a broad range of stimuli minimal change is found in response in similarity based classes. However, at the boundary of the category where similarity becomes more difficult to determine, an abrupt change in response strength is demonstrated. The findings from across all empirical Chapters 2-3 in the post testing for category membership align with published findings on natural categories. The category name, trained to the C stimuli did not always generalise to additional members that were not known pre-experimentally or targeted during the MTS protocol.

During category sort testing across the empirical chapters (Chapter 2-3) participants often demonstrated some level of pre-knowledge for the categories targeted. While these stimuli were not targeted for use in experimental stages, the stimuli that were targeted for use were often paired with additional stimuli, which were not targeted for use or correctly sorted. It was expected that category membership for the directly targeted stimuli trained during experimental stages, would generalise to both those pre-experimentally known and to the additional members the targeted stimuli may have had an association with during the pre-experimental category sort tests. For all participants additional members were correctly sorted at post-testing however there were occasions when expected generalization to untrained category members was not seen. Within Chapter 3, clear differences could be seen in terms of the derived (untrained) relations found in the MTS protocol in comparison to the Montessori Method aspect where all relations are directly trained during the protocol. Interestingly, participant responding during the post-category sort tests revealed little difference in responding, even in the Montessori Method similar errors at post-testing were found although the stimuli had all been directly trained. The findings of the study additionally demonstrated that under the EBI protocol children had a greater exposure to the targeted stimuli in terms of learning opportunities. While lack of generalization may be attributed to the decrease in perceptual commonality, other explanations must be explored in future research such as longer mastery criteria or specific training arrangements which has been suggested previously by authors in the field (Barnes, McCullagh, & Keenan, 1990; Fields, 1991). Future research with young populations could indeed examine a protocol such as that provided by Fields et al. (1991) which combines primary generalization and equivalence class formation to examine natural categories.

Efficacy

Rehfeldt (2011) called for further analysis of the ecological validity of EBI procedures. With over thirty years of empirically validated data, equivalence procedures do provide an opportunity to the behavioural field to develop programmes that have strong transferability to educational settings (Twyman, 2011). The data presented in the thesis critically have provided an important preliminary step in disseminating research on EBI evidence based teaching protocols. The use of the touch-screen which was easily trained in a normative population removed the need to additionally train responding skills such as, mouse or keyboard movements, an important factor when considering technology which has applications across a variety of ages and populations. In fact across the studies where the touch screen responding was used, only one participant (P4 in Experiment 1, Chapter 2) did not have previous exposure to touch-screen technology. No difference in terms of usability was found for any one participant who used the touch screen device. As emphasised by Still et al. (2015), the ease of training the response system is of particular interest with very young children, and offers further opportunity to examine very young children and children with a variety of disabilities. One area of interest centres on future development of software, but it must be emphasized that ease of use in terms of a response mechanism can be seen as only one aspect of usability. Other areas such as learnability, efficiency and error tolerability must be also considered. Such developments may in turn allow for a generality of EBI procedures that could be used effectively within society across a variety of settings. It is important to note that a key difference in comparing EBI procedures lies in the presentation of the materials, in the current thesis match-to-sample phases where computerised often traditional teaching lessons are delivered via table top procedures using tactile printed materials. Future research is needed to explore if differences exist when teaching methods are more exactly matched.

Impediments and Limitations

Within the context of the current thesis limitations have been identified which pertain to both environmental and procedural limitations, some which are expected within applied research. Recruitment and retention of participants across Chapters 2-4 specifically with the typically developing population presented as a challenge. The duration of these empirical studies was a factor in the retention of participants, this was mainly due to the fact that the language assessment required six month duration between testing. This meant that recruitment in specific time frames was crucial in order to accommodate for holidays that are standard and especially with pre-schoolers the transition to primary education. Indeed many of the difficulties reported regarding research with young children were encountered throughout Chapters 2-4 (McLay 2014). Short attention spans are often reported as one key difficulty with young children and this was remediated through shortened session times which incorporated frequent breaks.

One key limitation identified with engaging in applied research with this population lies in inter-observer reliability. All of the studies took place within school settings where the use of video recording equipment may either be prohibited or consent from both the facilities owners and parents or guardians of all children attending the service is required; regardless of whether the children are participating in the study. If consent is refused by anyone person then other means must be found to assess reliability as was the case in the current thesis. The obvious solution is to have a second person present but this in a practical sense is not always achievable, especially when programmes of research are conducted over long periods of time. The use of automated data recording through the touchscreen does offer some assurance of validity; data collection is immediate and tends to reduce any possibility of experimenter cuing (Still et al., 2015). Indeed with the younger population they had a tendency to hold the device in a manner similar to a book which may have resulted in difficulties in trying to use video equipment. More recently software programmes have been developed which allow for video recording of screen activity which do not infringe in the manner that traditional video recording does. This type of solution may serve as a future means to remediate such privacy issues.

Limitations in terms of the procedures used in Chapters 2-4 have been discussed through the thesis and we will briefly summarise those limitations now. The MTS procedure used in Chapters 2-4 relied upon visual and auditory modalities, meaning examination with other populations, specifically those who may be nonverbal or whom use alternative communication systems possible. (Barnes et al., 1990; LeBlanc et al., 2003; Dube, McIlvane, Callahan, & Stoddard, Lane, Clow, Innis & Critchfield, 1998; 1993; Sidman, 1971). The findings of Chapter 3, whereby participants demonstrated vocal tacting of the category name after being taught to receptively identify only the C stimuli was unexpected. Future examination of this phenomenon is therefore required and in hindsight a similar test could have been incorporated into the methodology for each of the empirical studies. In addition use of other research designs which incorporate probes as more systematic periods could be incorporated at different stages of the protocol to identify and monitor the emergence of skills for example before training the category name.

Conclusion

The current programme of research examined the development of categorisation in young children through EBI procedures and the findings add to the current literature in a number of ways. Two different procedures often employed in stimulus equivalence research were examined through EBI protocols and explained over three empirical chapters. The delivery and incorporation of technology, the touch screen and student response systems were extremely novel for the participants involved. Indeed the current research (Chapter 2 and 3) add to and expand the applied behavioural literature on EBI and technology integration. Despite living in a technology driven world, whereby new technology is becoming a part of everyday life, including education, limited research and in turn data exists on the benefits and efficacy of these technologies. It is critically important that behavioural technology endeavour to keep pace with computing technology employed, in the current context, educational settings. The EBI procedures used targeted functional and individualised skills for each of the participants and additionally targeted generic skills typically taught in traditional education group settings. While stimulus equivalence can provide a functional explanation for the development of equivalence classes consisting of associate category classes, other competing theories can also provide similar explanations. This of course, is expected as all of the current theories of language and cognition explored build upon similar behavioural principals or developed on the basis of an existing theory. The findings from the current programme of research add to the limited published research which has specifically examined the transferability of EBI procedures to examine non arbitrary real world stimuli in natural contexts.

A crucial criticism of equivalence procedures has been the lack of generality and acceptance outside of the behavioural field. EBI procedures as demonstrated in the current thesis designed to address specific individual skill deficit may begin to advance the field, and address this lack of generality and acceptance. The second key development that can be taken from the findings presented across all three empirical studies is the successful merger of scientifically validated procedures with existing technology. The explosion of computing technology over recent decades, as recognised by Twyman (2011), offers behavioural researchers a new and exciting chapter in EBI research. Research which incorporates or expands upon technology (existing or emerging) may lead to the recognition and dissemination of behavioural principals more generally and begin to address the misconception in other fields that behaviour analysts have little to offer beyond an account of basic learning process (Medin & Rips, 2005; Murphy 2002). The thesis has additionally made an important contribution to the dearth of literature examining group contingencies and equivalence based instruction specifically with young children. Unquestionably, if such procedures are to ever become accepted within mainstream education, further investigation is warranted to examine group learning under equivalence paradigms. These preliminary results provided support for the argument that

EBI has application within mainstream educational settings. However, as recommended by a variety of researchers including Sidman (2009) and Rehfeldt (2011), the scope of skills that are taught require further investigation in order to establish the generalised application of EBI procedures. Finally, applied studies examining non-arbitrary equivalence class formation in natural settings, may provide new research questions which merit examination under more stringent laboratory conditions.

References

Arntzen, E., & Holth, P. (2011). Probability of stimulus equivalence as a function of class size vs. number of classes. *The Psychological Record*, *50*(1), 6.

Baer, D. M., Wolf, M. M., & Risley, T. R. (1968). Some current dimensions of applied behavior analysis1. *Journal of applied behavior analysis*, *1*(1), 91-97.

Barnes, D. (1994). Stimulus equivalence and relational frame theory. *The Psychological record*, *44*(1), 91-124.

Barnes, D., McCullagh, P., & Keenan, M. (1990). Equivalence class formation in non-hearing impaired children and hearing impaired children. *The Analysis of Verbal Behavior*, *8*, 19.

Barnes, D., Lawlor, H., Smeets, P., & Roche, B. (1996). Stimulus equivalence and academic self-concept among mildly mentally handicapped and nonhandicapped children. *The Psychological Record*, *46*(1), 87-107.

Barnes, D., & Roche, B. (1996). Relational frame theory and stimulus equivalence are fundamentally different: A reply to Saunders. *The Psychological Record*, *46*, 489-508.

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

Barnes-Holmes, D., Hayes, S., & Roche, B. (2001). The (not so) strange death of stimulus equivalence. *European Journal of Behavior Analysis*, *2*, 35-41.

Barnes-Holmes, D., Healy, O., & Hayes, S.C. (2000). Relational frame theory and the relational evaluation procedure: Approaching human language as derived relational responding. In J.C. Leslie & D.E. Blackman (Eds.) *Experimental and applied analyses of human behavior* (pp. 149-180). Reno, NV: Context Press.

Barsalou, L. (1992). *Cognitive psychology: An overview for cognitive scientists*. NJ: Erlbaum: Hillsdale.

Boelens, H., Van Den Broek, M., & Van Klarenbosch, T. (2011). Symmetric matching to sample in 2-year-old children. *The Psychological Record*, *50*(2), 6.

Ethics Committee of the British Psychological. (2010). Code of Ethics and Conduct Guidance. Retrieved from
http://www.bps.org.uk/system/files/documents/code_of_ethics_and_conduct.pdf

Bruner, J., Goodnow, J., & George, A. (1956). Austin. A Study of Thinking. *New York: John Wiley & Sons, Inc, 14*, 330.

Bzoch, K., & League, R. (1991). *Receptive-expressive emergent language scale*. Austin, TX: Pro-Ed.

Cassidy, S., Roche, B., & Hayes, S. (2011). A relational frame training intervention to raise Intelligence Quotients: A pilot study. *The Psychological Record*, *61*(2), 2.

Chalmers, T. C., Smith, H. Jr., Blackburn, B., Silverman, B., Schroeder, B., Reitman, D., & Ambroz, A. (1981). A method for assessing the quality of a randomized control trial. *Controlled Clinical Trials, 2*(1), 31–49.

Chomsky, N. (1959). A review of BF Skinner's Verbal Behavior. *Language*, *35*(1), 26-58.

Clayton, M. C., & Hayes, L. J. (2012). Conceptual differences in the analysis of stimulus equivalence. *The Psychological Record*, *49*(1), 10.

Cochrane, A., Barnes-Holmes, D., & Barnes-Holmes, Y. (2010). The perceived-threat behavioral approach test (PT-BAT): Measuring avoidance in high-, mid-, and low-spider-fearful participants. *The Psychological Record*, *58*(4), 6.

Colbert, B. (2005). *The effects of response cards on the performance and generalization of parenting skills* (Graduate Theses and Dissertations). University of South Florida.

Cooper, J., Heron, T. E., & Heward, W. L. (2007). *Applied behavior analysis* (2nd ed.). Pearson.

Cossentino, J. (2005). Ritualizing Expertise: A Non-Montessorian View of the Montessori Method. *American Journal of Education*, *111*(2), 211-244. doi:10.1086/426838

Cox, M., & Rowlands, A. (2000). The effect of three different educational approaches on children's drawing ability: Steiner, Montessori and traditional. *British Journal of Educational Psychology*, *70*(4), 485-503. doi:10.1348/000709900158263

Critchfield, T., & Fienup, D. (2010). Using stimulus equivalence technology to teach statistical inference in a group setting. *Journal of Applied Behavior Analysis, 43*(4), 763-768.

Critchfield, T., & Fienup, D. (2013). A ‘‘happy hour’’effect in translational stimulus relations research. *Experimental Analysis of Human Behavior Bulletin, 29*, 2-7.

Crow, K. (2008). Four Types of Disabilities: Their Impact on Online Learning. *Techtrends*, *52*(1), 51-55. doi:10.1007/s11528-008-0112-6

de Alcantara Gil, M., de Oliveira, T., & McIlvane, W. (2011). Conditional discriminations by preverbal children in an identity matching-to-sample task. *The Psychological Record*, *61*(3), 327.

de Rose, J. C., & de Souza, D. G. Hanna (1996). Teaching reading and spelling: Exclusion and stimulus equivalence. *Journal of Applied Behavior Analysis*, *29*, 451-469.

Devany, J., Hayes, S., & Nelson, R. (1986). Equivalence class formation in language-able and language-disabled children. *Journal of the Experimental Analysis of Behavior, 46*(3), 243-257.

Dube, W. V., & McIlvane, W. J. (1996). *Some implications of a stimulus control topography analysis for emergent behavior and stimulus classes (pp. 197-218)*. In T.R. Zentall and P.M. Smeets (Eds.), Stimulus class formation in humans and animals. Amsterdam: Elsevier.

Dube, W., McIlvane, W., Callahan, T., & Stoddard, L. (1993). The search for stimulus equivalence in nonverbal organisms. *The Psychological Record*.

Dugdale, N. & Lowe, C.F. (1990). Naming and stimulus equivalence. In D.E. Blackman & H. Lejeune (Eds.), *Behavior analysis in theory and practice: Contributions and controversies* (pp. 115- 138). Brighton, UK: Lawrence Erlbaum.

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

Dymond, S., & Barnes, D. (1995). A transformation of self-discrimination response functions in accordance with the arbitrarily applicable relations of sameness, more than, and less than. *Journal of the Experimental Analysis of Behavior, 64*(2), 163-184.

Dymond, S., Dunsmoor, J., Vervliet, B., Roche, B., & Hermans, D. (2014). Fear generalization in humans: Systematic review and implications for anxiety disorder research. *Behavior Therapy*.

Dymond, S., & Rehfeldt, R. (2001). Supplemental measures of derived stimulus relations. *Experimental Analysis of Human Behavior Bulletin*, *19*, 8-12.

Dymond, S., & Roche, B. (2013). *Advances in relational frame theory*. Oakland, CA: Context Press.

Eikeseth, S., Rosales-Ruiz, J., Duarte, A., & Baer, D. M. (2012). The quick development of equivalence classes in a paper-and-pencil format through written instructions. *The Psychological Record*, *47*(2), 7.

Eikeseth, S., & Smith, T. (1992). The development of functional and equivalence classes in high-functioning autistic children: The role of naming. *Journal of the Experimental Analysis of Behavior*.

Elias, N., Goyos, C., Saunders, M., & Saunders, R. (2008). Teaching manual signs to adults with mental retardation using matching-to-sample procedures and stimulus equivalence. *The Analysis of Verbal Behavior*, *24*(1), 1.

Fields, L., & Moss, P. (2008). Formation of partially and fully elaborated generalized equivalence classes. *Journal of the Experimental Analysis of Behavior*, *90*(2), 135-168.

Fields, L., & Reeve, K. (2011). A methodological integration of generalized equivalence classes, natural categories, and cross-modal perception. *The Psychological Record*, *51*(1), 4.

Fields, L., Hobbie-Reeve, S., Adams, B., & Reeve, K. (1999). Effects of training directionality and class size on equivalence class formation by adults. *The Psychological Record*, *49*(4), 703-724.

Fields, L., Matneja, P., Varelas, A., Belanich, J., Fitzer, A., & Shamoun, K. (2002). The formation of linked perceptual classes. *Journal of the Experimental Analysis of Behavior*, *78*(3), 271-290. doi:10.1901/jeab.2002.78-271

Fields, L., Reeve, K., Adams, B., & Verhave, T. (1991). Stimulus generalization and equivalence classes: A model for natural categories. *Journal of the Experimental Analysis of Behavior*, *55*(3), 305-312.

Fields, L., Travis, R., Roy, D., Yadlovker, E., Aguiar-Rocha, L., & Sturmey, P. (2009). Equivalence class formation: A method for teaching statistical interactions. *Journal of Applied Behavior Analysis*, *42*(3), 575-593.

Fields, L., Verhave, T., & Fath, S. (1984). Stimulus equivalence and transitive associations: A methodological analysis. *Journal of the Experimental Analysis of Behavior*, *42*(1), 143-157.

Fienup, D., Covey, D., & Critchfield, T. (2010). Teaching brain—behavior relations economically with stimulus equivalence technology. *Journal of Applied Behavior Analysis*, *43*(1), 19-33.

Fienup, D. M., & Critchfield, T. S. (2010). Transportability of equivalence-based programmed instruction: efficacy and efficiency in a college classroom. *Journal of applied behavior analysis*, *44*(3), 435-450.

Fienup, D., & Dixon, M. (2006). Acquisition and maintenance of visual-visual and visual-olfactory equivalence classes. *European Journal of Behavior Analysis*, *7*(1), 87.

Fisher, S. (1916). The process of generalizing abstraction; and its product, the general concept. *The Psychological Monographs*, *21*(2).

Fisher, W., Piazza, C., Bowman, L., Hagopian, L., Owens, J., & Slevin, I. (1992). A comparison of two approaches for identifying reinforcers for persons with severe and profound disabilities. *Journal of Applied Behavior Analysis*, *25*(2), 491-498.

Friman, P., Hayes, S., & Wilson, K. (1998). Why behavior analysts should study emotion: The example of anxiety. *Journal of Applied Behavior Analysis*, *31*(1), 137-156.

Galizio, M., Stewart, K., & Pilgrim, C. (2004). Typicality effects in contingency-shaped generalized equivalence classes. *Journal of the Experimental Analysis of Behavior*, *82*(3), 253-273.

Gengerelli, J. (1927). Mutual interference in the evolution of concepts. *The American Journal of Psychology*, 639-646.

George, C. (2010). Effects of response cards on performance and participation in social studies for middle school students with emotional and behavioral disorders. *Behavioral Disorders*, *35*(3), 200.

Green, G. (1990). Differences in development of visual and auditory-visual equivalence relations. *American Journal on Mental Retardation*.

Green, G., & Saunders, R. R. (1998). Stimulus equivalence. In K. A. Lattal, & M. Perone (Eds.), *Handbook of research methods in human operant behavior* (pp. 229– 262). New York: Plenum Press.

Green, G., Stromer, R., & Mackay, H. (1993). Relational learning in stimulus sequences. *The Psychological Record*.

Groskreutz, N., Karsina, A., Miguel, C., & Groskreutz, M. (2010). Using complex auditory—visual samples to produce emergent relations in children with autism. *Journal of Applied Behavior Analysis*, *43*(1), 131-136.

Gross, A., & Fox, E. (2009). Relational frame theory: An overview of the controversy. *The Analysis of Verbal Behavior, 25*(1), 87.

Haegele, K., McComas, J., Dixon, M., & Burns, M. (2011). Using a stimulus equivalence paradigm to teach numerals, English words, and Native American words to preschool-age children. *Journal of Behavioral Education, 20*(4), 283-296.

Hall, G., & Chase, P. (1991). The relationship between stimulus equivalence and verbal behavior. *The Analysis of Verbal Behavior, 9*, 107.

Hayes, S. (1989). Nonhumans have not yet shown stimulus equivalence. *Journal of the Experimental Analysis of Behavior*, *51*(3), 385-392.

Hayes, S., & Barnes, D. (1997). Analyzing derived stimulus relations requires more than the concept of stimulus class. *Journal of the Experimental Analysis of Behavior*, *68*(2), 235-244.

Hayes, S., Barnes-Holmes, D., & Roche, B. (2001). *Relational frame theory*. New York: Kluwer Academic/Plenum Publishers.

Hayes, S., Strosahl, K., & Wilson, K. (1999). *Acceptance and commitment therapy: An experiential approach to behavior change.*

NCCA (1999). *Primary School Curriculum*. Dublin: Government of Ireland Publications.

He, H., Yan, H., Zuo, L., Liu, L., & Zhang, X. (2009). [Effects of Montessori education on the intellectual development in children aged 2 to 4 years]. Zhongguo Dang Dai Er Ke Za Zhi. *Chinese Journal of Contemporary Pediatrics, 11*(12), 1002-1005.

Herrnstein, R., & Loveland, D. (1964). Complex visual concept in the pigeon. *Science*, *146*(3643), 549-551.

Heward, W. (1996). Everyone Participates in This Class: Using Response Cards to Increase Active Student Response. *Teaching Exceptional Children*, *28*(2), 4-10.

Horne, P., & Lowe, C. (1996). On the origins of naming and other symbolic behavior. *Journal of the Experimental Analysis of Behavior*, *65*(1), 185-241.

Hourcade, J. P., Perry, K. B., & Sharma, A. (2008, June). PointAssist: helping four year olds point with ease. In *Proceedings of the 7th international conference on Interaction design and children* (pp. 202-209). ACM.

Hughes, S., & Barnes-Holmes, D. (2014). Associative concept learning, stimulus equivalence, and Relational Frame Theory: Working out the similarities and differences between human and nonhuman behavior. *Journal of the Experimental Analysis of Behavior, 101*(1), 156-160.

Hull, C. (1920). Quantitative aspects of evolution of concepts: An experimental study. *Psychological Monographs*, *28*(1).

Hull, C. (1939). The problem of stimulus equivalence in behavior theory. *Psychological Review*, *46*(1), 9.

Johnson, E., & Nelson, M. (2009). *The Montessori method*. Owatonna, MN: Learning ZoneXpress.

Jordan, C., Pilgrim, C., & Galizio, M. (2001). Conditional discrimination and stimulus equivalence in young children following three different baseline training procedures. *Experimental Analysis of Human Behavior Bulletin*, *19*(3), 7.

Keintz, K., Miguel, C., Kao, B., & Finn, H. (2011). Using conditional discrimination training to produce emergent relations between coins and their values in children with autism. *Journal of Applied Behavior Analysis, 44*(4), 909-913.

Keller, F., & Schoenfeld, W. (1950). *Principles of psychology*. New York: Appleton-Century-Crofts.

Kennedy, C. H. (2005). *Single-case designs for educational research*. Prentice Hall.

Kilroe, H., Murphy, C., Barnes-Holmes, D., & Barnes-Holmes, Y. (2014). Using the T-IRAP interactive computer program and applied behavior analysis to teach relational responding in children with autism. *Behavioral Development Bulletin*, *19*(2), 60.

Krafft, K., & Berk, L. (1998). Private speech in two preschools: Significance of open-ended activities and make-believe play for verbal self-regulation. *Early Childhood Research Quarterly*, *13*(4), 637-658. doi:10.1016/s0885-2006(99)80065-9

Kuo, Z. (1923). A Behavioristic Experiment on Inductive Inference. *Journal of Experimental Psychology*, *6*(4), 247.

Lakoff, G. (1987). *Women, fire, and dangerous things: What categories reveal about the mind.* Chicago: University of Chicago Press.

Leading early years education. (2005). In *Consultative Conference on Education*. Dublin. Retrieved from https://www.into.ie/ROI/Publications/LeadingEarlyYears.pdf

LeBlanc, L., Miguel, C., Cummings, A., Goldsmith, T., & Carr, J. (2003). The effects of three stimulus-equivalence testing conditions on emergent US geography relations of children diagnosed with autism. *Behavioral Interventions*, *18*(4), 279-289.

Leigland, S. (1997). Is a new definition of verbal behavior necessary in light of derived relational responding?. *The Behavior Analyst*, *20*(1), 3.

Libby, M., Weiss, J., Bancroft, S., & Ahearn, W. (2008). A comparison of most-to-least and least-to-most prompting on the acquisition of solitary play skills. *Behavior Analysis in Practice*, *1*(1), 37.

Lillard, A. (2012). Preschool children's development in classic Montessori, supplemented Montessori, and conventional programs. *Journal of School Psychology*, *50*(3), 379-401.

Lillard, A., & Else-Quest, N. (2006). The early years: Evaluating montessori education. *Science*, *313*(5795), 1893-1894.

Lipkens, R., Hayes, S., & Hayes, L. (1993). Longitudinal study of the development of derived relations in an infant. *Journal of Experimental Child Psychology*, *56*(2), 201-239.

Lopata, C., Wallace, N. V., & Finn, K. V. (2005). Comparison of academic achievement between Montessori and traditional education programs. *Journal of research in childhood education*, *20*(1), 5-13.

Maguire, R., Stromer, R., Mackay, H., & Demis, C. (1994). Matching to complex samples and stimulus class formation in adults with autism and young children. *Journal of Autism and Developmental Disorders*, *24*(6), 753-772.

Martyn, M. (2007). Clickers in the classroom: An active learning approach. *Educause Quarterly, 30*(2), 71.

McIlvane, W. J**.** (2013). Simple and complex discrimination learning. In G. J. Madden (Ed.), *APA handbooks in psychology*. *APA handbook of behavior analysis, vol. 2: Translating principles into practice* (pp. 129-163). Washington, D.C.: American Psychological Association.

McLay, L., Church, J., & Sutherland, D. (2014). Variables affecting the emergence of untaught equivalence relations in children with and without autism. *Developmental Neurorehabilitation*, (0), 1-13.

McLay, L., Sutherland, D., Church, J., & Tyler-Merrick, G. (2013). The formation of equivalence classes in individuals with autism spectrum disorder: A review of the literature. *Research in Autism Spectrum Disorders*, *7*(2), 418-431.

Medin, D., & Rips, L. (2005). Concepts and categories: Memory, meaning, and metaphysics. *The Cambridge Handbook of Thinking and Reasoning*, 37-72.

Medin, D., & Schaffer, M. (1978). Context theory of classification learning. *Psychological Review*, *85*(3), 207.

Medin, D., Wattenmaker, W., & Hampson, S. (1987). Family resemblance, conceptual cohesiveness, and category construction. *Cognitive Psychology*, *19*(2), 242-279.

Merwin, R., & Wilson, K. (2010). Preliminary findings on the effects of self-referring and evaluative stimuli on stimulus equivalence class formation. *The Psychological Record*, *55*(4), 5.

Miguel, C., Petursdottir, A., Carr, J., & Michael, J. (2008). The role of naming in stimulus categorization by preschool children. *Journal of the Experimental Analysis of Behavior*, *89*(3), 383-405.

Miller, N., & Dollard, J. (1941). *Social learning and imitation*. New Haven: Pub. for the Institute of human relations by Yale University press.

Montessori, M. (1964). The Montessori Method: Scientific Pedagogy as Applied to Child Education in" The Children's Houses," translated from the Italian by Anne E. *George, Cambridge, Mass: Robert Bentley*, *377*.

Montessori.org.uk,. (2015). *Locations, Montessori Training Centres | Montessori Jobs & Teacher Training Course College & School UK*. Retrieved 7 June 2015, from http://www.montessori.org.uk/msa

Montessorialliance.ie,. (2015). Retrieved 13 February 2015, from http://www.montessorialliance.ie/parents/primary-montessori-schools/

Montessori-namta.org,. (2015). *How many Montessori schools are there?*. Retrieved 7 June 2015, from http://www.montessori-namta.org/FAQ/Montessori-Education/How-many-Montessori-schools-are-there

Murphy, G. (2002). *The big book of concepts*. Cambridge, Mass.: MIT Press.

Ninness, C., Barnes-Holmes, D., Rumph, R., McCuller, G., Ford, A., & Payne, R. et al. (2006). Transformations of mathematical and stimulus functions. *Journal of Applied Behavior Analysis*, *39*(3), 299-321.

Ninness, C., Dixon, M., Barnes-Holmes, D., Rehfeldt, R., Rumph, R., & McCuller, G. et al. (2009). Constructing and deriving reciprocal trigonometric relations: A functional analytic approach. *Journal of Applied Behavior Analysis*, *42*(2), 191-208.

O’Connor, J., Barnes-Holmes, Y., & Barnes-Holmes, D. (2011). Establishing contextual control over symmetry and asymmetry performances in typically developing children and children with autism. *The Psychological Record*, *61*(2), 8.

O'Connor, J., Rafferty, A., Barnes-Holmes, D., & Barnes-Holmes, Y. (2009). The role of verbal behavior, stimulus nameability, and familiarity on the equivalence performances of autistic and normally developing children. *The Psychological Record*, *59*(1), 53-79.

O'Donnell, J., & Saunders, K. (2003). Equivalence relations in individuals with language limitations and mental retardation. *Journal of the Experimental Analysis of Behavior*, *80*(1), 131-157.

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

O'Hora, D., Peláez, M., Barnes-Holmes, D., Rae, G., Robinson, K., & Chaudhary, T. (2010). Temporal relations and intelligence: Correlating relational performance with performance on the WAIS-III. *The Psychological Record*, *58*(4), 5.

O'Hora, D., Roche, B., Barnes-Holmes, D., & Smeets, P. (2002). Response latencies to multiple derived stimulus relations: Testing two predictions of relational frame theory. *The Psychological Record*, *52*(1), 51-76.

Pelaez, M., Gewirtz, J., Sanchez, A., & Mahabir, N. (2000). Exploring stimulus equivalence formation in infants. *Behavioral Development Bulletin*, *9*(1), 20.

Peláez-Nogueras, M. (1996). Thought without naming. *Journal of the Experimental Analysis of Behavior*, *65*(1), 299.

Pérez-González, L. A., Herszlikowicz, K., & Williams, G. (2010). Stimulus relations analysis and the emergence of novel intraverbals. *The Psychological Record*, *58*(1), 7.

Pilgrim, C. (1996). Can the naming hypothesis be falsified?. *Journal of the Experimental Analysis of Behavior*, *65*(1), 284.

Pilgrim, C., Jackson, J., & Galizio, M. (2000). Acquisition of arbitrary conditional discriminations by young normally developing children. *Journal of the Experimental Analysis of Behavior*, *73*(2), 177-193.

Pratton, J., & Hales, L. (1986). The Effects of Active Participation on Student Learning. *The Journal of Educational Research*, *79*(4), 210-215.

The Psychology Society of Ireland. (2015). Code of Professional Ethics. Retrieved 07/01/2016 from

http://www.psychologicalsociety.ie/find-a-psychologist/PSI%202011-

Pytte, C., & Fienup, D. (2012). Using equivalence-based instruction to increase efficiency in teaching neuroanatomy. *Journal of Undergraduate Neuroscience Education*, *10*(2), 125.

Quillian, M. (1967). Word concepts: A theory and simulation of some basic semantic capabilities. *Behavioral Science, 12*(5), 410-430.

Quinn, P., & Eimas, P. (1997). A reexamination of the perceptual-to-conceptual shift in mental representations. *Review of General Psychology*, *1*(3), 271.

Quinn, P., Eimas, P., & Tarr, M. (2001). Perceptual categorization of cat and dog silhouettes by 3-to 4-month-old infants. *Journal of Experimental Child Psychology*, *79*(1), 78-94.

Qwizdom.com,. (2015). *Qwizdom Audience Response, Polling, Voting, and Events*. Retrieved 7 June 2015, from http://qwizdom.com/corporate/home/?lang=en

Rehfeldt, R. A., & Barnes-Holmes, Y. (Eds.). (2009). *Derived relational responding: Applications for learners with autism and other developmental disabilities: A progressive guide to change*. New Harbinger Publications.

Rehfeldt, R. (2011). Toward a technology of derived stimulus relations: An analysis of articles published in the Journal of Applied Behavior Analysis, 1992-2009. *Journal of Applied Behavior Analysis*, *44*(1), 109-119.

Riley, D. (1968). *Discrimination learning*. Boston: Allyn and Bacon.

Rosales, R., & Rehfeldt, R. A. (2007). Contriving transitive conditioned establishing operations to establish derived manding skills in adults with severe developmental disabilities. *Journal of Applied Behavior Analysis*,*40*(1), 105.

Saunders, R., Drake, K., & Spradlin, J. (1999). Equivalence class establishment, expansion, and modification in preschool children. *Journal of the Experimental Analysis of Behavior*, *71*(2), 195-214.

Saunders, R., Wachter, J., & Spradlin, J. (1988). Establishing auditory stimulus control over an eight-member equivalence class via conditional discrimination procedures. *Journal of the Experimental Analysis of Behavior*, *49*(1), 95-115.

Schusterman, R., Kastak, D., & Reichmuth, C. (1997). What's in a name? Equivalence by any other name would smell as sweet. *Journal of the Experimental Analysis of Behavior*, *68*(2), 252-258.

Sella, A., Ribeiro, D., & White, G. (2014). Effects of an Online Stimulus Equivalence Teaching Procedure on Research Design Open-Ended Questions Performance of International Undergraduate Students. *The Psychological Record*, *64*(1), 89-103.

Shimizu, H., Yoon, S., & McDonough, C. (2010). Teaching skills to use a computer mouse in preschoolers with developmental disabilities: Shaping moving a mouse and eye-hand coordination. *Research in Developmental Disabilities, 31*(6), 1448-1461.

Sidman, M. (1971). Reading and auditory-visual equivalences. *Journal of Speech, Language, and Hearing Research*, *14*(1), 5-13.

Sidman, M. (1994). *Equivalence relations and behavior: A research story*. Boston, MA, US: Authors Cooperative.

Sidman, M. (1997). Equivalence relations. *Journal of the Experimental Analysis of Behavior*, *68*(2), 258-266.

Sidman, M. (2000). Equivalence relations and the reinforcement contingency. *Journal of the Experimental Analysis of Behavior*, *74*(1), 127-146.

Sidman, M. (2009). Equivalence relations and behavior: An introductory tutorial. *The Analysis of Verbal Behavior*, *25*(1), 5.

Sidman, M., Rauzin, R., Lazar, R., Cunningham, S., Tailby, W., & Carrigan, P. (1982). A search for symmetry in the conditional discriminations of rhesus monkeys, baboons, and children. *Journal of the Experimental Analysis of Behavior*, *37*(1), 23-44.

Sidman, M., & Tailby, W. (1982). Conditional discrimination vs. matching to sample: An expansion of the testing paradigm. *Journal of the Experimental Analysis of Behavior*, *37*(1), 5-22.

Sidman, M., Wilson-Morris, M., & Kirk, B. (1986). Matching-to-sample procedures and the development of equivalence relations: The role of naming. *Analysis and Intervention in Developmental Disabilities*, *6*(1), 1-19.

Silver Lining Multimedia (2009). Picture This Professional Edition (Version 3.0). [Computer software]. Poughkeepsie, NY.

Skinner B. F. (1948). *Walden two*. New York: Macmillan; 1948

Skinner, B. F. (1960). Teaching machines. *The review of economics and statistics*, 189-191.

Skinner, B. F. (1961). Why we need teaching machines. *Harvard Educational Review.*

Skinner, B. F. (1969b). An operant analysis of problem solving. In B. F. Skinner, *Contingencies of reinforcement* (pp. 133-157). New York: Appleton-Century-Crofts.

Skinner, B. F. (1981). Selection by consequences. *Science, 213*(4507), 501-504.

Slattery, B., Stewart, I., & O'Hora, D. (2011). Testing for transitive class containment as a feature of hierarchical classification. *Journal of the Experimental Analysis of Behavior*, *96*(2), 243-260.

Smoke, K. (1932). An objective study of concept formation. *Psychological Monographs, 42*(4).

Smyth, S., Barnes-Holmes, D., & Forsyth, J. P. (2006). A derived transfer of simple discrimination and self-reported arousal functions in spider fearful and non-spider-fearful participants. *Journal of the experimental analysis of behavior,85*(2), 223-246.

Spence, K. (1937). The differential response in animals to stimuli varying within a single dimension. *Psychological Review*, *44*(5), 430.

Still, K., May, R. J., Rehfeldt, R. A., Whelan, R., & Dymond, S. (2015). Facilitating derived requesting skills with a touchscreen tablet computer for children with autism spectrum disorder. *Research in Autism Spectrum Disorders*.

Tarbox, J., Zuckerman, C., Bishop, M., Olive, M., & O'Hora, D. (2011). Rule-governed behavior: Teaching a preliminary repertoire of rule-following to children with autism. *The Analysis of Verbal Behavior*, *27*(1), 125.

Taylor, I., & O'Reilly, M. (2011). Generalization of supermarket shopping skills for individuals with mild intellectual disabilities using stimulus equivalence training. *The Psychological Record*, *50*(1), 4.

Tierney, K., De Largy, P., & Bracken, M. (1995). Formation of an equivalence class incorporating haptic stimuli. *The Psychological Record*, *45*(3), 431-437.

Tusla.ie,. (2015). *List of Early Years Services by County | Tusla - Child and Family Agency*. Retrieved 23 February 2015, from http://www.tusla.ie/services/preschool-services/list-of-pre-school-services-by-county

Twyman, J. (2011). Emerging technologies and behavioural cusps: A new era for behaviour analysis. *European Journal of Behavior Analysis, 12*(2), 461-482.

Vargas, J. S. (2013). *Behavior analysis for effective teaching*. Routledge.

Walker, B., & Rehfeldt, R. (2012). An evaluation of the stimulus equivalence paradigm to teach single-subject design to distance education students via blackboard. *Journal of Applied Behavior Analysis*, *45*(2), 329-344.

Wechsler, D. (1992). Wechsler intelligence scale for children–Third edition–UK Manual. London: Psychological Corp, Europe.

Whitaker, C. (1996). Aristotle's De interpretatione: contradiction and dialectic.

Wright, A., & Cumming, W. (1971). Color-naming functions for the pigeon. *Journal of the Experimental Analysis of Behavior*.

Wynn, J., & Smith, T. (2003). Generalization between receptive and expressive language in young children with autism. *Behavioral Interventions*, *18*(4), 245-266.

Zentall, T., Galizio, M., & Critchfield, T. (2002). Categorization, concept learning, and behavior analysis: An introduction. *Journal of the Experimental Analysis of Behavior*, *78*(3), 237-248.

Zentall, T. R., & Smeets, P. M. (Eds.). (1996). *Stimulus class formation in humans and animals*. Elsevier.

Zentall, T., Wasserman, E., Lazareva, O., Thompson, R., & Rattermann, M. (2008). Concept learning in animals. *Comparative Cognition & Behavior Reviews, 3*, 13-45.

Zentall, T., Wasserman, E., & Urcuioli, P. (2014). Associative concept learning in animals. *Journal of the Experimental Analysis of Behavior*, *101*(1), 130-151.

Zimmerman, I., & Steiner, V. G. & Pond, E. (2011). *Preschool Language Scales-Fifth Edition (PLS-5).*

Zimmerman, I. L., Steiner, V. G., & Pond, R. E. (2002). *Preschool language scale* (Vol. 3). San Antonio, TX: Psychological Corporation.

Appendices

Appendix A: Copy of ethical application and approval letter for Study 1 (Chapter 2) including appendices.

Office of the Vice-President for Research

Dublin City University
RESEARCH ETHICS COMMITTEE

APPLICATION FOR APPROVAL OF A PROJECT
INVOLVING **HUMAN PARTICIPANTS**

Application No. *(office use only)* DCUREC/2012/ ☐☐☐

This application form is to be used by researchers seeking ethics approval for individual projects and studies. **An electronic copy** of your completed application must be submitted to the DCU Research Ethics Committee. **Student applicants must cc their supervisor on that e-mail –** this applies to undergraduate, masters and postgraduate students.

NB - The application should consist of <u>one file only</u>, with an electronic signature from the PI. The completed application must incorporate all supplementary documentation, especially that being given to the proposed participants. It must be proofread and spellchecked before submission to the REC. All sections of the application form should be completed. Applications which do not adhere to these requirements will not be accepted for review and will be returned directly to the applicant.

Applications must be completed on the form; answers in the form of attachments will not be accepted, except where indicated. No hardcopy applications will be accepted. **Research must <u>not</u> commence until written approval has been received from the Research Ethics Committee.**

Note: If your research requires approval from the Biosafety Committee, this approval should be in place prior to REC submission. Please attach the approval from the BSC to this submission.

PROJECT TITLE	Derived Categorisation in Young Children
PRINCIPAL INVESTIGATOR(S)	Dr. Sinéad Smyth

Please confirm that **<u>all</u>** supplementary information is included in your application (in electronic copy). If questionnaire or interview questions are submitted in draft form, a copy of the final documentation must be submitted for final approval when available.

	INCLUDED		NOT APPLICABLE
Bibliography	☒		☐
Recruitment advertisement	☐		☒
Plain language statement/Information Statement	☒		☐
Informed Consent form	☒		☐
Evidence of external approvals related to the research	☐		☒
Questionnaire	☐ draft	☐ final	☒
Interview Schedule	☐ draft	☐ final	☒
Debriefing material	☐		☒
Other	☒		☐

Please note:

1. Any amendments to the original approved proposal must receive prior REC approval.
2. As a condition of approval investigators are required to document and report immediately to the Secretary of the Research Ethics Committee any adverse events, any issues which might negatively impact on the conduct of the research and/or any complaint from a participant relating to their participation in the study

Please submit the electronic copy of your completed application to fiona.brennan@dcu.ie
Fiona Brennan, Research Officer, Office of the Vice-President for Research and Innovation
(Ph. 01-7007816)

Last updated February 2012 Page 1

Office of the Vice-President for Research

1. ADMINISTRATIVE DETAILS

THIS PROJECT IS:
(tick as many as apply)

- ☐ Research Project
- ☐ Practical Class
- ☒ Student Research Project
  (please give details)
  - ☐ Research Masters
  - ☐ Taught Masters
  - ☒ PhD
  - ☐ Undergraduate
- ☐ Funded Consultancy
- ☐ Clinical Trial
- ☐ Other - *Please Describe:*

Project Start Date: **October 2012** **Project End date:** **October 2015**

1.1 INVESTIGATOR CONTACT DETAILS *(see Guidelines)*

PRINCIPAL INVESTIGATOR(S):

TITLE	*SURNAME*	*FIRST NAME*	*PHONE*	*FAX*	*EMAIL*
Dr.	Smyth	Sinead	7422		sinead.smyth@dcu.ie

OTHER INVESTIGATORS:

TITLE	*SURNAME*	*FIRST NAME*	*PHONE*	*FAX*	*EMAIL*
Prof	Gallagher	Pamela	8958		pamela.gallagher@dcu.ie
Prof	Leslie	Julian	+4428 70123090		jc.leslie@ulster.ac.uk
Ms	Barron	Ronda			barron.r2@mail.dcu.ie

FACULTY/DEPARTMENT/SCHOOL/ CENTRE: School of Nursing and Human Sciences

(NB – if Nursing and Human Sciences, please note all students including PhD's must attach the letter from their Ethics Advisory Committee to this application)

1.2 WILL THE RESEARCH BE UNDERTAKEN ON-SITE AT DUBLIN CITY UNIVERSITY?

☐ YES ☒ NO

(If NO, give details of off-campus location.)
Research will take place within educational settings, primary schools, special education facilities, and crèche or afterschool facilities.

1.3 IS THIS PROTOCOL BEING SUBMITTED TO ANOTHER ETHICS COMMITTEE, OR HAS IT BEEN PREVIOUSLY SUBMITTED TO AN ETHICS COMMITTEE?)

☒ YES ☐ NO

(If YES, please provide details and copies of approval(s) received etc.) **Approved by University of Ulster Research Ethics Committee REC/11/0368 See Appendix 1 for copies of letter and condition/amendments.**

DECLARATION BY INVESTIGATORS

The information contained herein is, to the best of my knowledge and belief, accurate. I have read the University's current research ethics guidelines, and accept responsibility for the conduct of the procedures set out in the attached application in accordance with the guidelines, the University's policy on Conflict of Interest, Code of Good Research Practice and any other condition laid down by the Dublin City University Research Ethics Committee or its Sub-Committees. I have attempted to identify all risks related to the research that may arise in conducting this research and acknowledge my obligations and the rights of the participants.

If there any affiliation or financial interest for researcher(s) in this research or its outcomes or any other circumstances which might represent a perceived, potential or actual conflict of interest this should be declared in accordance with Dublin City University policy on Conflicts of Interest.

I and my co-investigators or supporting staff have the appropriate qualifications, experience and facilities to conduct the research set out in the attached application and to deal with any emergencies and contingencies related to the research that may arise.

Electronic Signature(s):

Last updated February 2012 Page 3

Principal investigator(s): _ Sinéad Smyth

Print Name(s) here:______Sinéad Smyth____

Date: __2/11/12____

2. PROJECT OUTLINE

Categorisation is a very important skill learned in childhood. Children often learn simple categories, quickly through day to day interaction, but may need to be directly taught complex categories. Categorisation is a critical skill in the development of receptive language ability (Ungerer & Sigman, 2005). However, for children with developmental delay and/or Autistic Spectrum Disorder more extensive training in categorisation might be needed. Programs devised to teach this skill often are lengthy, requiring each object, picture and their relations to be taught separately. Typically developing children are also taught in the same manner however the process is usually more expedient in this cohort. However, the natural environment often does not present the opportunity for either population to learn complex categories and in some contexts traditional teaching methods may not be appropriate.

Within the field of behaviour analysis, one parsimonious way in which new associations can be quickly trained is through stimulus equivalence. Stimulus equivalence involves training a limited number of associations directly (e.g., apple-orange, orange-banana) and then testing for the derivation of untrained association (e.g., apple-banana). Match-to-sample (MTS) tasks are the most commonly used method of training stimulus pairs and testing for the emergence of derived relations. Such tasks are commonly established in educational programs for both typically developing individuals and those with learning disabilities (Sundberg & Partington, 1998). A MTS task typically consists of the presentation of a sample stimulus (e.g., A1) and an array of comparisons (B1 and B2). The participant responds by selecting a comparison (e.g., B1) upon a particular sample stimulus presentation. Feedback follows selection as to whether the correct choice was made (in the examples given in parentheses, choosing B1 in the presence of A1 would be correct). Stimuli may range from simple to complex, for example objects, pictures, words and may be visual, textual or auditory. The procedure may be based on a variety of concepts such as, same-as, different, negated (e.g. not fruit), before and after.

A previous study conducted by the experimenter Ronda Barron in 2010 under the supervision of Dr. Sinead Smyth (Barron, 2010) investigated if real world categories could be established in preschool children with Autistic Spectrum Disorder (ASD). A key component of this study was that vocal responses were not required from participants. Participants were required to select and match pictures representative of categories e.g. apple, pear, banana = fruit electronically via a touch screen computer. This was later followed by a categorisation sort test whereby participants were asked to sort pictures into categories such as, fruit, clothing, and toys. Two of the three participants demonstrated the formation of equivalence classes and also derived categorization. One of these participants required remedial action. The third participant however did not demonstrate symmetry at AB, BA training and testing following three sets of remedial action. Furthermore, the data indicated that category training took place after a large number of trials.

The proposed study consists of two experiments; Experiment 1 is an attempt to replicate Barron (2010) through the establishment of real world categories in children with ASD. The purpose of the second experiment is to extend Barron (2010) investigating the establishment of real world categories in typically developing children. It is important to explore any findings of this procedure with a typically developing population firstly by removing the variables that are typically associated with developmentally delayed populations such as language delay or disorder. The data yielded may inform if there is a link between language ability and performance. Secondly, in the developmentally delayed population (Barron 2010), category training took place following a large number of trials.

However, this procedure has not been examined with a typically developing population which is essential in order to explore the efficacy of this procedure as an expedient method of training categories. In keeping with Barron, the procedure for both experiments will involve a matching-to-sample procedure but without the use of naming as a criterion, that is no verbal language is required. For the ASD population, the same procedure employed by Barron (2010) will be exactly replicated. The same procedure will be employed in Experiment 2 with some small changes. The main change being that the stimuli employed will be more complex categories in keeping with the age and prior knowledge of the participants. Complex categories may for typically developing children may include sub categorisation such as, dairy products and categorising by feature, for example stripes and colours. Category knowledge for participants with ASD may be more general such as, food, animals and clothing.

For both experimental populations, it is envisaged that the proposed study would greatly enhance participants' knowledge in a more expedient fashion. Categorisation is a critical skill for the development of receptive language ability (Ungerer & Sigman, 2005) and thus the skills trained will have relevance to participants' daily lives. Furthermore, the procedures discussed here may serve as a means of directing future educational procedures for children with and without developmental delay.

2.1 LAY DESCRIPTION *(see Guidelines)*

Two experiments will be conducted with two populations; Experiment 1 will be conducted with young children with a diagnosis of Autistic Spectrum Disorder and Experiment 2 with typically developing young children. The purpose of the two experiments is to investigate a method for teaching young children to categorise objects without direct training. That is, to group common objects of a category for example, animals or food together without directly teaching every object to the category. The proposed research aims to explore the efficacy of this training method by tailoring the categories so that each child is pre-screened and taught categories which were previously unknown to them. This means that the training will be individualised to focus on existing deficits, making it more functional for the learner and increasing the applicability to developmentally delayed populations. Importantly, the categories used will have relevance to each individual child (e.g., food, clothing etc.).

Spoken language is not a criteria to participate however the typically developing population (Experiment 2) should have normally language ability reflective of their age, the ASD (Experiment 1) population may differ in that spoken language may be delayed or absent.. For both experiments, participation will initially involve a language assessment and a test of existing knowledge of different categories (e.g., food, clothes etc.). This will help us to decide what categories need to be trained. Once this has been completed, the computer training and testing will begin. Pictures of objects will be presented on the screen and the child will be asked to match them. At this stage, correct responses will be rewarded with tokens which can be exchanged for time to play with preferred items or activities, no food or liquids will be used at any stage of the experiment. Children can access breaks at any stage.

Following this training, a test will take place to see if the child has developed any pairing of objects that have not been directly trained. During this stage the child will not be told whether their responses are correct or not. Finally, post testing will involve the re-administration of the category sort task for the trained objects as well as the re-administration of the language assessment. This will allow a comparison of before and after the computerised training.

Duration of experimental sessions will be no longer than 30 minutes (including breaks) for each participant. It is estimated that participation will last a maximum of 16 weeks for each child a maximum of 24 weeks for those with an Autistic Spectrum Disorder. Starting dates for participants will be staggered and sessions will take place twice weekly. The duration has been considered to account for session duration and to incorporate school holidays

2.2 AIMS OF AND JUSTIFICATION FOR THE RESEARCH *(see Guidelines)*

The proposed study will focus on the application of the methodology as a teaching protocol to increase knowledge in a particular area (e.g., Ninness, Rumph, McCuller, Harrison, Ford, & Ninness, 2005). Rehfeldt (2011) highlighted the importance of programmes of applied research in testing assumptions that education approaches under laboratory conditions will transfer to the real world. There are a number of key areas that need to be addressed when attempting to assess the value of such a methodology in real world settings. Previous studies have taught all participants the same generic relations (the children in Migue et al. 2008 were taught to match states as being in either the north or south of the United States of America). The proposed research aims to explore the efficacy of this training method by tailoring the categories so that each child is pre-screened and taught categories which were previously unknown to them. This means that the training will be individualised to focus on existing deficits, making it more functional for the learner and increasing the applicability to developmentally delayed populations.

Miguel et al. (2008) indicated that naming of the to-be-matched stimuli is an important part of the learning process. One potential future applications of the proposed study is for use with children with developmental delay, a population which often presents with poor verbal skills. As such it is deemed important to assess language levels and to further investigate this claim. Finally, the proposed study will be computerised. Previous research with young children typically depended on table top procedures (e.g., Miguel et al., 2008.; cf Moran et al., 2010). The proposed study will employ a small touch-screen computer which even young children with developmental delay have used successfully (see description of pilot work below). No known research has used this type of technology to implement the methodological design proposed.

The principle investigator Dr Smyth and the Phd Student Ronda Barron have previously conducted research in this area (Barron, Smyth, & Leslie, under preparation). This project piloted the methodology with preschool children with developmental delay. The data demonstrate that the protocol is suitable for use with a young developmentally delayed population and also provide support for the suggestion that performance is linked to language ability because the two children with higher verbal skills performed better on the task. Further research is needed to investigate the role of language as well as the comparative efficacy as a teaching method. The use of a typically developing population may provide additional data to support these findings as this population would not have the possible language delays often found in developmentally delayed populations. Applying this method of training to a typically developing population will assist the investigation of the training method more generally so that it (or an alternative) can be applied to a developmentally delayed population.

2.3 PROPOSED METHOD *(see Guidelines)*

All experimental sessions will take place within a room separate to the participants' classroom and will minimally contain a table and two chairs. Duration of experimental sessions will be no longer than 30 minutes (including breaks) for each participant. It is estimated that participation will last a maximum of 16 weeks for each child a maximum of 24 weeks for those with an Autistic Spectrum Disorder. Starting dates for participants will be staggered and sessions will take place twice weekly. The duration has been considered to account for session duration and to incorporate school holidays.

Experiment 1: Categorisation training with children with a diagnosis of Autistic Spectrum Disorder (ASD).

Materials: The tasks will be computer-based, and will be presented on a touch screen tablet computer. The stimuli used will consist of pictures of objects or words to be categorised. Three sets of three stimuli will be employed for each participant, each set comprising of three objects belonging to the same category (e.g., apple, orange, pear = fruit).

Procedure: Pre-experimental tests will consist of the administration of a standardised and norm referenced assessment of language (see Appendix 2). In addition, participants will be given a sort test in which they are asked to sort pictures of items according to their category [e.g. fruit, clothing, toys]. If a participant reaches 50% correct responding in any given category then that category will be excluded and retesting with other categories will commence. This stage is designed to ensure that deficits in the participants' knowledge are targeted and that any effects seen are not due to pre-experimental knowledge.

Experimental Phases 1-7 will utilise a three choice computerised matching to sample procedure for training and testing. This procedure is commonly used in stimulus equivalence experiments and involves presentation of a sample stimulus (e.g. apple) which must be matched to one of an array of comparison stimuli (e.g., sock, orange, teddy). During training reinforcement will be given for choosing the correct comparison (in this case orange) but no feedback will be given during testing phases (see Appendix 3 for a schematic)

Category training (e.g., orange is a fruit) will take place followed by another category sort test designed to determine if the child will derive category membership for other members of the stimulus set (e.g., apple/banana = fruit). The same language assessment as before will be conducted 6 months after first administration.

Data analysis: In keeping with other single-subject research, data analysis for all experiments will be descriptive and will compare within and across participants (Kazdin, 2010). Inferential statistical analyses will not be conducted. Data collection will include written reports, and computerized responding on the learning task. Data will be held on a computer stored in an office, backup of data and any written material will be stored in a filing cabinet. All data will subsequently be stored in a secure location for a period of six years.

Experiment 2: Categorisation training with typically developing children.

Experiment 2 will be identical to Experiment 1 apart from the following minor changes.

Participants: For the typically developing population, four children depending upon skills level, participants may be able to give written consent. The visual and textual instruction board with the additions to the children's daily schedule will be implemented if required; ensuring the children fully understand what is required (see Appendix 4 and 5)

Materials: The same computerised programme will be used to display the stimuli however, different categorises will be chosen commensurate with the participants' pre-experimental knowledge. The categories chosen for this population will be more complex (e.g., example money, mathematical concepts, sub-categories etc.), but will still be functional to each individual participant in that the categories to be taught were previously unknown to them.

2.4 PARTICIPANT PROFILE *(see Guidelines)*

Two populations will be sampled during the study. Experiment 1 will be conducted with children with developmental delay such as Autistic Spectrum Disorder (ASD) and Experiment 2 will study typically developing children. Both populations to be sampled are classed as a vulnerable group due to their age and in the case of the developmental population also language delay, however a number of steps will be taken to ensure the safety of this group. Parents will receive a plain language statement and written informed consent will be sought from the parents of the children. The children themselves will also be given information about the study (verbally and/or in picture form as is deemed appropriate). The children will be asked to indicate before each session if they wish to take part and will be able to ask for a break or to terminate the session at any point. The short length of the experimental sessions (max 30 mins) and the frequency of breaks mean that boredom and frustration are unlikely. The researcher will look for signs of these and will terminate the sessions as appropriate. The sessions will be beneficial for the children as they will teach categories that were previously unknown.

Participants: Children aged 3-6 (n=5) will be sampled from Dublin based child care facility and or specialised education centre and schools with which the researchers have previously collaborated. For Experiment 1 five children with ASD will be recruited from within a special education school. In Experiment 2 five typically developing children will be recruited from childcare facilities such as crèches and afterschool facilities. The participants with the highest receptive language scores from both populations will be recruited to participate and the other children will be retained as back up participants. Children with low levels of receptive language (pre-test), extensive pre-existing category knowledge or major visual or motor problems will be excluded from the study. Parents will be sent an information sheet through the facility and their child will be invited to take part in the study. Informed consent will be sought from parents/guardians. Due to their young age, it will not be possible to get signed consent from the children themselves but the process will be explained to them verbally and in picture form and they will be asked if they wish to participate before each session. Typically developing children may give written consent and this has been accounted for (see Appendix 4 for sample).

It is important to note that the research project is being conducted within the area of behaviour analysis in which research is often single subject or of small numbers (Kazdin, 2010). Any sample sizes mentioned are entirely consistent with previous research in the area, including that published in the flagship journals of behaviour analysis, the Journal of Applied Behavior Analysis (JABA) and the Journal of the Experimental Analysis of Behaviour (JEAB).

2.5 MEANS BY WHICH PARTICIPANTS ARE TO BE RECRUITED *(see Guidelines)*

All facilities to be approached by the researcher are listed public on the Department of Education and Sciences websites and also that of the Health Service Executives. The researcher has worked within the preschool and primary level education sector for over 10 years. Research contacts are already available within one special education preschool and one childcare facility offering after school programs. Other facilities will be recruited as necessary. Once ethical approval has been granted these facilities will take the research proposal to their board or director and a letter of acceptance will be made available.

Where new facilities are to be recruited the researcher will make initial contact via telephone identify herself and ask to speak to the owner or manager of the facility. If unavailable an appointment or return call will be requested. The researcher will establish if the facility is willing to participate in research studies. If the facility is one which is will to accept researchers into their facilities then a brief description of the project will be given. The researcher will offer to send the information packs and consent by either mailing electronically or via postal service.

Parents will be approached by the facility and an information pack given, where appropriate the researcher will organize a site visit to meet parents and answer any questions they may have. A deadline for returning of pack will be agreed with the facility such as a two week period.

2.6 PLEASE EXPLAIN WHEN, HOW, WHERE, AND TO WHOM RESULTS WILL BE DISSEMINATED, INCLUDING WHETHER PARTICIPANTS WILL BE PROVIDED WITH ANY INFORMATION AS TO THE FINDINGS OR OUTCOMES OF THE PROJECT?

The proposed research will firstly form one part of the researchers PhD research area and will therefore be subject to examination in the form of a thesis. The proposed will be written up for publication in peer reviewed flagship journals in the area such as the Journal of Applied Behaviour Analysis, and the Journal of the Experimental Analysis of Behaviour. Dissemination of the findings will also take place at national and international conferences including those of the Psychological Society of Ireland (including the Division of Behaviour Analysis), the Association for Behaviour Analysis (International).

2.7 OTHER APPROVALS REQUIRED *Has permission to gain access to another location, organisation etc. been obtained? Copies of letters of approval to be provided when available.*

☐ YES ☒ NO ☐ NOT APPLICABLE

(If YES, please specify from whom and attach a copy. If NO, please explain when this will be obtained.)

A letter of approval to conduct research at the respective facilities will be granted once ethical approval has been granted for the study.

2.8 HAS A SIMILAR PROPOSAL BEEN PREVIOUSLY APPROVED BY THE REC?

☐ YES ☒ NO

(If YES, please state both the REC Application Number and Project Title)

3. RISK AND RISK MANAGEMENT

3.1 ARE THE RISKS TO SUBJECTS AND/OR RESEARCHERS ASSOCIATED WITH YOUR PROJECT GREATER THAN THOSE ENCOUNTERED IN EVERYDAY LIFE?

☐ YES ☒ NO *If YES, this proposal will be subject to full REC review*
If NO, this proposal may be processed by expedited administrative review

3.2 DOES THE RESEARCH INVOLVE:

	YES	NO
• use of a questionnaire? (attach copy)?	☐	☒
• interviews (attach interview questions)?	☐	☒
• observation of participants without their knowledge?	☒	☐
• participant observation (provide details in section 2)?	☒	☐
• audio- or video-taping interviewees or events?	☐	☒
• access to personal and/or confidential data (including student, patient or client data) without the participant's specific consent?	☐	☒
• administration of any stimuli, tasks, investigations or procedures which may be experienced by participants as physically or mentally painful, stressful or unpleasant during or after the research process?	☐	☒
• performance of any acts which might diminish the self-esteem of participants or cause them to experience embarrassment, regret or depression?	☐	☒
• investigation of participants involved in illegal activities?	☐	☒
• procedures that involve deception of participants?	☐	☒
• administration of any substance or agent?	☐	☒
• use of non-treatment of placebo control conditions?	☐	☒
• collection of body tissues or fluid samples?	☐	☒
• collection and/or testing of DNA samples?	☐	☒
• participation in a clinical trial?	☐	☒
• administration of ionising radiation to participants?	☐	☒

3.3 POTENTIAL RISKS TO PARTICIPANTS AND RISK MANAGEMENT PROCEDURES *(see Guidelines)*

No adverse effects expected. There is a possibility of challenging behaviour but the use of break cards are designed to minimize this risk. Possible benefits for participants involved if successful will be acquired knowledge of categories which are relevant to their daily lives. Other benefits such as the ability to understand complex instructions for example, versus having to follow daily instructions of put on your t-shirt and jumper, the individual may learn to respond in the same way to, put on your clothes. The use of a procedure as designed here may direct other research in methods for teaching young children.

3.4 ARE THERE LIKELY TO BE ANY BENEFITS (DIRECT OR INDIRECT) TO PARTICIPANTS FROM THIS RESEARCH?

☒ YES ☐ NO *(If YES, provide details.)*

Possible benefits for participants involved if successful will be acquired knowledge of categories which are relevant to their daily lives. Other benefits such as the ability to understand complex instructions for example, versus having to follow daily instructions of put on your t-shirt and jumper, the individual may learn to respond in the same way to, put on your clothes. The use of a procedure as designed here may direct other research in methods for teaching young children.

3.5 ARE THERE ANY SPECIFIC RISKS TO RESEARCHERS? *(e.g. risk of infection or where research is undertaken at an off-campus location)*

☐ YES ☒ NO *(If YES, please describe.)*

3.6 ADVERSE/UNEXPECTED OUTCOMES *(see Guidelines)*

The study has been designed to account for the population and ages of the participants. The use of the visual and textual instructions board and the additional pictorial and verbal representation added to the participants' daily schedule is designed to help participants during the study developed predictability of what is required of them during the study. The sessions are designed to be short no longer than 30 minutes in total (including breaks) ensuring that participants access rewards frequently and eliminating frustration due to boredom or repetition.

A secondary selection of reinforcing items determined through preference assessment as having a middle level value will be made available to any participant whom does not earn any tokens during the experiment. Access to these items will be set at one minute and this will be communicated to the student either verbally or through the use of a pictorial representation at the beginning of each experimental session.

In addition, a break card will be placed on the computer station within reach of the participants. This will act as a means for them to communicate any distress during any of the experimental sessions. For both experimental populations some of the participants may already have a means of communicating distress via verbal or augmentative communication and any form will be accepted during the experiment. If a participant communicates distress the experiment will be stopped and resumed at a later stage. The duration of the break will be no longer than one day. Participants within Experiment 1 or Experiment 2 who communicate distress across five consecutive experimental sessions may be excluded from the study

3.7 MONITORING *(see Guidelines)*

All experimental phases will be run by the experimenter. Occasionally additional experimenters will be required but if this is required it would be regarding computerized training and testing phases only, training will be given by the experimenter. Any additional experimenters will be DCU psychology students. All data for computerized phases are collected electronically per occurrence and recorded manually. Data will be checked and verified by the researcher following each experimental session. All participants follow the same instructions which are laid out in a visual and textual instruction board so there would be no change in the instructions participants receive. Meetings will take place on a regular basis and weekly updates will be given to the principal investigator and others as necessary. Supervision will be given by the Chief Investigator weekly or more frequently if deemed necessary.

3.8 SUPPORT FOR PARTICIPANTS *(see Guidelines)*

Many children with a diagnosis of Autistic Spectrum Disorder often present with a communication disorder, however, the typically developing population to be included in this study may not have a previously diagnosed communication disorder. If during the experiment the language assessment Preschool Language Scale -5 (PLS-5) indicates that a delay maybe present supports will be offered to the parents in the form of contact details for formal speech and language assessment.

The PLS-5 was recently updated to include information about the significance of discrepancies between auditory comprehension (receptive language) and expressive communication. Current research indicates that "many children who have a language delay or language disorder exhibit a large discrepancy between their receptive and expressive language skills." The PLS-5 includes information and guidance for evaluating the difference between a child's receptive and expressive language scores. This information includes a process to determine if the difference between the two scores is statistically significant. According to the PLS-5 Examiner's Manual, "When the absolute value difference between two standard scores is statistically significant, the difference is considered to be a true difference rather than due to measurement error or random fluctuation". The Manual then quotes research from Sattler (2008): "… differences between standard scores that occur in less than 10% to 15% of the normative sample should be considered unusual." Such differences between scores occur very infrequently in the normative population. Therefore, it is the discrepancy between the child's receptive and expressive language versus an overall total language score that is indicative of a communication disorder. The fact that this issue has been included in the scoring procedures for the PLS-5, which consists of normative data on 1400 children from 2010, supports this position

3.9 DO YOU PROPOSE TO OFFER PAYMENTS OR INCENTIVES TO PARTICIPANTS?

☐ YES ☒ NO *(If YES, please provide further details.)*

3.10 DO ANY OF THE RESEARCHERS ON THIS PROJECT HAVE A PERSONAL, FINANCIAL OR COMMERCIAL INTEREST IN ITS OUTCOME THAT MIGHT INFLUENCE THE INTEGRITY OF THE RESEARCH, OR BIAS THE CONDUCT OR RESULTS OF THE RESEARCH, OR UNDULY DELAY OR OTHERWISE AFFECT THEIR PUBLICATION?

☐ YES ☒ NO *(If Yes, please specify how this conflict of interest will be addressed.)*

4. INVESTIGATORS' QUALIFICATIONS, EXPERIENCE AND SKILLS *(Approx. 200 words – see Guidelines)*

The project will be managed by Dr Sinéad Smyth. Dr Smyth has previous experience managing projects at undergraduate, MSc and PhD level. The researcher Ronda Barron who will undertake the research has already completed a taught MSc in the area and has over ten years' experience working with children with and without developmental delay. Co-supervision of the PhD student will be undertaken by Prof Julian Leslie (University of Ulster) and Dr Pamela Gallagher (DCU), who have extensive experience in the areas of Derived Relational Responding (DRR) (Prof Leslie) and psychological research more generally (both Prof Leslie & Dr Gallagher).

5. CONFIDENTIALITY/ANONYMITY

5.1 WILL THE IDENTITY OF THE PARTICIPANTS BE PROTECTED?

☒ YES ☐ NO *(If NO, please explain)*

IF YOU ANSWERED YES TO 5.1, PLEASE ANSWER THE FOLLOWING QUESTIONS:

5.2 **HOW WILL THE ANONYMITY OF THE PARTICIPANTS BE RESPECTED?** *(see Guidelines)*

Confidentially of all participants will be respected and each participant will be given a participant identification number e.g. P1. The participants will know the researcher by name and the researcher will know the participants by name therefore anonymity cannot be respected in this circumstance.

5.3 **LEGAL LIMITATIONS TO DATA CONFIDENTIALITY:** *(Have you included appropriate information in the plain language statement and consent form? See Guidelines)*

☒ YES ☐ NO *(If NO, please advise how participants will be advised.)*

Participants will be advised within the introductory letter and plain language statement.

6 DATA/SAMPLE STORAGE, SECURITY AND DISPOSAL *(see Guidelines)*

6.1 **HOW WILL THE DATA/SAMPLES BE STORED?** *(The REC recommends that all data be stored on campus)*

Stored at DCU ☒
Stored at another site ☐ **(***Please explain where and for what purpose)*

6.2 **WHO WILL HAVE ACCESS TO DATA/SAMPLES?**

Access by named researchers only ☒
Access by people other than named researcher(s) ☒ **(***Please explain who and for what purpose)*
Other : ☐ **(***Please explain)*
Data will be accessed in the form of a PhD thesis by PhD examiners.

6.3 **IF DATA/SAMPLES ARE TO BE DISPOSED OF, PLEASE EXPLAIN HOW, WHEN AND BY WHOM THIS WILL BE DONE?**

Data will be destroyed after six years, the data will be stored in DCU and therefore documents will be shredded following DCU policy. Disposal will be conducted by the researcher and/or the Principal Investigator.

7. FUNDING

7.1 **HOW IS THIS WORK BEING FUNDED?**

The experimenter Ronda Barron is a full time PhD student in the School of Nursing and Human Sciences currently being funded through the School of Nursing and Human Sciences Post Doctoral staff grant awarded to Dr. Sinead Smyth.

7.2 **PROJECT GRANT NUMBER (If relevant and/or known)**
N/A

7.3 **DOES THE PROJECT REQUIRE APPROVAL BEFORE CONSIDERATION FOR FUNDING BY A GRANTING BODY?**

☐ YES ☒ NO

7.4 **HOW WILL PARTICIPANTS BE INFORMED OF THE SOURCE OF THE FUNDING?**

This information will be provided on the information sheet given to participants' parents/guardians.

7.5 DO THE FUNDERS OF THIS PROJECT HAVE A PERSONAL, FINANCIAL OR COMMERCIAL INTEREST IN ITS OUTCOME THAT MIGHT COMPROMISE THE INDEPENDENCE AND INTEGRITY OF THE RESEARCH, OR BIAS THE CONDUCT OR RESULTS OF THE RESEARCH, OR UNDULY DELAY OR OTHERWISE AFFECT THEIR PUBLICATION?

☐ YES ☒ NO *(If Yes, please specify how this conflict of interest will be addressed.)*

8. PLAIN LANGUAGE STATEMENT *(Approx. 400 words – see Guidelines)*

Parents will receive a plain language statement and written informed consent will be sought from the parents of the children. The children themselves will also be given information about the study verbally and/or in picture form as is deemed appropriate (see appendix 4).

Experiment 1 Plain Language Statement ASD population

Introduction to the Research Study

You are being asked to allow your child to take part in a research study designed to teach category membership to young children. The study entitled "Derived Categorisation in Young children" is being conducted by Ronda Barron a PhD student in the School of Nursing and Human Sciences, Dublin City University and is supervised by Principal Investigator, Dr Sinéad Smyth of the School of Nursing and Human Sciences, Dublin City University. This study is being funded through the School of Nursing and Human Sciences Post Doctoral staff grant awarded to Dr. Sinead Smyth.

Purpose

The purpose of this study is to investigate a method for teaching young children with a diagnosis of Autistic Spectrum Disorder to categorise objects without direct training. In other words, teaching them to group common objects of a category for example, animals or food together without directly teaching every object to the category. For example, through teaching a child that shoes are a type of clothes and later that socks belong in the same category, the child may identify without being directly taught that socks are clothes. Importantly, the categories used will have relevance to each individual child (e.g., food, toys, clothing etc.) and will teach categories previously unknown to him/her.

Benefits

Categorisation is an important skill for the development of receptive language ability, which is our ability to understand spoken language. A very simple computer based program will be used to train pairs of objects (e.g. apple, banana and orange) children may then be able to demonstrate other similar pairings that are not directly taught (e.g. apple, banana, orange, pear and grape). Previous research has indicated that this teaching method will help to increase the skills of the children involved and that it may also help in the development of current teaching procedures. Spoken language is not a necessary criterion for participation in this study.

Confidentiality

All participant information will be treated as confidential, and in no case will it be possible to identify participants either during the study or from the final written report. Data collection will include written reports, and computerized responding on the learning task. In both cases, children will be given a participant code (e.g. P1) and real names will not be used. This information will be store separately from the signed consent form. Data will be held on a password protected computer stored in a locked office at DCU, backup of data and any written material will be stored in a filing cabinet. Data will be destroyed following a six year period.

The experimenter will have direct contact with your child and will know them by name. This means that your child will not be anonymous to the experimenter. However, as outlined your child's identify will not be revealed to anyone other than the experimenter and chief investigator.

Participant confidentiality will be protected to the extent permitted by laws & regulations such as those described under The Child Protection Act. While it is not anticipated that any concerns could arise from participation is the study the procedures set out by your child facility/school under their policies will be followed under any such instance.

What will participation involve?

1. Participation will initially involve a language assessment and a test of your child's existing knowledge of different categories (e.g., food types, clothes etc.). This will help us to decide what categories need to be trained.

2. Once this has been completed, the computer training and testing will begin. Pictures of objects will be presented on the screen and your child will be asked to match them. At this stage, correct responses will be rewarded with points or tokens which can be exchanged for time to play with preferred items or activities, no food or liquids will be used at any stage of the experiment. Children can access breaks at any stage.

3. Following this training, a test will take place to see if your child has developed any pairing of objects that have not been directly trained. During this stage your child will not be told whether their responses are correct or not.

4. Finally, post testing will involve the re-administration of the category sort task for the trained objects as well as the re-administration of the language assessment. This will allow a comparison of before and after the computerised training.

Risk

Your child will simply be asked to complete sorting and matching tasks on a computer and with picture cards. No risks to your child are anticipated (i.e., nothing above the level of risk encountered in daily life). Steps have been taken to avoid any possible frustration and/or boredom and therefore the children will be able to ask for a break at any stage during the experiment using their individual mode of communication (e.g., Picture exchange, sign language or vocally). If your child does not earn tokens he/she will be given one minute access to a selection of other preferred items/activities.

How long will participation take?

The total length of participation for each child is estimated at 24 weeks. Two sessions will be conducted weekly and the duration of each session will be no longer than 30 minutes (including breaks), sessions will be conducted during your child's school day. A follow up for language assessment will be conducted 6 months following the original start date. Categorisation is a very useful skill for children to learn and this study might add to the general skills that your child is being taught on a daily basis.

The researchers will answer any further questions about the research, now or during the course of the project, and contact details are presented below:

Dr. Sinead Smyth
Rm H245D
School of Nursing and Human Sciences
Dublin City University
Dublin 9
Email: sinead.smyth@dcu.ie
Ph: 01 700 5000 EXT: 7422

Ronda Barron

School of Nursing and Human Sciences
Dublin City University
Dublin 9
Email: ronda.barron2@mail.dcu.ie

If participants have concerns about this study and wish to contact an independent person, please contact:

The Secretary, Dublin City University Research Ethics Committee, c/o Office of the Vice-President for Research, Dublin City University, Dublin 9. Tel 01-7008000

Experiment 2 Plain Language Statement typically developing population

Introduction to the Research Study

You are being asked to allow your child to take part in a research study designed to teach category membership to young children. The study entitled "Derived Categorisation in Young children" is being conducted by Ronda Barron a PhD student in the School of Nursing and Human Sciences, Dublin City University and is supervised by Principal Investigator, Dr Sinéad Smyth of the School of Nursing and Human Sciences, Dublin City University. This study is being funded through the School of Nursing and Human Sciences Post Doctoral staff grant awarded to Dr. Sinead Smyth.

Purpose

The purpose of this study is to investigate a method for teaching young children to categorise objects without direct training. In other words, teaching them to group common objects of a category for example, animals or food together without directly teaching every object to the category. For example, through teaching a child that shoes are a type of clothes and later taught socks belong in the same category, the child may identify without being directly taught that socks are clothes. Importantly, the categories used will have relevance to each individual child (e.g., food, toys, clothing etc.) and will teach categories previously unknown to him/her.

Benefits

Categorisation is an important skill for the development of receptive language ability, which is our ability to understand spoken language. **A** very simple computer based program will be used to train pairs of objects (e.g. apple, banana and orange) children may then be able to demonstrate other similar pairings that are not directly taught (e.g. apple, banana, orange, pear and grape). Previous research has indicated that this teaching method will help to increase the skills of the children involved and that it may also help in the development of current teaching procedures.

Confidentiality

All participant information will be treated as confidential, and in no case will it be possible to identify participants either during the study or from the final written report. Data collection will include written reports, and computerized responding on the learning task. In both cases, children will be given a participant code (e.g. P1) and real names will not be used. This information will be store separately from the signed consent form. Data will be held on a password protected computer stored in a locked office at DCU, backup of data and any written material will be stored in a filing cabinet. Data will be destroyed following a six year period.

The experimenter will have direct contact with your child and will know them by name. This means that your child will not be anonymous to the experimenter. However, as outlined your child's identify will not be revealed to anyone other than the experimenter and chief investigator.

Participant confidentiality will be protected to the extent permitted by laws & regulations such as those described under The Child Protection Act. While it is not anticipated that any concerns could arise from participation is the study the procedures set out by your child facility/school under their policies will be followed under any such instance.

What will participation involve?

1. Participation will initially involve a language assessment and a test of your child's existing knowledge of different categories (e.g., food types, clothes etc.). This will help us to decide what categories need to be trained.

2. Once this has been completed, the computer training and testing will begin. Pictures of objects will be presented on the screen and your child will be asked to match them. At this stage, correct responses will be

rewarded with points or tokens which can be exchanged for time to play with preferred items or activities, no food or liquids will be used at any stage of the experiment. Children can access breaks at any stage.

3. Following this training, a test will take place to see if your child has developed any pairing of objects that have not been directly trained. During this stage your child will not be told whether their responses are correct or not.

4. Finally, post testing will involve the re-administration of the category sort task for the trained objects as well as the re-administration of the language assessment. This will allow a comparison of before and after the computerised training.

Risk

Your child will simply be asked to complete sorting and matching tasks on a computer and with picture cards. No risks to your child are anticipated (i.e., nothing above the level of risk encountered in daily life). Steps have been taken to avoid any possible frustration and/or boredom and therefore the children will be able to ask for a break at any stage during the experiment using their individual mode of communication (e.g., Picture exchange, sign language or vocally). If your child does not earn tokens he/she will be given one minute access to a selection of other preferred items/activities.

How long will participation take?

The total length of participation for each child is estimated at 16 weeks. Two sessions will be conducted weekly and the duration of each session will be no longer than 30 minutes (including breaks), sessions will be conducted during your child's school day. A follow up for language assessment will be conducted 6 months following the original date. Categorisation is a very useful skill for children to learn and this study might add to the general skills that your child is being taught on a daily basis.

The researchers will answer any further questions about the research, now or during the course of the project, and contact details are presented below:

Dr. Sinead Smyth
Rm H245D
School of Nursing and Human Sciences
Dublin City University
Dublin 9
Email: sinead.smyth@dcu.ie
Ph: 01 700 5000 EXT: 7422

Ronda Barron

School of Nursing and Human Sciences
Dublin City University
Dublin 9
Email: ronda.barron2@mail.dcu.ie

If participants have concerns about this study and wish to contact an independent person, please contact:

The Secretary, Dublin City University Research Ethics Committee, c/o Office of the Vice-President for Research, Dublin City University, Dublin 9. Tel 01-7008000

9. INFORMED CONSENT FORM *(Approx. 300 words – see Guidelines)*

Consent form for experiment 1 ASD population

I give my consent for my child ___________________________ to participate in the research titled, "Derived Categorisation in Young children", being conducted by Ronda Barron a PhD student in the School of Nursing and Human Sciences, Dublin City University and Chief Investigator, Dr Sinéad Smyth of the School of Nursing and Human Sciences, Dublin City University. This study is being funded through the School of Nursing and Human Sciences Post Doctoral staff grant awarded to Dr. Sinead Smyth.

Purpose

The purpose of this study is to investigate a method for teaching young children with a diagnosis of Autistic Spectrum Disorder to categorise objects without direct training. That is, to group common objects of a category for example, animals or food together without directly teaching every object to the category. For example, through teaching a child that shoes are a type of clothes and later taught socks belong in the same category, the child may identify without being directly taught that socks are clothes. Importantly, the categories used will have relevance to each individual child (e.g., food, toys, clothing etc.) and will teach categories previously unknown to him/her.

Participant – please complete the following (Circle Yes or No for each question)

I have read the Information Sheet (or had it read to me)	*Yes/No*
I understand the information provided	*Yes/No*
I have had an opportunity to ask questions and discuss this study	*Yes/No*
I have received satisfactory answers to all my questions	*Yes/No*

Confirmation that involvement in the Research Study is voluntary

I understand that this participation is entirely voluntary; I or my child can withdraw consent at any time without penalty and have the results of the participation, to the extent that it can be identified as my child's, returned to me, removed from the research records, or destroyed	*Yes/No*

Confidentiality

All participant information will be treated as confidential, and in no case will it be possible to identify participants either during the study or from the final written report. Data collection will include written reports, and computerized responding on the learning task. In both cases, children will be given a participant code (e.g. P1) and real names will not be used. This information will be store separately from the signed consent form. Data will be held on a password protected computer stored in a locked office at DCU, backup of data and any written material will be stored in a filing cabinet. Data will be destroyed following a six year period.

The experimenter will have direct contact with your child and will know them by name. This means that your child will not be anonymous to the experimenter. However, as outlined your child's identify will not be revealed to anyone other than the experimenter and chief investigator.

Participant confidentiality will be protected to the extent permitted by laws & regulations such as those described under The Child Protection Act. While it is not anticipated that any concerns could arise from participation is the study the procedures set out by your child facility/school under their policies will be followed under any such instance.

I have read and understood the information in this form. My questions and concerns have been answered by the researchers, and I have a copy of this consent form. Therefore, I consent to take part in this research project

Participants/Parents Signature: ______________________________

Name in Block Capitals: ______________________________

Witness: ______________________________

Date: ______________________________

If participants have further questions about this study or their rights, or if they wish to lodge a complaint or concern, they may contact:

The Chief Investigator, Dr. Sinead Smyth, School of Nursing and Human Sciences, Dublin City University, Dublin 9. Ph: 01 700 5000 EXT: 7422

If participants have concerns about this study and wish to contact an independent person, please contact:

The Secretary, Dublin City University Research Ethics Committee, c/o Office of the Vice-President for Research, Dublin City University, Dublin 9. Tel 01-7008000

Consent form for experiment 2 typically developing population

I give my consent for my child ______________________ to participate in the research titled, "Derived Categorisation in Young children", being conducted by Ronda Barron a PhD student in the School of Nursing and Human Sciences, Dublin City University and Chief Investigator, Dr Sinéad Smyth of the School of Nursing and Human Sciences, Dublin City University. This study is being funded through the School of Nursing and Human Sciences Post Doctoral staff grant awarded to Dr. Sinead Smyth.

Purpose

The purpose of this study is to investigate a method for teaching young children with a diagnosis of Autistic Spectrum Disorder to categorise objects without direct training. That is, to group common objects of a category for example, animals or food together without directly teaching every object to the category. For example, through teaching a child that shoes are a type of clothes and later taught socks belong in the same category, the child may identify without being directly taught that socks are clothes. Importantly, the categories used will have relevance to each individual child (e.g., food, toys, clothing etc.) and will teach categories previously unknown to him/her.

Participant – please complete the following (Circle Yes or No for each question)

I have read the Information Sheet (or had it read to me)	*Yes/No*
I understand the information provided	*Yes/No*
I have had an opportunity to ask questions and discuss this study	*Yes/No*
I have received satisfactory answers to all my questions	*Yes/No*

Confirmation that involvement in the Research Study is voluntary

I understand that this participation is entirely voluntary; I or my child can withdraw consent at any time without penalty and have the results of the participation, to the extent that it can be identified as my child's, returned to me, removed from the research records, or destroyed	*Yes/No*

Confidentiality

All participant information will be treated as confidential, and in no case will it be possible to identify participants either during the study or from the final written report. Data collection will include written reports, and computerized responding on the learning task. In both cases, children will be given a participant code (e.g. P1) and real names will not be used. This information will be store separately from the signed consent form. Data will be held on a password protected computer stored in a locked office at DCU, backup of data and any written material will be stored in a filing cabinet. Data will be destroyed following a six year period.

The experimenter will have direct contact with your child and will know them by name. This means that your child will not be anonymous to the experimenter. However, as outlined your child's identify will not be revealed to anyone other than the experimenter and chief investigator.

Participant confidentiality will be protected to the extent permitted by laws & regulations such as those described under The Child Protection Act. While it is not anticipated that any concerns could arise from participation is the study the procedures set out by your child facility/school under their policies will be followed under any such instance.

I have read and understood the information in this form. My questions and concerns have been answered by the researchers, and I have a copy of this consent form. Therefore, I consent to take part in this research project

Participants/Parents Signature: ______________________________

Name in Block Capitals: ______________________________

Witness: ______________________________

Date: ______________________________

If participants have further questions about this study or their rights, or if they wish to lodge a complaint or concern, they may contact:

The Chief Investigator, Dr. Sinead Smyth, School of Nursing and Human Sciences, Dublin City University, Dublin 9. Ph: 01 700 5000 EXT: 7422

If participants have concerns about this study and wish to contact an independent person, please contact:

The Secretary, Dublin City University Research Ethics Committee, c/o Office of the Vice-President for Research, Dublin City University, Dublin 9. Tel 01-7008000

References

Barron, R., Smyth, S., & Leslie, J. C., (under preparation). *An individualised programme of real world category training in preschool children with autism spectrum disorder.*

Kazdin, A. E. (2010). *Single-Case Research Designs: Methods for Clinical and Applied Settings.* USA: Oxford University Press.

Miguel, C. F., Petursdottir, A. I., Carr, J. E., & Michael, J. E. (2008). The role of naming in stimulus categorization by preschool children. *Journal of the Experimental Analysis of Behavior, 89,* 383-405.

Moran, L., Stewart, I., McElwee, J., & Ming, S. (2010). The Training and Assessment of Relational Precursors and Abilities (TARPA): a preliminary analysis. *Journal of autism and developmental disorders, 40*(9), 1149-53. doi:10.1007/s10803-010-0968-0

Ninness, C., Rumph, R., McCuller, G., Harrison, C., Ford, A. M., & Ninness, S. K. (2005). A functional analytic approach to computer-interactive mathematics. *Journal of Applied Behavior Analysis, 38(1)*, 1-22. doi:10.1901/jaba.2005.2-04

Rehfeldt, R. A. (2011). Toward a technology of derived stimulus relations: an analysis of articles published in the journal of applied behavior analysis, 1992-2009. *Journal of Applied Behavior Analysis,*, *44*(1), 109-19. doi:10.1901/jaba.2011.44-109

Sundberg, M. L., & Partington, J.W. (1998). Teaching language to children with autism or other developmental disabilities. Danville, CA: Behavior Analysts, Inc.

Ungerer, J., &Sigman, M. (1987). Categorization skills and receptive language development in autistic children. *Journal of Autism and Developmental Disorders, 17,* 3-16

Appendix 1

Office of the Vice-President for Research

Memo

To: Professor J Leslie, G122, L&HS, CE

From: Elaine McCormick, Research Governance Section, 1H12, Jordanstown

Date: **Ref:** EM/JD

University of Ulster
Research Ethics Committee

Project Number: REC/11/0368

Project Title: Derived categorisation in young children

Outcome: Approved to proceed subject to amendment – to be reviewed by the Research Office

Please find attached the comments of the Research Ethics Committee on your recent application.

<u>You should address these comments point by point in a covering letter and highlight or underline any revisions made to the application and associated materials.</u> Please send your response (either 1 copy, or by e-mail to e.mccormick@ulster.ac.uk) to the Research Governance section. You should note that your application does not require to be resubmitted for reconsideration at a future meeting, but you should also note that you cannot commence any research on human subjects until your response has been considered and a letter of approval has been issued.

If you have any queries, please contact Nick Curry or Elaine McCormick.

If you do not intend to proceed with the project or if you anticipate a significant delay in responding to the concerns of the committee, please contact the Research Governance section.

I look forward to hearing from you in the near future. Please quote the **Project Number** in all correspondence.

Thank you and best wishes.

Elaine McCormick
Admin Officer
Research Governance
e,mccormick@ulster.ac.uk
Ext: 66518

Last updated February 2012 Page 25

App No REC/11/0368

Title: Derived categorisation in young children

Outcome 3a – Approved to proceed subject to amendment; to be reviewed by the Research Office

Comments/requirements:

1. Please ensure that a letter of permission to conduct the study is obtained from the school principal. This should be lodged with Research Governance before the study commences.
2. Please clarify how the parents will be approached regarding recruitment.
3. The language in the information sheet is possibly too technical and dense. Is it appropriate for parents who might be non-expert? Can it be revised?
4. Please clarify the recruitment process for normally developing children. How will pre-selection work and could appendix 12 be reviewed to make it more child-friendly (eg, cartoons and bigger typeface rather than photos etc)?

Appendix 2: Information regarding the Play and Language Scale – 3 similar to the assessment which will be used for Pre and post experimental testing, a copy of the scoring sheet is also attached.

PLS-3 is a standardized and norm referenced evaluation tool used to assess receptive and expressive language skills in infants and young children (2 weeks through 6 years, 11 months of age). It also assesses behaviors considered to be language precursors. The tool directly screens children and interviews caregivers.

The auditory comprehension subscale is used to evaluate the child's receptive language skills in the areas of attention; semantics (context) - vocabulary and concepts; structure (form) - morphology and syntax; and integrative thinking skills. The expressive communication subscale is used to assess expressive language in the areas of vocal development; social communication; semantics (content) -- vocabulary and concepts; structure (form) -- morphology and syntax; and integrative thinking skills.

There are three supplemental, optional measures: Articulation Screener; Language Sample Checklist; and Family Information and Suggestions Form. The guidelines for modifying administration for children with severe developmental delays, severe physical impairments, and hearing impairments are provided in the manual.

PLS-3 (UK)

Name ____________ Address ____________

Age ________ Gender F ___ M ___ School ____________

Teacher ____________ Examiner ____________

PRESCHOOL LANGUAGE SCALE-3(UK)

	Day	Month	Year
Date of Test			
Date of Birth			
Chronological Age			

	RAW SCORE CALCULATION		NORM-REFERENCED SCORES					
			Standard Score (SS)	SS Confidence Interval (-% level)	Percentile Rank (PR)	PRs for SS Confidence Interval values	Age Equivalents	Age Equivalent Confidence Interval
Auditory Comprehension	Last AC task administered							
	Minus number of 0 scores	–						
	AC RAW SCORE			to		to		to
Expressive Communication	Last EC task administered							
	Minus number of 0 scores	–						
	EC RAW SCORE			to		to		to
Total Language Score	AC Standard Score							
	plus EC Standard Score	+						
	STANDARD SCORE TOTAL			to		to		
	AC Raw Score + EC Raw Score							to

Supplementary Measures

Articulation Screener Raw Score ______	☐ indicates performance typical of age-peers ☐ may indicate need for further evaluation ☐ strongly indicates need for further evaluation
Language Sample Checklist	☐ reinforces information obtained on PLS-3 (UK) ☐ differs greatly from information obtained on PLS-3 (UK)
Background Information Form	☐ reinforces information obtained on PLS-3 (UK) ☐ differs greatly from information obtained on PLS-3 (UK)

Other test scores/relevant data

	Standard Scores	AC Score	EC Score	Total Score	Standard Scores
	150	•	•	•	150
+3SD	145	•	•	•	145
	140	•	•	•	140
	135	•	•	•	135
+2SD	130	•	•	•	130
	125	•	•	•	125
	120	•	•	•	120
+1SD	115	•	•	•	115
	110	•	•	•	110
	105	•	•	•	105
Mean	100	•	•	•	100
	95	•	•	•	95
	90	•	•	•	90
-1SD	85	•	•	•	85
	80	•	•	•	80
	75	•	•	•	75
-2SD	70	•	•	•	70
	65	•	•	•	65
	60	•	•	•	60
-3SD	55	•	•	•	55
	50	•	•	•	50

See Chapter 5 in the *Examiner's Manual* to determine whether the difference between AC and EC scores is significant.

Published by The Psychological Corporation Limited, 32 Jamestown Rd, London NW1 7BY. Adapted by The Psychological Corporation Limited, by permission. Printed in the United Kingdom. ISBN: 0 7491 0635 2.

THE PSYCHOLOGICAL CORPORATION LIMITED

Starting point: Begin testing at the age level one year below the child's chronological age. Exceptions: Begin with task 1 for children under 1 year, 6 months. Begin with task 37 for children over 5 years, 11 months.
To score: Mark "✓" (correct response), "–" (incorrect response) or "NR" (no response) in the blanks. Pass criteria for numbered tasks are shown in parentheses below the task stimulus. Score "1" in the box if the pass criterion is met; score "0" if the pass criterion is not met.
Baseline: Three consecutive "1" scores prior to the first "0" score. (See manual if double baseline obtained.)
Ceiling: Five consecutive "0" scores.

Note: Items with an asterisk (*) can be scored as a "1" if you observe the child performing the behaviour spontaneously.

0 – 0 to 0 – 5 (Birth to 5 months)

Auditory Comprehension

1. *Looks intently at a speaker ____
(Pass: Watches the speaker's face during play)

2. Reacts to the sound of kitchen foil
Materials: Kitchen foil
Keep the foil out of the child's reach ____
(Pass: Reacts to the sound of foil)

3. *Turns head to locate the source of sound ____
(Pass: Turns head to locate any sound)

4. Discriminates one sound from another ____
Materials: Kitchen foil, keys
(Pass: After getting used to and ignoring the foil, reacts to the keys)

Expressive Communication

1. *Vocalizes a variety of pleasure and displeasure sounds
Pleasure: laughs ___ gurgles ___ giggles ___ squeals ___ chuckles ___ other: ____
Displeasure: cries: ___ screams ___ fusses ___ other: ____
(Pass: Vocalizes a minimum of two pleasure or displeasure sounds)

2. *Vocalizes when talked to (vocal contagion) ____
(Pass: Responds to speech by vocalizing)

3. *Laughs
Materials: Teddy
Tickle or play with the child ____
(Pass: Smiles and makes any sound showing pleasure)

4. *Engages in solitary vocal play ___
(Pass: Coos or babbles)

0 – 6 to 0 – 11 (6 to 11 months)

Auditory Comprehension

5. Anticipates an event or a signal
Materials: Teddy
Repeat four times: **"Teddy's going to kiss the baby!"** Move Teddy towards the child. **"Kiss the baby!"** ____
(Pass: Anticipates Teddy's movement)

6. Follows line of regard (joint attention)
Materials: Teddy
Walk Teddy across the table. **"Teddy's going for a walk."**
Drop Teddy off the edge. **"Uh-oh!"**
Look over the edge. **"Is Teddy over there?"** ___
(Pass: Follows your gaze when you look *away* from where Teddy disappeared)

7. *Responds to "No" ____
Materials: Ball
(Pass: Withdraws or pauses before reaching for ball when you say **"No"**)
Note: Observe the child's response to **"No"** if the child's caregiver happens to tell the child **"No"** spontaneously during the testing.

8. *Understands a specific word or phrase (other than "No") ____
Write the word or phrase here: ____
(Pass: Responds to a specific word or phrase)

Expressive Communication

5. *Combines sounds to form syllables ___
Write examples below: ____
(Pass: Produces two different sound combinations)

6. *Approximates sounds made by another person ___
(Pass: Vocalizes similar sounds when someone vocalizes to him/her)

7. *Communicates nonverbally, using gestures or pushing and pulling behaviours ____
(Pass: Spontaneously gestures without a model from you or the caregiver; pushes or pulls someone to communicate a message)

8. *Produces at least four different consonant-like sounds ____
Write the sounds produced below: ____
(Pass: Produces four or more different consonant-like sounds)

2

1 – 0 to 1 – 5 (12 to 17 months)

9. *Maintains attention for two minutes ___
Materials: Toys or books
(Pass: Plays with you, a toy, or a book for two or more minutes)

10. Follows simple instructions with cues
Materials: Ball, shoe box, keys
a. Place the keys near the child. **"Give me the keys."** ___
b. Place the box on the table. Hand the ball to the child. **"Put the ball in the box."** ___
c. Roll the ball to the child, then hold out your hands. **"Throw the ball."** ___
(Pass: Two correct)

11. Identifies familiar objects
Materials: Spoon, mug, sock, ball
"Give me the ...."
a. **ball** ___ b. **sock** ___ c. **spoon** ___
(Pass: Consistently identifies one object)

12. Identifies pictures
Materials: *Picture Manual*, p. 1
"Look at the pictures. Where is the ...?" a. **dog** ___ b. **baby** ___
(Pass: Consistently points to one picture)

9. *Has a vocabulary of at least one word ___
Sound combination: ___
Word represented: ___
(Pass: Consistently uses the same sound combination for an object or a person)

10. *Initiates a game or social routine ___
Describe what the child does below:
___
(Pass: Initiates play with examiner or caregiver)

11. *Varies the sounds produced in syllable strings ___
Write examples below:
___
(Pass: Produces three to four syllables in one breath, varying the sounds produced within the sequence)

12. *Imitates a word
"Can you say ...?"
Tick the words the child imitates:
a. **Mummy** ___ b. **ball** ___
c. **bye-bye** ___ d. **doggie** ___
e. **biscuit** ___ f. other: ___
(Pass: Imitates one word)

1 – 6 to 1 – 11 (18 to 23 months)

13. Follows simple instructions without gestural cues
Materials: Brick, shoe box
a. **"Put the brick on the table."** ___
b. **"Put the brick in the box."** ___
c. **"Give the brick to me."** ___
(Pass: Two correct)

14. Identifies pictures
Materials: *Picture Manual*, p. 2
"Show me the ...."
a. **ball** ___ b. **shoe** ___ c. **spoon** ___ d. **mug** ___
(Pass: Two correct)

15. Indicates body parts on self
"Where is your ...?" a. **hair** ___ b. **eye** ___ c. **nose** ___ d. **foot** ___
e. **ear** ___ f. **hand** ___ g. **mouth** ___ h. **tummy** ___
(Pass: Four correct)

16. Understands verbs in context
Materials: Teddy, spoon, mug
a. **"Teddy's hungry. Give him something to *eat*."** ___
b. **"Teddy's thirsty. Give him something to *drink*."** ___
c. **"Teddy wants to sleep. Let teddy go to *sleep*."** ___
(Pass: Two correct)

13. *Has a vocabulary of at least 10 words ___
Write the words below:
___
(Pass: Spontaneously says at least 10 different words)

14. Names objects
Materials: Sock, ball, mug, brick
"What is this?" a. ball ___ b. sock ___ c. mug ___ d. brick ___
(Pass: Two correct)

15. *Produces a succession of single word utterances ___
(Pass: Produces a succession of two or three words to talk about an event, with a one- to two-second pause between words)
Note: If the child produces three words in one breath (no pauses between words), credit this task and task 18.

16. *Uses one pronoun
Point to the child's shoe. **"Is this *my* shoe?"** ___
(Pass: Uses *my*, *mine*, *you*, or *me* spontaneously in response to the question presented)

3

2 - 0 to 2 - 5 (24 to 29 months)

Auditory Comprehension

17. Understands spatial concepts
Materials: Shoe box, seven bricks
Arrange the bricks around the box: two in front, two beside, and two in the box.
Hand a brick to the child. a. **"Put the brick *in* the box."** ___
Turn the box upside down. Place two bricks on it, two in front, and two beside it. b. **"Take the bricks *off* the box."** ___
Place two bricks in the box and two bricks beside the box. c. **"Take the bricks *out of* the box."** ___
(Pass: Two correct)

18. Understands several pronouns
Materials: Teddy, three mugs, three spoons
"We're having a picnic. Everyone gets a mug. You take a mug."
a. **"Now give one to *me*."** ___ b. **"Give one to *him*."** ___
c. **"You take a spoon. Now give a spoon to *me*."** ___ d. **"Give one to *him*."** ___
e. **"Show me *your* spoon."** ___ f. **"Where's *my* spoon?"** ___
Pretend to eat, then say, **"The picnic's over! Let's put everything away!"**
(Pass: Four correct)

19. Understands quantity concepts
Materials: Eight bricks, shoe box
a. **"Give me just *one*."** ___ b. **"Put *some* bricks here."** ___
c. **"I'll put these bricks here. Put *the rest* of the bricks over there."** ___
d. **"Now put *all* the bricks in the box."** ___
(Pass: Two correct)

20. Recognizes action in pictures
Materials: *Picture Manual*, p. 3
"Point to …." a. **washing** ___ b. **playing** ___ c. **blowing** ___
(Pass: Two correct)

Expressive Communication

17. *Can express negation using negative forms (e.g., "no", "not", "no more") in a phrase.
Write examples below:

(Pass: Expresses a negative form plus at least one further word)

18. *Combines three or four words in spontaneous speech ______
Write examples below:

(Pass: Produces a three- or four-word phrase or sentence)

19. Name pictures
Materials: *Picture Manual*, p. 51
"What is this?"
a. book ___ b. car ___ c. bottle ___ d. banana ___ e. cat ___
(Pass: Four correct)

20. *Uses plurals
Materials: *Picture Manual*, p. 52
"What are these?"
a. socks ___
b. bricks ___
c. shoes ___
(Pass: One correct)

2 - 6 to 2 - 11 (30 to 35 months)

Auditory Comprehension

21. Understands use of objects
Materials: *Picture Manual*, p. 4
"Show me what …."
a. **you can ride** ___ b. **we use to sweep the floor** ___
c. **you use to do your hair** ___ d. **we use to cut paper** ___
(Pass: Two correct)

22. Understands descriptive concepts
Materials: *Picture Manual*, pp. 5–7
"Which one is …?" a. **big** ___ b. **wet** ___ c. **little** ___
(Pass: Two correct)

23. Understands part/whole relationships
Materials: *Picture Manual*, p. 8
"Show me the …."
a. **door of the car** ___ b. **nose of the cow** ___
c. **tail of the horse** ___ d. **wheels of the train** ___
(Pass: Three correct)

24. Understands pronouns
Materials: *Picture Manual*, pp. 9–11
"Show me …." a. **They are playing.** ___
b. **She is on the stairs.** ___ c. **He is in the pool.** ___
(Pass: Two correct)

Expressive Communication

21. Answers *what*, *where*, and *yes/no* questions
Materials: *Picture Manual*, p. 53
a. **"What is he holding?"** (pillow) ___
b. **"Is he sleeping?"** (no) ___
c. **"Where is the boy?"** (in the car) ___
(Pass: Two correct)

22. *Uses *verb* + '*–ing*'
Materials: *Picture Manual*, p. 54
"The boy is playing."
a. **"Tell me about the girl."** (eating) ___
b. **"Tell me about *this* girl."** (sleeping) ___
(Pass: One correct)

23. *Produces basic sentences
"Tell me about your pets." or **"Tell me about your (toys/sister/baby)."** ____
(Pass: Uses two or more four- to five-word sentences to answer)

24. *Uses possessives
Materials: *Picture Manual*, p. 55
a. **"This is the boy's cat. Whose cat is this?"** ___
b. **"This is the dog's food. Whose food is this?"** ___
(Pass: One correct; uses a possessive pronoun or the *'s* ending)

4

3 - 0 to 3 - 5 (36 to 41 months)

Auditory Comprehension

25. Understands descriptive concepts
Materials: *Picture Manual*, pp. 12–14
"Show me the …."
a. **one that is heavy** ___ b. **one that is empty** ___
c. **ones that are the same** ___
(Pass: Two correct)

26. Groups objects
Materials: *Picture Manual*, p. 15
"Show me all the …."
a. **things we eat** ___ b. **animals** ___
c. **toys** ___
(Pass: Two correct)

27. Understands negatives (*not + location* and *not + verb*)
Materials: *Picture Manual*, pp. 16–17
a. **"Which toy is not in the box?"** ___
b. **"Who is not eating?"** ___
(Pass: Two correct)

28. Identifies colours
Materials: *Picture Manual*, p. 18
"Show me the … one."
a. **red** ___ b. **orange** ___ c. **yellow** ___
d. **purple** ___ e. **green** ___ f. **blue** ___
(Pass: Four correct)

Expressive Communication

25. Describes how an object is used
"Tell me what you do with a …."
a. **spoon** ___
b. **towel** ___
c. **coat** ___
(Pass: Two correct)

26. Answers questions logically
"What do you do when …."
a. **you're sleepy** ___
b. **your hands are dirty** ___
c. **you're cold** ___
(Pass: Two correct)

27. *Uses several pronouns spontaneously
Uses *I, he, she, we,* and *they* in spontaneous conversation ___
(Pass: Uses any three pronouns listed)

28. Talks about remote events
a. **"What do you do when you've lost something?"** ___
b. **"What do you do before you cross the road?"** ___
(Pass: One correct)

3 - 6 to 3 - 11 (42 to 47 months)

Auditory Comprehension

29. Compares objects
Materials: *Picture Manual*, p. 19
"Which one is heavier, a … or a …?" a. **boot, shoe** ___
b. **bed, chair** ___ c. **lock, leaf** ___ d. **car, lorry** ___
(Pass: Three correct)

30. Makes inferences
Materials: *Picture Manual*, pp. 20–23
a. **"Charlie played outside and got his shoes all wet. What was it like outside?"** ___
b. **"Annie grazed her knees and elbows. How do you think Annie got hurt?"** ___
c. **"Rachel came home from school. She was very hungry. What do you think she did first?"** ___
d. **"Ben's dog was very dirty. What should Ben do?"** ___
(Pass: Three correct)

31. Identifies pictures
Materials: *Picture Manual*, pp. 24–27
"Show me the …."
a. **caterpillar** ___ b. **doctor** ___ c. **toolbox** ___ d. **triangle** ___
(Pass: Three correct)

32. Indicates body parts on self
"Show me your …."
a. **head** ___ b. **arm** ___ c. **knee** ___ d. **elbow** ___
e. **thumb** ___ f. **chin** ___ g. **eyebrow** ___
(Pass: Six correct)

Expressive Communication

29. Completes analogies
Say, **"Finish this for me."**
a. **"A ladybird is little. An elephant is…."** (big) ___
b. **"Ice cream is cold. Fire is …."** (hot) ___
c. **"You're awake during the day. You sleep at …."** (night) ___
(Pass: Two correct)

30. Repeats sentences
"Say this back to me."
a. **"We saw Jim riding his bike."** ___
b. **"We can go to the park when the cartoons are over."** ___
c. **"I like to go swimming with my friends."** ___
(Pass: One correct)

31. *Uses auxiliaries
Materials: *Picture Manual*, p. 56
"Here Johnny is telling Mum, 'I can ride a bike'. Here Johnny is saying, 'I can turn on the lights'. What is Johnny saying here?" ___
(Pass: Uses any auxiliary before the verb)

32. Answers *when* questions
a. **"When do you eat breakfast?"** ___
b. **"When does it get dark outside?"** ___
(Pass: One correct)

4 – 0 to 4 – 5 (48 to 53 months)

Auditory Comprehension

33. Understands spatial concepts
Materials: Brick, Teddy
Place the brick on the table. **"Put the brick … Teddy."**
a. **under** ___ b. **behind** ___ c. **next to** ___ d. **in front of** ___
(Pass: Three correct)

34. Compares animals
Materials: *Picture Manual*, p. 28
"Which one has …?" a. **the longest nose** ___
b. **a long, thin tail** ___ c. **a bushy tail** ___ d. **pointed ears** ___

35. Understands complex instructions
Materials: *Picture Manual*, p. 29
a. **"Point to a kitten that is not black."** ___
b. **"Point to the white kitten that is sleeping."** ___
c. **"Point to the small black kitten in the box."** ___
d. **"Point to the kitten with black ears and a white face."** ___
(Pass: Three correct)

36. Identifies pictures
Materials: *Picture Manual*, pp. 30–32
"Show me the …."
a. **parachute** ___ b. **wheelbarrow** ___ c. **stamp** ___
(Pass: Two correct)

Expressive Communication

33. *Uses prepositions
Materials: Teddy
"Tell me where Teddy is." Place Teddy …
a. on the chair ___ b. behind the chair ___
c. next to the chair ___ d. in front of the chair ___
(Pass: Two correct)

34. Repeats irregular and regular forms of past tense
"Say this back to me." a. **"James *ran* fast and *won* the race."** ___
b. **"Annie *fell* and *dropped* her milk."** ___
c. **"George *listened* to the radio and *danced*."** ___
(Pass: Two correct)

35. Describes a procedure
a. **"Tell me how to make a sandwich."** ___
b. **"Tell me what you do when you get dressed in the morning."** ___
(Pass: One correct)

36. Name members of the category 'animals'
Materials: *Stopwatch*
"Name all the animals you can think of until I tell you to stop." ___
Write the responses produced within one minute below:

(Pass: Names at least six animals)

4 – 6 to 4 – 11 (54 to 59 months)

Auditory Comprehension

37. Understands descriptive concepts
Materials: *Picture Manual*, pp. 33–35
a. **"Can you see the paper chains? Point to the one that is long."** ___
b. **"Look at their hair. Whose hair is curly?"** ___
c. **"Look at the children. Point to the one who is short."** ___
(Pass: Two correct)

38. Understands time concepts
Materials: *Picture Manual*, p. 36
a. **"Which pictures show *night*?"** ___
(If the child points to only one appropriate picture, say "Any more?")
b. **"Which pictures show *day*?"** ___
(If the child points to only one appropriate picture, do not prompt)
(Pass: Two correct)

39. Understands quantity concepts
Materials: *Picture Manual*, pp. 37–8
a. **"Count the fish. Which fish-tank has three fish?"** ___
b. **"Count the strawberries on the plates. Which plate has five?"** ___
(Pass: Two correct)

40. Understands passive voice sentences
Materials: *Picture Manual*, pp. 39–40
"Show me …."
a. **"Grandad was kissed by the baby."** ___
b. **"The dog was chased by the goat."** ___
(Pass: Two correct)

Expressive Communication

37. Defines words
"Tell me what a … is."
a. **fork** ___
b. **car** ___
c. **shoe** ___
(Pass: Two correct)

38. Repeats complex sentences
"Say this back to me."
a. **"Bob washed the dishes, then watched TV."** ___
b. **"The boy who has red hair is my neighbour."** ___
c. **"Mum is reading the newspaper and Dad is sleeping in the chair."** ___
(Pass: One correct)

39. Names categories
**"Listen: dog, cat, horse, pig, goat—these are all *animals*.
Tell me what these are."**
a. **"Lego, doll, ball, puzzle—these are all …."** ___
b. **"Hat, shirt, dress, shorts, jeans—these are all …."** ___
c. **"Beefburgers, cereal, oranges, mashed potatoes, pizza—these are all …."** ___
(Pass: Two correct)

40. Responds to *why* questions by giving a reason
a. **"Why do you brush your teeth?"** ___
b. **"Why do you wear shoes?"** ___
c. **"Why do you keep ice-cream in the freezer?"** ___
(Pass: Two correct)

5 – 0 to 5 – 11 (60 to 71 months)

Auditory Comprehension

41. Understands *noun + two modifying adjectives*
Materials: *Picture Manual*, p. 41
a. **"Point to the furry white dog."** ___
b. **"Point to the small black dog."** ___
(Pass: Two correct)

42. Understands quantity concepts
Materials: *Picture Manual*, p. 42
a. **"Jack shared half a biscuit with his brother. Which picture shows *half* a biscuit?"** ___
b. **"Which picture shows a *whole* biscuit?"** ___
(Pass: Two correct)

43. Understands *–er* ending as "one who acts/carries out an action"
Materials: *Picture Manual*, pp. 43–44
"Find the …."
a. **skater** ___
b. **bowler** ___
(Pass: Two correct)

44. Understands time/sequence concepts
Materials: *Picture Manual*, p. 45
"These pictures show a boy having a bath."
a. **"What happened *last*?"** ___
b. **"What happened *first*?"** ___
(Pass: Two correct)

Expressive Communication

41. *Uses adjectives to describe people and objects
Materials: *Picture Manual*, p. 57
"Now you be the teacher."
a. **"Tell me which car to point to."** ___
b. **"Tell me which girl to point to."** ___
(Pass: One correct)

42. Builds sentences
"I'm going to make up something about a cat and a mouse. Listen: The cat chases the mouse. Now *you* make up something about …."
a. **a *girl* and *flowers*** ___
b. **a *cow* and a *farm*** ___
c. **a *boy* and a *bicycle*** ___
(Pass: Two correct; uses both *italicized* words in the sentence)

43. Defines words
"I'm going to ask you what some words mean. What is a …? Tell me *two* things about a …."
a. **banana** ___
b. **telephone** ___
c. **piano** ___
(Pass: Two correct)

44. Uses words that express quantity
Materials: *Picture Manual*, p. 58
Point to each picture.
a. **"This girl's glass is *full*. This girl's glass is …"** (empty) ___
b. **"Sam didn't get much spaghetti. He got *less* than she did. She got …"** (more, loads, etc) ___
(Pass: Two correct)

7

6 – 0 to 6 – 11 (72 to 83 months)

Auditory Comprehension

45. Adds and subtracts numbers to five
a. **"If you had three pounds and lost one, how many would you have?"** ___
b. **"If you have two crayons and I give you two more crayons, how many will you have?"** ___
c. **"If you have three sweets and I give you two more sweets, how many will you have?"** ___
(Pass: Two correct; shows correct number of fingers or tells answer)

46. Indicates body parts on self
"Show me your …."
a. **wrist** ___
b. **heel** ___
c. **ankle** ___
(Pass: Two correct)

47. Understands time concepts
Materials: *Picture Manual*, p. 46
"These pictures show the different times of year. Point to the picture that shows …."
a. **autumn** ___
b. **summer** ___
(Pass: Two correct)

48. Identified pictures
Materials: *Picture Manual*, pp. 47–50
"Show me the …."
a. **flask** ___
b. **thorns** ___
c. **compass** ___
d. **choir** ___
(Pass: Three correct)

Expressive Communication

45. Uses comparative and superlative forms (*–er, –est*)
"Listen. I want you to finish this sentence for me."
a. **"A chair is heavy, but a bed is even …."** (heav*ier*) ___
b. **"A light is bright, but the sun is even …."** (bright*er*) ___
c. **"A bike is fast, a car is faster, but a plane is the …."** (fast*est*) ___
d. **"A telephone is loud, a car horn is louder, but an ambulance siren is the …."** (loud*est*) ___
(Pass: Three correct; uses *–er* or *–est* as a suffix where appropriate)

46. Retells a story with visual support
Materials: *Picture Manual*, pp. 59–60
"This is a story about a girl and her dog, Rover. Listen to the story. I want you to tell *me* the story after I've finished."
a. **"Jenny had a dog named Rover. Rover liked to sleep on an old blanket by the door.**
b. **One night it rained and rained. Rover got soaking wet!**
c. **Jenny talked to her dad. 'Dad, Rover got all wet in the rain. Can you build a kennel for Rover?' Dad said, 'O.K.! And you can help me build it.'**
d. **The next day, Jenny and her dad started work. Rover sniffed around. He wondered what was going on.**
e. **Soon the new kennel was finished. Jenny painted Rover's name over the door. She said, 'Look, Rover! How do you like your new home?'**
f. **Jenny was surprised when Rover ran off. Jenny said, 'Hey Rover! Where are you going?'**
g. **Rover dragged his blanket from the porch and put it inside the kennel. Then he arranged his blanket just the way he liked it.**
h. **Now when it rains, Rover is snug and dry in his new home! Now you tell me the story."**

Introduction ___ Sequence ___ Conclusion ___
(Pass: Story has introduction, sequence, and conclusion)

47. Uses *–er* ending to indicate "one who acts/carries out an action"
"A person who *teaches* is a teacher."
a. **"A person who *sings* is a …."** (singer) ___
b. **"A person who *dances* is a …."** (dancer) ___
c. **"The person who *wins* a game is the …."** (winner) ___
(Pass: Two correct)

48. Uses irregular plurals
Materials: *Picture Manual*, p. 61
Point to each picture.
a. **"This girl lost one tooth. This girl lost two …."** (teeth) ___
b. **"Here is one man. Here are two …."** (men) ___
c. **"Here is one mouse. Here are two …."** (mice) ___
(Pass: Two correct)

8

TASK ANALYSIS: CHECKLIST

Auditory Comprehension

Birth to 5 months

____ 1. Looks intently at speaker
____ 2. Reacts to sound of kitchen foil
____ 3. Turns head to locate the source of sound
____ 4. Discriminates one sound from another

6 to 11 months

____ 5. Anticipates an event or signal
____ 6. Follows line of regard (joint attention)
____ 7. Responds to "No"
____ 8. Understands a word or phrase (other than "No")

1–0 to 1–5

____ 9. Maintains attention for two minutes
____ 10. Follows simple instructions with cues
____ 11. Identifies familiar objects (ball, sock, spoon)
____ 12. Identifies pictures (dog, baby)

1–6 to 1–11

____ 13. Follows simple instructions without gestural cues
____ 14. Identifies pictures (ball, shoe, spoon, mug)
____ 15. Indicates body parts on self (hair, eye, nose, etc)
____ 16. Understands verbs in context (eat, drink, sleep)

2–0 to 2–5

____ 17. Understands spatial concepts (in, off, out of)
____ 18. Understands several pronouns (me, him, your, my)
____ 19. Understands quantity concepts (one, some, rest, all)
____ 20. Recognizes action in pictures

2–6 to 2–11

____ 21. Understands use of objects
____ 22. Understands descriptive concepts (big, wet, little)
____ 23. Understands part/whole relationships
____ 24. Understands pronouns (they, she, he)

3–0 to 3–5

____ 25. Understands descriptive concepts (heavy, empty, same)
____ 26. Groups objects
____ 27. Understands negatives
____ 28. Identifies colours

3–6 to 3–11

____ 29. Compares objects
____ 30. Makes inferences
____ 31. Identifies pictures (caterpillar, doctor, toolbox, triangle)
____ 32. Indicates body parts on self (head, arm, knee, etc.)

4–0 to 4–5

____ 33. Understands spatial concepts (under, behind, next to, in front of)
____ 34. Compares animals
____ 35. Understands complex instructions
____ 36. Identifies pictures (parachute, wheelbarrow, stamp)

4–6 to 4–11

____ 37. Understands descriptive concepts (long, curly, short)
____ 38. Understands time concepts (night, day)
____ 39. Understands quantity concepts (three, five)
____ 40. Understands passive voice sentences

5–0 to 5–11

____ 41. Understands *noun + two modifying adjectives*
____ 42. Understands quantity concepts (whole, half)
____ 43. Understands *–er* as "one who acts/carries out an action"
____ 44. Understands time/sequence concepts (last, first)

6–0 to 6–11

____ 45. Adds and subtracts numbers to five
____ 46. Indicates body parts on self (wrist, heel, ankle)
____ 47. Understands time concepts (autumn, summer)
____ 48. Identifies pictures (flask, thorns, etc.)

Expressive Communication

Birth to 5 months

____ 1. Vocalizes a variety of pleasure/displeasure sounds
____ 2. Vocalizes when talked to
____ 3. Laughs
____ 4. Engages in solitary vocal play

6 to 11 months

____ 5. Combines sounds to form syllables
____ 6. Approximates sounds made by another person
____ 7. Communicates nonverbally
____ 8. Produces at least four different consonant sounds

1–0 to 1–5

____ 9. Has a vocabulary of at least one word
____ 10. Initiates a game or social routine
____ 11. Varies the sounds produced in syllable strings
____ 12. Imitates a word

1–6 to 1–11

____ 13. Has a vocabulary of at least 10 words
____ 14. Names objects (ball, sock, mug, brick)
____ 15. Produces successive single-word utterances
____ 16. Uses one pronoun (my, mine, you, me)

2–0 to 2–5

____ 17. Expresses negation
____ 18. Combines three or four words in spontaneous speech
____ 19. Names pictures (book, car, bottle, banana, etc.)
____ 20. Uses plurals (socks, bricks, shoes)

2–6 to 2–11

____ 21. Answers *what, where, yes/no* questions
____ 22. Uses *verb + 'ing'*
____ 23. Produces basic sentences
____ 24. Uses possessives

3–0 to 3–5

____ 25. Describes how an object is used
____ 26. Answers questions logically
____ 27. Uses several pronouns (I, he, she, we, they)
____ 28. Talks about remote events

3–6 to 3–11

____ 29. Completes analogies
____ 30. Repeats sentences
____ 31. Uses auxiliaries
____ 32. Answers *when* questions

4–0 to 4–5

____ 33. Uses prepositions
____ 34. Repeats irregular and regular forms of past tense
____ 35. Describes a procedure
____ 36. Names members of the category 'animals'

4–6 to 4–11

____ 37. Defines words (fork, car, shoe)
____ 38. Repeats complex sentences
____ 39. Names categories
____ 40. Responds to *why* questions

5–0 to 5–11

____ 41. Uses adjectives to describe people and objects
____ 42. Builds sentences
____ 43. Defines words (banana, telephone, piano)
____ 44. Uses words that express quantity (empty, more)

6–0 to 6–11

____ 45. Uses comparative –er and superlative *–est*
____ 46. Retells a story with visual support
____ 47. Uses *–er* ending to indicate "one who acts/carries out an action"
____ 48. Uses irregular plurals (*teeth, men, mice*)

TASK ANALYSIS: PROFILE

Instructions: Draw a line across the Profile at the child's chronological age. Circle the tasks failed.

Auditory Comprehension

Age in months	Attention*	Semantics: Vocabulary	Semantics: Quantity	Semantics: Quality	Semantics: Spatial	Semantics: Time/Sequence	Structure: Morphology	Structure: Syntax	Integrative Thinking Skills
Birth–5	1, 2, 3, 4								
6–11	5, 6	7, 8							
12–17	9	10, 11, 12							
18–23		13, 14, 15, 16							
24–29		20	19		17		18		
30–35				22			24		21, 23
36–41				25, 28			27		26
42–47		31, 32							29, 30
48–53		36			33			35	34
54–59			39	37		38		40	
60–71			42			44	43	41	
72–83		46, 48				47			45

Expressive Communication

Age in months	Vocal Development*	Social Communication*	Semantics: Vocabulary	Semantics: Quantity	Semantics: Quality	Semantics: Spatial	Semantics: Time/Sequence	Structure: Morphology	Structure: Syntax	Integrative Thinking Skills
Birth–5	1, 4	2, 3								
6–11	5, 8	6, 7								
12–17	11	10, 12	9							
18–23			13, 14					16	15	
24–29			19					17, 20	18	
30–35								21, 22, 24	23	
36–41								27		25, 26, 28
42–47							32	31	30	29
48–53						33		34		35, 36
54–59									38	37, 39, 40
60–71				44	41				42	43
72–83							46	45, 47, 48		

*Indicates skills that are precursors to language

SUPPLEMENTARY MEASURE: ARTICULATION SCREENER (ages 2.6 to 6.11)

Instructions: Administer all items, regardless of the child's age, to obtain a raw score.
Score '1' if the underlined sound is correctly articulated. Score '0' if the child substitutes, distorts, or omits the underlined sound.

Say, **"We're going to play a word game now. Say these words. Say, ..."**

2.6 to 2.11

1. my ___
2. home ___
3. pie ___
4. hop ___
5. won ___
6. to ___
7. hat ___

3.0 to 3.5

8. bee ___
9. web ___
10. do ___
11. mud ___

3.6 to 3.11

12. key ___
13. bake ___
14. go ___
15. dog ___
16. fun ___
17. puff ___

4.0 to 4.5

18. so ___
19. house ___
20. shoe ___
21. push ___
22. jam ___
23. fudge ___
24. chop ___
25. much ___
26. zoo ___
27. buzz ___

4.6 to 4.11

28. yet ___
29. dove ___
30. like ___
31. ball ___

5.0 to 5.11

32. rabbit ___
33. door ___

6.0 to 6.11

34. think ___
35. teeth ___
36. street ___
37. strong ___

Child's chronological age ___
Raw score ___

See Chapter 6 in the *Examiner's Manual* for interpretation of the raw score.

Based on the raw score:

___ performance is typical of age peers
___ further evaluation may be indicated
___ further evaluation is strongly suggested

SUPPLEMENTARY MEASURE: LANGUAGE SAMPLE CHECK LIST

Instructions: Check all the descriptors that apply to language the child produced spontaneously (see Language Sample, p. 13 of Record Form).

MORPHOLOGY/SYNTAX (Structure)

The child:

____ did not talk spontaneously
____ spoke in one word utterances
____ spoke in successive single word utterances
____ spoke in two- to three-word utterances
____ spoke in four- to five-word sentences
____ used expanded sentences
____ used complex sentences

Total number of morphemes ____ ÷
Total number of utterances ____ =
Mean Length of Utterance (MLU) ____
See Chapter 6 in the *Examiner's Manual* for interpretation of the MLU.
Age: ____ to ____ months

The child used:

Tense markers

____ present tense (*–ing, –s*)
____ past tense (*–ed*)
____ irregular past tense (*ran, won*)
____ future tense (*will, gonna*)
____ copula (*is/are*)

Pronouns

____ subjective (*he, she, it, we, they*)
____ objective (*him, her, them*)
____ possessive (*his, her, hers, its, their, theirs*)

Plurals

____ regular (*–s, es*)
____ irregular (*feet, men*)

Possessive markers (*'s*) ____

Articles (*a, the*) ____

Negatives (*no, not, don't*) ____

Questions

____ *wh-* questions (*who, what, where, when, why*)
____ yes–no (*is/are, can/could, do/does, will/would*)

SEMANTICS (Content)

The child:

____ named objects/pictures (e.g., *baby, puppy*)
____ used action words (e.g., *eat, running*)
____ used words denoting possession (e.g., *Mummy* coat, *mine*)
____ used words denoting recurrence (e.g., *more, again*)
____ used words to describe objects/people (e.g., *little* ball, *pretty* baby)
____ used words denoting time (e.g., *now, in a minute, before*)
____ used words denoting place (e.g., *here, in* the box, *up*)
____ used words denoting quantity (e.g., *five, lots, few*)
____ used words to give reasons (e.g., *so, because*)

Connected speech was usually:

____ organized
____ disorganized

____ on topic
____ off topic

____ appropriately sequenced
____ out of sequence

SOCIAL LANGUAGE (Use)

Using words or gestures, the child:

____ directed your attention to something
____ tried to get you to do something
____ tried to get your attention
____ talked about what he or she was doing
____ named an object
____ greeted someone or said goodbye
____ played with you
____ protested or complained
____ answered when you talked to him or her
____ 'practised' or repeated words
____ asked a question

____ told you about an event or object
____ talked about recent experiences (e.g., volunteered information, answered your questions, and stayed on topic briefly)
____ maintained a conversation (answered you, gave additional information or asked a question, and paused to let you respond)
____ used language to control another's behaviour
____ used language to interact with another person

____ repeated or reworded messages you didn't understand
____ stayed on topic
____ used indirect requests or hints
____ roleplayed stereotypic themes (e.g., plays house, pretends to be a hero)

SPEECH INTELLIGIBILITY

____ poor
____ fair
____ good

12

LANGUAGE SAMPLE

Instructions: Record the child's spontaneous utterances below.

13

BACKGROUND INFORMATION FORM

Date ______________

Family Information

Name of child ______________________________

Date of Birth ______________ (Day/Month/Year) Age ______________

Name family members living at home: ______________________________

Language(s) spoken in the home: ______________________________

Medical History

- Were there any problems during pregnancy or difficulties at birth? ☐ no ☐ yes
- Was your child born before the due date? ☐ no ☐ yes
- Has your child been hospitalized at any time? ☐ no ☐ yes
- Has your child had his or her vision checked? ☐ no ☐ yes
- Does your child have any diagnosed mental, physical, or emotional disabilities? ☐ no ☐ yes
- Does your child have any allergies? ☐ no ☐ yes

If you responded "yes" to any of the above, please explain or describe here: ______________________________

____

Hearing Status

Does your child

- Talk in a very loud voice? ☐ no ☐ yes
- Turn up the volume on the radio and TV? ☐ no ☐ yes
- Hear you if his or her back is turned? ☐ no ☐ yes
- Hear you if you talk to him or her from another room? ☐ no ☐ yes
- Have a history of ear infections? ☐ no ☐ yes
  How many? _____ When was the most recent? __________

Has your child had a hearing test? ☐ no ☐ yes If yes, when: ______________________________

Understanding Language

When you talk to your child, how much does he or she understand? Tick one:

☐ A few words
☐ Many words and phrases
☐ Simple directions
☐ Almost everything you say

Additional Comments/Examples: ______________________________

____

Communicating With You

How does your child usually let you know what he or she wants?
Tick all that apply:

☐ Cries
☐ Points to what he or she wants
☐ Uses gestures (e.g., gestures for 'give it to me')
☐ Makes a few sounds
☐ Makes many different sounds
☐ Uses a few words
☐ Says many words, but only says one word at a time
☐ Says two or three word sentences
☐ Uses long sentences

Additional Comments/Examples: ______________________________

____

Does your child

- Answer when you talk to him or her? ☐ no ☐ yes
- Talk about what he or she is doing? ☐ no ☐ yes
- Ask for help? ☐ no ☐ yes

Can the family understand your child's speech? ☐ no ☐ yes
Can people outside of the family understand your child's speech? ☐ no ☐ yes

What does your child like to talk about? ______________________________

____

15

Previous Therapy/Treatment

Your child ☐ has ☐ has not been enrolled in therapy/treatment before.

Comments about previous therapy/treatment: ______________________________

____

____

____

Additional information

____

____

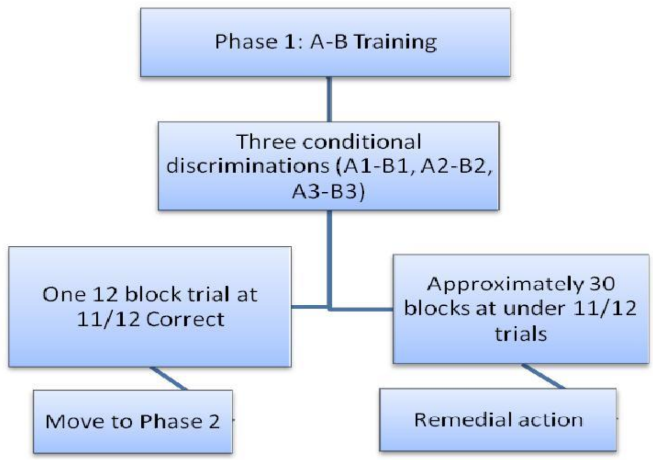
____

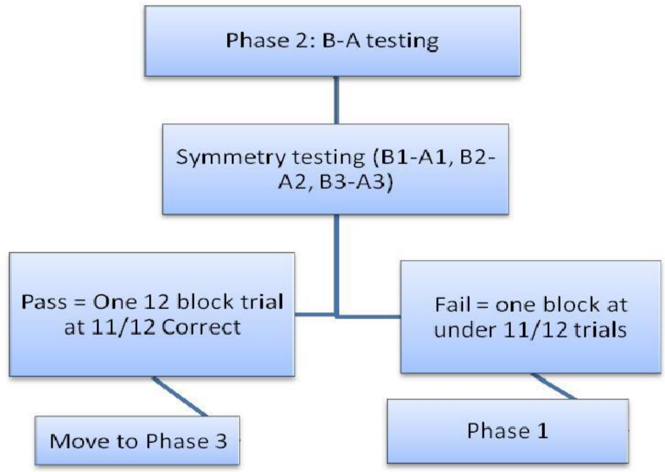
____

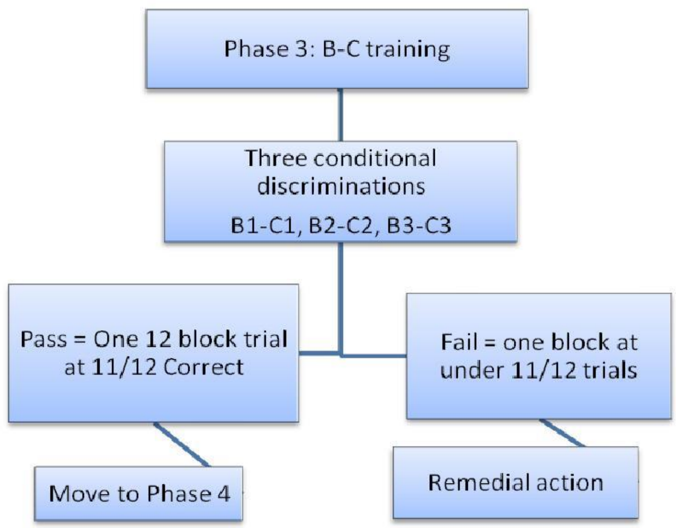
____

THE PSYCHOLOGICAL CORPORATION LIMITED

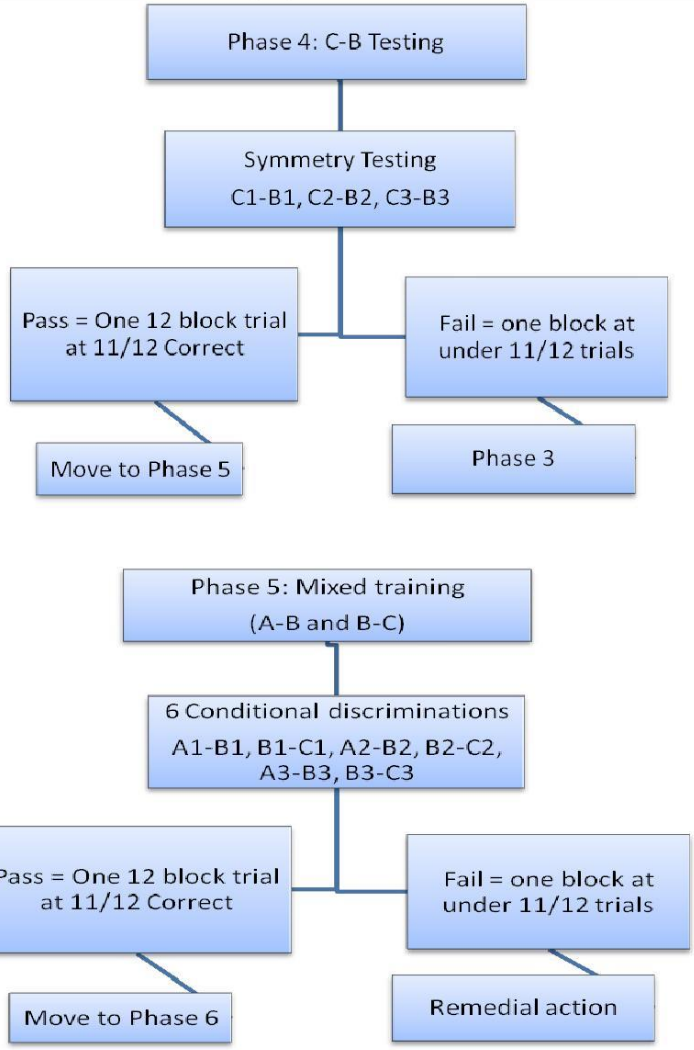
Appendix 3: Schematic representative of computerized experimental phases. In Experimental Phases 1-7 all stimuli are representative pictures of categories identified for training during the category sort test. The stimuli are represented alphanumerically (for example the category fruit: A1 (apple), B1 (Orange) and C1, (Banana). The category clothing is represented as A2 (T-shirt), B2 (Socks) and C2 (Coat) and the category transport A3 (Car), B3 (Train) and C3 (Aeroplane).



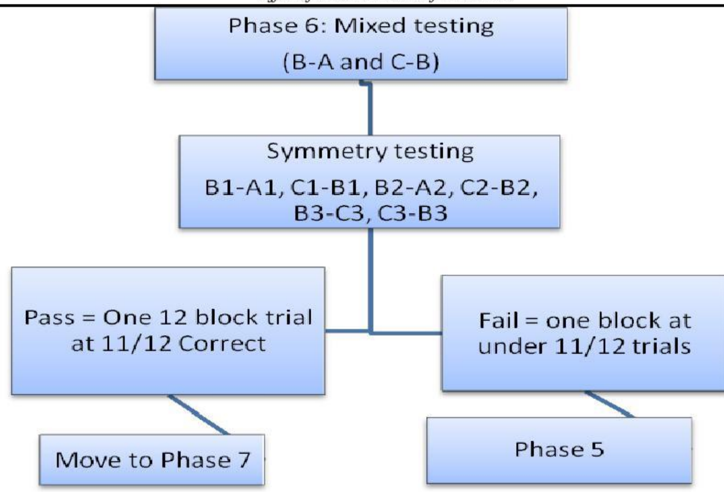

Phase 2: B-A testing
Symmetry testing (B1-A1, B2-A2, B3-A3)
Pass = One 12 block trial at 11/12 Correct
Fail = one block at under 11/12 trials
Move to Phase 3
Phase 1

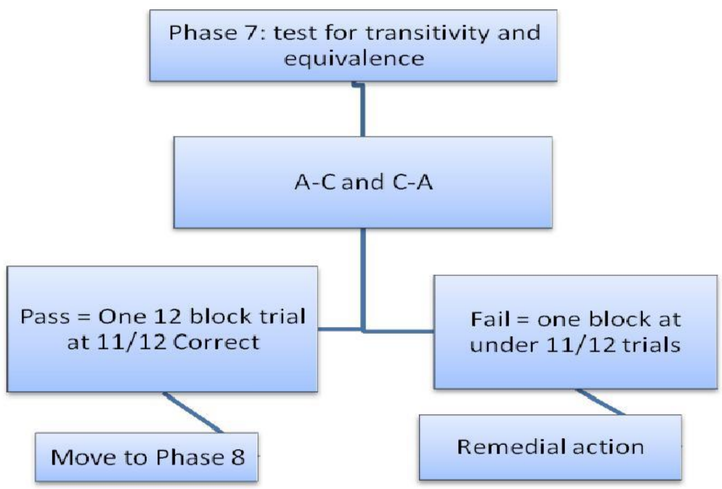

Phase 3: B-C training
Three conditional discriminations
B1-C1, B2-C2, B3-C3
Pass = One 12 block trial at 11/12 Correct
Fail = one block at under 11/12 trials
Move to Phase 4
Remedial action

Office of the Vice-President for Research



Last updated February 2012 Page 45


Phase 6: Mixed testing
(B-A and C-B)
Symmetry testing
B1-A1, C1-B1, B2-A2, C2-B2, B3-C3, C3-B3
Pass = One 12 block trial at 11/12 Correct
Fail = one block at under 11/12 trials
Move to Phase 7
Phase 5

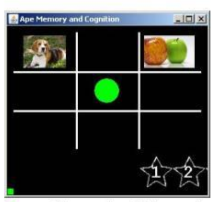

Phase 7: test for transitivity and equivalence
A-C and C-A
Pass = One 12 block trial at 11/12 Correct
Fail = one block at under 11/12 trials
Move to Phase 8
Remedial action

Appendix 4: A sample of a visual textual board which will be used to explain the experimental sessions to the participants and section whereby participants can indicate participation (typically developing population).

When it is time for computer work, I will see this picture or my teacher will tell me "It's time for computer work".

We will go to the room where the computer is.

I will sit on a chair to do my computer work.



Sometimes I will be asked to sort pictures, sometimes to match pictures on the computer or to show pictures. I can get points for matching and showing pictures.

If I feel upset or need to take a break I can ask for a break or show my teacher this break card. My teacher will stop computer work until later.

When I am finished my computer work I can swop my tokens for some toys to play with for a little while.

If I have no tokens I can play with some other toys for one minute.

If I do not want to take part, I can say so by saying so or telling my teacher I'm finished. I may want to try another time or not. It is okay not to take part and all I have to do is tell my teacher.

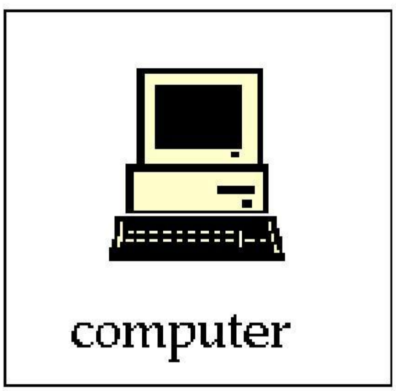
You can tick the box or write your name if you would like to take part.

I would like to take part ☐ I do NOT want to tak☐

Signed: _______________________________________

Appendix 5: A. Visual schedule similar to that used by the participants and B. symbol of a computer which will be used to communicate experimental sessions.

A.



B.

Ollscoil Chathair Bhaile Átha Cliath
Dublin City University

Dr. Sinéad Smyth
School of Nursing and Human Sciences

7th December 2012

REC Reference:	DCUREC/2012/208
Proposal Title:	**Derived Categorisation in Young Children**
Applicants:	Dr. Sinéad Smyth, Prof. Pamela Gallagher, Prof. Julian Leslie, Ms. Ronda Barron

Dear Sinéad,

Further to expedited review, the DCU Research Ethics Committee approves this research proposal. Materials used to recruit participants should note that ethical approval for this project has been obtained from the Dublin City University Research Ethics Committee. Should substantial modifications to the research protocol be required at a later stage, a further submission should be made to the REC.

Yours sincerely,

DCU
Research & Innovation

Dónal O'Mathúna

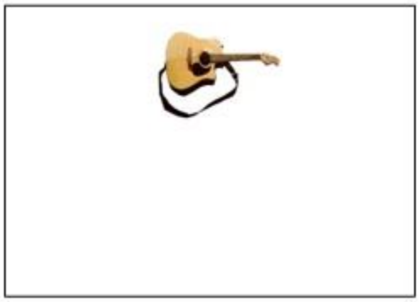
Dr. Donal O'Mathuna
Chairperson
DCU Research Ethics Committee

Taighde & Nuálaíocht Tacaíocht
Ollscoil Chathair Bhaile Átha Cliath,
Baile Átha Cliath, Éire

Research & Innovation Support
Dublin City University,
Dublin 9, Ireland

T +353 1 700 8000
F +353 1 700 8002
E research@dcu.ie
www.dcu.ie

Appendix B: Screen shots depicting how the computerised phases of the current study looked to participants.



1. Sample stimulus appears top centre once touched it disappeared.

2. Three comparison stimuli appear bottom left, middle and centre after 3s.

3. During training if incorrect response was made a red symbol appeared for 3 s.

4. If a correct response was made a green symbol appeared for 3 s and a token was delivered.

5. Following 12 trials the following screen appeared.

Appendix C: Copy of ethical application and approval letter for Study 2 (Chapter 3).

Research and Innovation Support

Dublin City University
RESEARCH ETHICS COMMITTEE

APPLICATION FOR APPROVAL OF A PROJECT INVOLVING **HUMAN PARTICIPANTS**

Application No. *(office use only)* DCUREC/2013/____

This application form is to be used by researchers seeking ethics approval for individual projects and studies. Your application must be e-mailed to the DCU Research Ethics Committee at rec@dcu.ie –no hardcopy required. **Student applicants must cc their supervisor on that e-mail** – this applies to undergraduate, masters and postgraduate students.

NB - The application should consist of one electronic file only, with an electronic signature from the PI. The completed application must incorporate all supplementary documentation, especially that being given to the proposed participants. It must be proofread and spellchecked before submission to the REC. All sections of the application form should be completed – please consult the Guidelines to Applicants page overleaf. Applications which do not adhere to these requirements will not be accepted for review and will be returned directly to the applicant.

Applications must be completed on the form; answers in the form of attachments will not be accepted, except where indicated. No hardcopy applications will be accepted. **Research must not commence until written approval has been received from the Research Ethics Committee.**

Note: If your research requires approval from the Biosafety Committee, this approval should be in place prior to REC submission. Please attach the approval from the BSC to this submission.

PROJECT TITLE	Derived Categorisation in Young Children2
PRINCIPAL INVESTIGATOR(S)	Dr. Sinéad Smyth

Please confirm that **all** supplementary information is included in your application (in electronic copy). If questionnaire or interview questions are submitted in draft form, a copy of the final documentation must be submitted for final approval when available.

Last updated January 2013 Page 1

Research and Innovation Support

	INCLUDED		NOT APPLICABLE
Bibliography	☒		☐
Recruitment advertisement	☐		☒
Plain language statement/Information Statement	☒		☐
Informed Consent form	☒		☐
Evidence of external approvals related to the research	☐		☒
Questionnaire	☐ draft	☐ final	☒
Interview Schedule	☐ draft	☐ final	☒
Debriefing material	☐		☒
Other	☒		☐

Please note:

1. Any amendments to the original approved proposal must receive prior REC approval.

2. As a condition of approval investigators are required to document and report immediately to the Secretary of the Research Ethics Committee any adverse events, any issues which might negatively impact on the conduct of the research and/or any complaint from a participant relating to their participation in the study

Please submit the electronic copy of your completed application to rec@dcu.ie

Guidelines to Applicants

1.1 PRINCIPAL INVESTIGATOR(S): *The named Principal Investigator is the person with primary responsibility for the research project. Doctoral researchers and Research Masters or their supervisors may be listed as Principal Investigators, depending on the conventions of the discipline and on the individual case. It should be made clear, in subsequent sections of this application, who is carrying out the research procedures. In the case of Taught Masters and undergraduate student projects the supervisors are Principal Investigators.*

2.0 PROJECT OUTLINE: *Provide a brief outline of the project, aims, methods, duration, funding, profile of participants and proposed interaction with them. This description must be in everyday language that is free from jargon. Please explain any technical terms or discipline-specific phrases.*

2.1 LAY DESCRIPTION: *Provide a brief outline of the project, including what participants will be required to do. This description must be in everyday language which is free from jargon. Please explain any technical terms or discipline-specific phrases. (No more than 300 words).*

2.2 AIMS OF AND JUSTIFICATION FOR THE RESEARCH: *State the aims and significance of the project (approx. 400 words). Where relevant, state the specific hypothesis to be tested. Also please provide a brief description of current research, a justification as to why this research should proceed and an explanation of any expected benefits to the community.* ***NB – all references cited should be listed in an attached bibliography.***

2.3 PROPOSED METHOD: *Provide an outline of the proposed method, including details of data collection techniques, tasks participants will be asked to do, the estimated time commitment involved, and how data will be analysed. If the project includes any procedure which is beyond already established and accepted techniques please include a description of it. (No more than 400 words.)*

2.4 PARTICIPANT PROFILE: *Provide number, age range and source of participants. Please provide a justification of your proposed sample size. Please provide a justification for selecting a specific gender.*

2.5 MEANS BY WHICH PARTICIPANTS ARE TO BE RECRUITED: *Please provide specific details as to how you will be recruiting participants. How will people be told you are doing this research? How will they be approached and asked if they are willing to participate? If you are mailing to or phoning people, please explain how you have obtained their names and contact details. This information will need to be included in the plain language statement. If a recruitment advertisement is to be used, please ensure you attach a copy to this application.*

3.3 POTENTIAL RISKS TO PARTICIPANTS AND RISK MANAGEMENT PROCEDURES: *Identify, as far as possible, all potential risks to participants (physical, psychological, social, legal or economic etc.), associated with the proposed research. Please explain what risk management procedures will be put in place.*

3.6 ADVERSE/UNEXPECTED OUTCOMES: *Please describe what measures you have in place in the event that there are any unexpected outcomes or adverse effects to participants arising from involvement in the project.*

3.7 MONITORING: *Please explain how you propose to monitor the conduct of the project (especially where several people are involved in recruiting or interviewing, administering procedures) to ensure that it conforms with the procedures set out in this application. In the case of student projects please give details of how the supervisor(s) will monitor the conduct of the project.*

3.8 SUPPORT FOR PARTICIPANTS: *Depending on risks to participants you may need to consider having additional support for participants during/after the study. Consider whether your project would require additional support, e.g., external counselling available to participants. Please advise what support will be available.*

4.0 INVESTIGATORS' QUALIFICATIONS, EXPERIENCE AND SKILLS: *List the academic qualifications and outline the experience and skills relevant to this project that the researchers and any supporting staff have in carrying out the research and in dealing with any emergencies, unexpected outcomes, or contingencies that may arise.*

5.2 HOW WILL THE ANONYMITY OF THE PARTICIPANTS BE RESPECTED? *Please bear in mind that where the sample size is very small, it may be impossible to guarantee anonymity/confidentiality of participant identity. Participants involved in such projects need to be advised of this limitation.*

5.3 LEGAL LIMITATIONS TO DATA CONFIDENTIALITY: *Participants need to be aware that confidentiality of information provided can only be protected within the limitations of the law - i.e., it is possible for data to be subject to subpoena, freedom of information claim or mandated reporting by some professions. Depending on the research proposal you may need to specifically state these limitations.*

6.0 DATA/SAMPLE STORAGE, SECURITY AND DISPOSAL: *For the purpose of this section, "Data" includes that in a raw or processed state (e.g. interview audiotape, transcript or analysis). "Samples" include body fluids or tissue samples.*

8.0 PLAIN LANGUAGE STATEMENT: *Written information in plain language that you will be providing to participants, outlining the phases and nature of their involvement in the project and inviting their participation. Please note that the language used must reflect the participant age group and corresponding comprehension level.*

9.0 INFORMED CONSENT FORM: *This is a very important document that should be addressed by participants to researchers, requiring participants to indicate their consent to specific statements, and give their signature.*

FOR FURTHER INFORMATION AND NOTES ON THE DEVELOPMENT OF PLAIN LANGUAGE STATEMENTS AND INFORMED CONSENT FORMS, PLEASE CONSULT THE DCU REC WEBSITE: **HTTP://WWW4.DCU.IE/RESEARCH/RESEARCH_ETHICS/REC_FORMS.SHTML**

1. ADMINISTRATIVE DETAILS

THIS PROJECT IS:
(tick as many as apply)

- ☐ Research Project
- ☐ Practical Class
- ☒ Student Research Project
  (please give details)
  - ☐ Research Masters
  - ☐ Taught Masters
  - ☒ PhD
  - ☐ Undergraduate
- ☐ Funded Consultancy
- ☐ Clinical Trial
- ☐ Other - *Please Describe:*

Project Start Date: **February 2013** **Project End date:** **October 2015**

1.1 INVESTIGATOR CONTACT DETAILS *(see Guidelines)*

PRINCIPAL INVESTIGATOR(S):

TITLE	*SURNAME*	*FIRST NAME*	*PHONE*	*FAX*	*EMAIL*
Dr.	Smyth	Sinead	7422		sinead.smyth@dcu.ie

OTHER INVESTIGATORS:

TITLE	*SURNAME*	*FIRST NAME*	*PHONE*	*FAX*	*EMAIL*
Prof	Gallagher	Pamela	8958		pamela.gallagher@dcu.ie
Prof	Leslie	Julian	+4428 70123090		jc.leslie@ulster.ac.uk
Ms	Barron	Ronda			barron.r2@mail.dcu.ie

FACULTY/DEPARTMENT/SCHOOL/ CENTRE: (School of Nursing and Human Sciences)

(NB – if Nursing and Human Sciences, please note all students including PhD's must attach the letter from their Ethics Advisory Committee to this application)

1.2 WILL THE RESEARCH BE UNDERTAKEN ON-SITE AT DUBLIN CITY UNIVERSITY?

☐ YES ☒ NO *(If NO, give details of off-campus location.)*

Research will take place within educational settings, primary schools, special education facilities, and crèche or afterschool facilities. These facilities are freely listed under the Department of Education and Health Service Executives websites. A letter of acceptance from the facility will be amended to DCU REC, please see Section 2.5.

1.3 IS THIS PROTOCOL BEING SUBMITTED TO ANOTHER ETHICS COMMITTEE, OR HAS IT BEEN PREVIOUSLY SUBMITTED TO AN ETHICS COMMITTEE?)

☒ YES ☐ NO *(If YES, please provide details and copies of approval(s) received etc.)*

DCUREC/2012/208

Derived Categorisation in Young Children, Teaching Protocol 1 described in this study was used to establish category membership with two populations the first typically developing and children with a diagnosis of autistic Spectrum Disorder. The current study is an extension of this and will compare Protocol 1 with a different but commonly used teaching method (see Appendix1).

DECLARATION BY INVESTIGATORS

The information contained herein is, to the best of my knowledge and belief, accurate. I have read the University's current research ethics guidelines, and accept responsibility for the conduct of the procedures set out in the attached application in accordance with the guidelines, the University's policy on Conflict of Interest, Code of Good Research Practice and any other condition laid down by the Dublin City University Research Ethics Committee or its Sub-Committees. I have attempted to identify all risks related to the research that may arise in conducting this research and acknowledge my obligations and the rights of the participants.

If there any affiliation or financial interest for researcher(s) in this research or its outcomes or any other circumstances which might represent a perceived, potential or actual conflict of interest this should be declared in accordance with Dublin City University policy on Conflicts of Interest.

I and my co-investigators or supporting staff have the appropriate qualifications, experience and facilities to conduct the research set out in the attached application and to deal with any emergencies and contingencies related to the research that may arise.

Electronic Signature(s):

Principal investigator(s):

________ Sinéad Smyth ____

Print Name(s) here:___Sinéad Smyth____

Date: _04/03/2013_____

2. PROJECT OUTLINE

Categorisation is a very important skill learned in childhood. Children often learn simple categories, quickly through day to day interaction, but may need to be directly taught complex categories. Categorisation is a critical skill in the development of receptive language ability (Ungerer & Sigman, 2005). However, the natural environment often does not present the opportunity to learn complex categories and in some contexts may not be appropriate.

A previous study conducted by the experimenter Ronda Barron in 2010 under the supervision of Dr. Sinead Smyth (Barron, Smyth, & Leslie, under preparation) investigated if real world categories could be established in preschool children with Autistic Spectrum Disorder (ASD). A key component of this study was that vocal responses were not required from participants. Participants were required to select and match pictures representative of categories e.g. apple, pear, banana = fruit electronically via a touch screen computer. Two of the three participants demonstrated the formation of equivalence between classes of objects and also derived (untrained) relations. One of these participants required remedial action. Furthermore, the data indicated that category training took place after a large number of trials. Barron, 2010 is currently being extended to investigate the establishment of real world categories in typically developing children DCUREC/2012/208 (which will henceforth be referred to as Study 1 of the researcher's PhD). Study 1 has already provided preliminary data which has shown that the procedure is an expedient and effective manner to train categorisation. In order to establish if the teaching protocol is effective within real world setting a comparison must be made with an already establish methodology of teaching.

Previous research with young children typically depended on table top procedures (e.g., Lovelt et al., 2011.; Miguel et al., 2008.; cf Moran et al., 2010). The proposed study, in keeping with Barron (2010) and Study 1 will use one teaching protocol that will employ a small touch-screen computer which even young children with developmental delay have used successfully (Barron, under preparation). No known research has used this type of technology to implement the methodological design proposed. The proposed study will compare this novel teaching protocol with a second, commonly used, teaching protocol derived from the Montessori System of teaching which was developed by Italian educator Maria Montessori in the early 1900s.

Children aged 3-6 (n=10) will be sampled from Dublin based child care facility or school with which the researchers have previously collaborated. A maximum number of 20 children will be screened for participation in this study. Parents will be sent an information sheet through the facility and their child will be invited to take part in the study. Approximately ten children will be recruited from a childcare facility such as crèches and afterschool facilities. Children with low levels of receptive language (as assessed in a pre-test), extensive pre-existing category knowledge or major visual or motor problems will be excluded from the study. Informed consent will be sought from parents/guardians. Due to their young age, it will not be possible to get signed consent from the children themselves but the process will be explained to them verbally and in picture form (see Appendix 2 for a sample) and they will be asked if they wish to participate before each session. Typically developing children may give written consent and this has been accounted for.

2.1 **LAY DESCRIPTION** *(see Guidelines)*

Two teaching protocols designed to teach typically developing young children to categorise pictures of objects (e.g. orange, apple and banana = fruit) will be compared using a within subjects design. In other words, the same participants will be taught different (non-overlapping) categories using two different teaching protocols. The order of training will be counterbalanced and for each protocol participants will be taught categories that were previously unknown to them. A testing phase will record the number of items correctly categorised after the teaching phases have been completed. It will be possible to compare the two teaching protocols based on performance in this test.

The first protocol is a simple computerised program, whereby children will match sample pictures to comparisons. The second protocol is designed to represent how children are often taught to categorise within traditional educational settings such as in the Montessori setting.

2.2 **AIMS OF AND JUSTIFICATION FOR THE RESEARCH** *(see Guidelines)*

This study aims to compare the efficacy of Teaching protocol 1 with another commonly used method. A number of studies have demonstrated that the methodology used within Teaching Protocol 1 has been successful in teaching a variety of skills to a cross-section of populations (e.g., Miguel et al., 2008.; cf Moran et al., 2010). Rehfeldt (2011) highlighted the importance of programmes of applied research in testing assumptions that education approaches under laboratory conditions will transfer to the real world. No known research to date has attempted to directly compare the methodology used in Teaching Protocol 1 with any methods commonly used in teaching settings.

Teaching protocol 1 will employ a small touch-screen computer which even young children with developmental delay have used successfully (Barron 2010). No known research has used this type of technology to implement the methodological design proposed. The study is also unique in that the study is tailored to the individual in that each child is pre-screened and taught categories which were previously unknown to them in both of the teaching protocols. This means that the training will be individualised to focus on existing deficits, making it more functional for the learner and increasing the applicability to the wider educational setting and other populations such as those with developmental delays. Importantly, the categories used will have relevance to each individual child (e.g., food, clothing etc.).

2.3 **PROPOSED METHOD** *(see Guidelines)*

Duration of sessions will be 30 minutes (including breaks) conducted twice weekly. It is estimated that participation will last a maximum of 16 weeks for each child. Starting dates for participants will be staggered and sessions will take place twice weekly.

Materials

Pictures of objects or words to be categorised (e.g., apple, orange and pear = fruit). There will be three sets of three pictures for each participant per teaching protocol.

Procedure

1. Participation will initially involve a language assessment, this a standardised assessment used to determine the child existing language abilities. The participants level of understanding of language (receptive) and use of language (expressive) are assessed and a normative scoring can be established. A test of the participants existing knowledge of different categories (e.g., food types, clothes etc.) will follow. This will help us to decide what categories need to be taught, ensuring that deficits in knowledge are targeted and any effects seen in the data are not due to pre-experimental knowledge.

2. Once this has been completed, the training and testing will begin. Participants will be assigned to one of two Teaching protocols. Teaching Protocol 1 is a computerised based program (see Appendix 4 for a detailed schematic). Teaching Protocol 2 is a table top based method of teaching commonly used within Montessori settings (see Appendix 5 for a sample lesson). Participants' will be presented with pictures of objects and will be asked to either show, name or match them. At this stage, correct responses will be rewarded this will be in the form of points or tokens (e.g. stars on a board) which can be exchanged for time to play with preferred items or activities, no food or liquids will be used at any stage of the experiment. Children can access breaks at any stage.

3. Following this training, a test will take place to see if the participant has developed any pairing of objects that have not been directly trained. During this stage your child will not be told whether their responses are correct or not.

4. Finally, post testing will involve the re-administration of the category sort task for the trained objects as well as the re-administration of the language assessment. This will allow a comparison of before and after the computerised training.

Data analysis: In keeping with other single-subject research, data analysis will be descriptive and will compare within and across participants (Kazdin, 2010). Inferential statistical analyses will not be conducted. Data collection will include written reports, and recorded performance in order to compare participant's performance on the two teaching protocols. Data analysis will include 1) performance in the category sort testing and 2) speed of acquisition for each teaching protocol.

2.4 PARTICIPANT PROFILE *(see Guidelines)*

The population to be sampled during the study will be typically developing children aged between 3 and 6 years. This is a within subjects design therefore the same participants will be taught different (non-overlapping) categories using two different teaching methods. The order of training will be counterbalanced for all participants.

The population to be sampled are classed as a vulnerable group due to their age. However, a number of steps will be taken to ensure the safety of this group. Written informed consent will be sought from the parents of the children and the children themselves will also be given information about the study (verbally and/or in picture form as is deemed appropriate). The children will be asked to indicate before each session if they wish to take part and will be able to ask for a break or to terminate the session at any point. The short length of the experimental sessions (max 30 minutes) and the frequency of breaks mean that boredom and frustration are unlikely. The researcher will look for signs of these and will terminate the sessions as appropriate. The sessions will be beneficial for the children as they will teach categories that were previously unknown.

Participants: Children aged 3-6 (n=10) will be sampled from Dublin based child care facility and schools with which the researchers have previously collaborated. Approximately ten children will be recruited from childcare facilities such as crèches and afterschool facilities. A maximum number of 20 children will be screened for participation in this study. The participants with the highest receptive language scores from both populations will be recruited to participate and the other children will be retained as back up participants. Children with low levels of receptive language (pre-test), extensive pre-existing category knowledge, and history of being taught within a Montessori or major visual or motor problems will be excluded from the study. Parents will be sent an information sheet through the facility and their child will be invited to take part in the study. Informed consent will be sought from parents/guardians. Due to their young age, it may not be possible to get signed consent from the children themselves but the process will be explained to them verbally and in picture form and they will be asked if they wish to participate before each session. Children at the older end of the age range may be able to give written consent and this has been accounted for (see Appendix 3 for sample).

It is important to note that the research project is being conducted within the area of behaviour analysis in which research is often single subject or of small numbers (Kazdin, 2010). Any sample sizes mentioned are entirely consistent with previous research in the area, including that published in the flagship journals of behaviour analysis, the Journal of Applied Behavior Analysis (JABA) and the Journal of the Experimental Analysis of Behaviour (JEAB).

2.5 MEANS BY WHICH PARTICIPANTS ARE TO BE RECRUITED *(see Guidelines)*

All facilities to be approached by the researcher are listed publically on the Department of Education and Sciences websites and also that of the Health Service Executives. The researcher has worked within the preschool and primary level education sector for over 10 years. Research contacts are already available within a childcare facility offering after school programs. Other facilities will be recruited as necessary. Once ethical approval has been granted these facilities will take the research proposal to their board or director and a letter of acceptance will be made available, a copy of this letter will be **appended to** DCU REC. Where new facilities are to be recruited the researcher will make initial contact via telephone identifying herself and will request to speak to the owner or manager of the facility. If unavailable an appointment or return call will be requested. The researcher will establish if the facility is willing to participate in research studies. If the facility is one which is will to accept researchers into their facilities then a brief description of the project will be given. The researcher will offer to send the information packs and consent by either mailing electronically or via postal service.

Parents will be approached by the facility and an information pack given, where appropriate the researcher will organize a site visit to meet parents and answer any questions they may have. A deadline for returning of pack will be agreed with the facility such as a two week period.

2.6 PLEASE EXPLAIN WHEN, HOW, WHERE, AND TO WHOM RESULTS WILL BE DISSEMINATED, INCLUDING WHETHER PARTICIPANTS WILL BE PROVIDED WITH ANY INFORMATION AS TO THE FINDINGS OR OUTCOMES OF THE PROJECT?

The proposed research will form one part of the researcher's PhD research area (Study 2) and will therefore be subject to examination in the form of a thesis. The proposed will be written up for publication in peer reviewed flagship journals in the area such as the Journal of Applied Behaviour Analysis, and the Journal of the Experimental Analysis of Behaviour. Dissemination of the findings will also take place at national and international conferences including those of the Psychological Society of Ireland (including the Division of Behaviour Analysis), the Association for Behaviour Analysis (International).

2.7 OTHER APPROVALS REQUIRED *Has permission to gain access to another location, organisation etc. been obtained? Copies of letters of approval to be provided when available.*

☐ YES ☒ NO ☐ NOT APPLICABLE

(If YES, please specify from whom and attach a copy. If NO, please explain when this will be obtained.)

*ONCE ETHICAL APPROVAL HAS BEEN GRANTED, FACILITIES IDENTIFIED WILL TAKE THE RESEARCH PROPOSAL TO THEIR BOARD OR DIRECTOR AND A LETTER OF ACCEPTANCE WILL BE MADE AVAILABLE, A COPY OF THIS LETTER WILL BE **APPENDED TO** DCU REC.*

2.8 HAS A SIMILAR PROPOSAL BEEN PREVIOUSLY APPROVED BY THE REC?

☒ YES ☐ NO

(If YES, please state both the REC Application Number and Project Title)

DCUREC/2012/208 Derived categorisation in Young Children

3. RISK AND RISK MANAGEMENT

3.1 ARE THE RISKS TO SUBJECTS AND/OR RESEARCHERS ASSOCIATED WITH YOUR PROJECT GREATER THAN THOSE ENCOUNTERED IN EVERYDAY LIFE?

☐ YES ☒ NO *If YES, this proposal will be subject to full REC review*
If NO, this proposal may be processed by expedited review

3.2 DOES THE RESEARCH INVOLVE:

YES **NO**

• use of a questionnaire? (attach copy)?	☐	☒
• interviews (attach interview questions)?	☐	☒
• observation of participants without their knowledge?	☐	☒
• participant observation (provide details in section 2)?	☒	☐
• audio- or video-taping interviewees or events?	☒	☐
• access to personal and/or confidential data (including student, patient or client data) without the participant's specific consent?	☐	☒
• administration of any stimuli, tasks, investigations or procedures which may be experienced by participants as physically or mentally painful, stressful or unpleasant during or after the research process?	☐	☒
• performance of any acts which might diminish the self-esteem of participants or cause them to experience embarrassment, regret or depression?	☐	☒
• investigation of participants involved in illegal activities?	☐	☒
• procedures that involve deception of participants?	☐	☒
• administration of any substance or agent?	☐	☒
• use of non-treatment of placebo control conditions?	☐	☒
• collection of body tissues or fluid samples?	☐	☒
• collection and/or testing of DNA samples?	☐	☒
• participation in a clinical trial?	☐	☒
• administration of ionising radiation to participants?	☐	☒

3.3 POTENTIAL RISKS TO PARTICIPANTS AND RISK MANAGEMENT PROCEDURES *(see Guidelines)*

No adverse effects expected. There is a possibility of frustration but the use of break cards are designed to minimize this risk.

3.4 ARE THERE LIKELY TO BE ANY BENEFITS (DIRECT OR INDIRECT) TO PARTICIPANTS FROM THIS RESEARCH?

☒ YES ☐ NO

(If YES, provide details.) Possible benefits for participants involved if successful will be acquired knowledge of categories which are relevant to their daily lives. Other benefits such as the ability to understand complex instructions for example, versus having to follow daily instructions of put on your t-shirt and jumper, the individual may learn to respond in the same way to, put on your clothes. The use of a procedure as designed here may direct other research in methods for teaching young children

3.5 ARE THERE ANY SPECIFIC RISKS TO RESEARCHERS? *(e.g. risk of infection or where research is undertaken at an off-campus location)*

☐ YES ☒ NO *(If YES, please describe.)*

3.6 ADVERSE/UNEXPECTED OUTCOMES *(see Guidelines)*

The study has been designed to account for the population and ages of the participants. The use of the visual and textual instructions board and the additional pictorial and verbal representation is designed to help participants during the study developed predictability of what is required of them. The sessions are designed to be short no longer than 30 minutes in total (including breaks) ensuring that participants access rewards frequently and eliminating frustration due to boredom or repetition.

A secondary selection of reinforcing items determined through preference assessment as having a middle level value will be made available to any participant whom does not earn any tokens (stars placed on a board to visually represent correct responses) during teaching protocol phases. Access to these items will be set at one minute and this will be communicated to the student either verbally or through the use of a pictorial representation at the beginning of each experimental session.

In addition, a break card will be placed within reach of the participants. This will act as a visual cue and also a means for them to communicate any distress during any of the experimental sessions (e.g. Illness, tiredness, frustration or boredom). However, verbal or augmentative communication and any form will be accepted during the experiment. If a participant communicates distress the experiment will be stopped and resumed at a later stage. The duration of the break will be no longer than one day. Any Participant who communicates distress across five consecutive sessions may be excluded from the study. Exclusion will be made following discussion with a supervising member of the research team. Supervisors will be informed in the first instance of distress. Other measures may be considered such as gaining access to breaks sooner, different toys as rewards, longer duration of breaks, using less difficult categories' if for example frustration is displayed. Session will take place twice weekly and therefore 5 consecutive sessions would allow the researchers to identify the reasons for frustration and make changes accordingly.

3.7 MONITORING *(see Guidelines)*

All phases of the study will be run by the experimenter. If it is deemed that additional experimenters will be required they will only run only teaching and testing phases, training will be given by the experimenter. Any additional experimenters will be DCU psychology students. All data for computerized phases are collected electronically per occurrence and recorded manually. All other data will be recorded manually. Data will be checked and verified by the researcher following each session. The informed consent form will have an optional section regarding video footage. For those whom do consent video footage will be taken of the participants' performance in randomly chosen tasks. This will enable inter-reliability data checks to be performed by another research team member. The video footage will only show the participants hands working at the task; at no point will their face be shown. Additionally, no audio will be recorded as this study does not require the participants to make verbal responses. The video will not be used in any other way than to validate the data collected within session.

All participants follow the same instructions which are laid out in a visual and textual instruction board so there would be no change in the instructions participants receive. Meetings will take place on a regular basis and weekly updates will be given to the principal investigator and others as necessary. Supervision will be given by the Chief Investigator weekly or more frequently if deemed necessary. In the absence of the Chief Investigator monitoring will pass to other Investigators.

3.8 SUPPORT FOR PARTICIPANTS *(see Guidelines)*

If during the experiment the language assessment Preschool Language Scale -5 (PLS-5) indicates that a delay maybe present supports will be offered to the parents in the form of contact details for formal speech and language assessment.

3.9 DO YOU PROPOSE TO OFFER PAYMENTS OR INCENTIVES TO PARTICIPANTS?

☐ YES ☒ NO *(If YES, please provide further details.)*

3.10 DO ANY OF THE RESEARCHERS ON THIS PROJECT HAVE A PERSONAL, FINANCIAL OR COMMERCIAL INTEREST IN ITS OUTCOME THAT MIGHT INFLUENCE THE INTEGRITY OF THE RESEARCH, OR BIAS THE CONDUCT OR RESULTS OF THE RESEARCH, OR UNDULY DELAY OR OTHERWISE AFFECT THEIR PUBLICATION?

☐ YES ☒ NO *(If Yes, please specify how this conflict of interest will be addressed.)*

4. INVESTIGATORS' QUALIFICATIONS, EXPERIENCE AND SKILLS *(Approx. 200 words – see Guidelines)*

The project will be managed by Dr Sinéad Smyth. Dr Smyth has previous experience managing projects at undergraduate, MSc and PhD level. The researcher Ronda Barron who will undertake the research has already completed a taught MSc in the area and has over ten years' experience working with children with and without developmental delay. Co-supervision of the PhD student will be undertaken by Prof Julian Leslie (University of Ulster) and Prof Pamela Gallagher (DCU), who have extensive experience in the areas of Derived Relational Responding (DRR) (Prof Leslie) and psychological research more generally (both Prof Leslie & Prof Gallagher).

5. CONFIDENTIALITY/ANONYMITY

5.1 WILL THE IDENTITY OF THE PARTICIPANTS BE PROTECTED?

☒ YES ☐ NO *(If NO, please explain)*

IF YOU ANSWERED YES TO 5.1, PLEASE ANSWER THE FOLLOWING QUESTIONS:

5.2 HOW WILL THE ANONYMITY OF THE PARTICIPANTS BE RESPECTED? *(see Guidelines)*

Confidentially of all participants will be respected and each participant will be given a participant identification number e.g. P1. The participants will know the researcher by name and the researcher will know the participants by name therefore anonymity cannot be respected in this circumstance.

5.3 LEGAL LIMITATIONS TO DATA CONFIDENTIALITY: *(Have you included appropriate information in the plain language statement and consent form? See Guidelines)*

☒ YES ☐ NO *(If NO, please advise how participants will be advised.)*

6 DATA/SAMPLE STORAGE, SECURITY AND DISPOSAL *(see Guidelines)*

6.1 HOW WILL THE DATA/SAMPLES BE STORED? *(The REC recommends that all data be stored on campus)*

Stored at DCU ☒
Stored at another site ☐ **(***Please explain where and for what purpose)*

6.2 WHO WILL HAVE ACCESS TO DATA/SAMPLES?

Access by named researchers only ☒
Access by people other than named researcher(s) ☒ **(***Please explain who and for what purpose)*
Other : ☐ **(***Please explain)*
Data will be accessed in the form of a PhD thesis by PhD examiners.

6.3 IF DATA/SAMPLES ARE TO BE DISPOSED OF, PLEASE EXPLAIN HOW, WHEN AND BY WHOM THIS WILL BE DONE?
All data including video footage will be destroyed after six years, the data will be stored in DCU. Disposal of data will be conducted under DCU policies by the researcher and/or the Principal Investigator.

7. FUNDING

7.1 HOW IS THIS WORK BEING FUNDED?

The experimenter Ronda Barron is a full time PhD student in the School of Nursing and Human Sciences currently being funded through the School of Nursing and Human Sciences Post Doctoral staff grant awarded to Dr. Sinead Smyth.

7.2 PROJECT GRANT NUMBER (If relevant and/or known)

N/A

7.3 DOES THE PROJECT REQUIRE APPROVAL BEFORE CONSIDERATION FOR FUNDING BY A GRANTING BODY?

☐ YES ☒ NO

7.4 HOW WILL PARTICIPANTS BE INFORMED OF THE SOURCE OF THE FUNDING?

This information will be provided on the information sheet given to participants' parents/guardians.

7.5 DO THE FUNDERS OF THIS PROJECT HAVE A PERSONAL, FINANCIAL OR COMMERCIAL INTEREST IN ITS OUTCOME THAT MIGHT COMPROMISE THE INDEPENDENCE AND INTEGRITY OF THE RESEARCH, OR BIAS THE CONDUCT OR RESULTS OF THE RESEARCH, OR UNDULY DELAY OR OTHERWISE AFFECT THEIR PUBLICATION?

☐ YES ☒ NO *(If Yes, please specify how this conflict of interest will be addressed.)*

8. PLAIN LANGUAGE STATEMENT *(Approx. 400 words – see Guidelines)*

Parents will receive a plain language statement and written informed consent will be sought from the parents of the children. The children themselves will also be given information about the study verbally and/or in picture form as is deemed appropriate (see appendix2).

Introduction to the Research Study

You are being asked to allow your child to take part in a research study designed to teach category membership to young children. The study entitled "Derived Categorisation in Young children 2" is being conducted by Ronda Barron a PhD student in the School of Nursing and Human Sciences, Dublin City University and is supervised by Principal Investigator, Dr Sinéad Smyth of the School of Nursing and Human

Sciences, Dublin City University. This study is being funded through the School of Nursing and Human Sciences Post Doctoral staff grant awarded to Dr. Sinead Smyth. This study has been granted ethical approval by Dublin City University Research Ethics Committee.

Purpose

The purpose of this study is to compare two methods for teaching young children to categorise objects without direct training. In other words, teaching them to group common objects of a category for example, animals or food together without directly teaching every object to the category. For example, through teaching a child that shoes are a type of clothes and later taught socks belong in the same category, the child may identify without being directly taught that socks are clothes. Importantly, the categories used will have relevance to each individual child (e.g., food, toys, clothing etc.) and will teach categories previously unknown to him/her. In addition this study will allow us to gather information that may help in understanding if one method is superior to the other in terms of how quickly categories are learnt. The children will be taught different types of categories, they will either be first taught using a simple computer based program or a using a method typically used in Montessori settings. After they have been taught one way they will later be taught new categories using the other method.

Benefits

Categorisation is an important skill for the development of receptive language ability, which is our ability to understand spoken language. Both teaching methods used will teach pairs of objects (e.g. apple, banana and orange) children may then be able to demonstrate other similar pairings that are not directly taught (e.g. apple, banana, orange, pear and grape). Previous research has indicated that one of the teaching methods will help to increase the skills of the children involved and that it may also help in the development of current teaching procedures. In addition this study will allow us to gather information that may help in understanding if one method is superior to the other in terms of how quickly categories are learnt. The children will be taught different types of categories, they will either be first taught using a simple computer based program or a using a method typically used in Montessori settings. After they have been taught one way they will later be taught new categories using the other method.

Confidentiality

All participant information will be treated as confidential, and in no case will it be possible to identify participants either during the study or from the final written report. Data collection will include written reports, and computerized responding on the learning task. In all cases, children will be given a participant code (e.g. P1) and real names will not be used. If you consent to video footage being taken of your child during parts of the research, your child's footage will be given the same participant code e.g. P1. This footage will be used only to verify data collection by another member of the research team whom will only know your child by his or her code. This participant information will be store separately from the signed consent form. Data will be held on a password protected computer stored in a locked office at DCU, backup of data and any written material will be stored in a filing cabinet. Data will be destroyed following a six year period.

The experimenter will have direct contact with your child and will know them by name. This means that your child will not be anonymous to the experimenter. However, as outlined your child's identify will not be revealed to anyone other than the experimenter and chief investigator.

Participant confidentiality will be protected to the extent permitted by laws & regulations such as those described under The Child Protection Act. While it is not anticipated that any concerns could arise from participation is the study the procedures set out by your child facility/school under their policies will be followed under any such instance.

What will participation involve?

1. Participation will initially involve a language assessment and a test of your child's existing knowledge of different categories (e.g., food types, clothes etc.). This will help us to decide what categories need to be taught.

2. Once this has been completed, the training and testing will begin. Pictures of objects will be presented and your child will be asked to either show, name or match them. At this stage, correct responses will be rewarded this will be in the form of points or tokens which can be exchanged for time to play with preferred items or activities, no food or liquids will be used at any stage of the experiment. Children can access breaks at any stage.

3. Following this training, a test will take place to see if your child has developed any pairing of objects that have not been directly trained. During this stage your child will not be told whether their responses are correct or not.

4. Finally, post testing will involve the re-administration of the category sort task for the trained objects as well as the re-administration of the language assessment. This will allow a comparison of before and after the computerised training.

Risk

Your child will simply be asked to complete mostly sorting and matching tasks with picture cards. No risks to your child are anticipated (i.e., nothing above the level of risk encountered in daily life). Steps have been taken to avoid any possible frustration and/or boredom and therefore the children will be able to ask for a break at any stage during the experiment. If your child does not earn tokens he/she will be given one minute access to a selection of other preferred items/activities.

How long will participation take?

The total length of participation for each child is estimated at 16 weeks. Two sessions will be conducted weekly and the duration of each session will be no longer than 30 minutes (including breaks), sessions will be conducted during your child's school day. A follow up for language assessment will be conducted 6 months following the original date. Categorisation is a very useful skill for children to learn and this study might add to the general skills that your child is being taught on a daily basis.

The researchers will answer any further questions about the research, now or during the course of the project, and contact details are presented below:

Dr. Sinead Smyth
Rm H245D
School of Nursing and Human Sciences
Dublin City University
Dublin 9
Email: sinead.smyth@dcu.ie
Ph: 01 700 5000 EXT: 7422

Ronda Barron
School of Nursing and Human Sciences
Dublin City University
Dublin 9
Email: ronda.barron2@mail.dcu.ie

If participants have concerns about this study and wish to contact an independent person, please contact:

The Secretary, Dublin City University Research Ethics Committee, c/o Office of the Vice-President for Research, Dublin City University, Dublin 9. Tel 01-7008000

9. INFORMED CONSENT FORM *(Approx. 300 words – see Guidelines)*

I give my consent for my child ___________________________ to participate in the research titled, "Derived Categorisation in Young children", being conducted by Ronda Barron a PhD student in the School of Nursing and Human Sciences, Dublin City University and Chief Investigator, Dr Sinéad Smyth of the School of Nursing and Human Sciences, Dublin City University. This study is being funded through the School of Nursing and Human Sciences Post Doctoral staff grant awarded to Dr. Sinead Smyth. This study has been granted ethical approval through Dublin City Universities Research Ethics Committee.

Purpose

Categorisation is an important skill for the development of receptive language ability, which is our ability to understand spoken language. Both teaching methods used will teach pairs of objects (e.g. apple, banana and orange) children may then be able to demonstrate other similar pairings that are not directly taught (e.g. apple, banana, orange, pear and grape). Previous research has indicated that one of the teaching methods will help to increase the skills of the children involved and that it may also help in the development of current teaching procedures. In addition this study will allow us to gather information that may help in understanding if one method is superior to the other in terms of how quickly categories are learnt. The children will be taught different types of categories, they will either be first taught using a simple computer based program or a using a method typically used in Montessori settings. After they have been taught one way they will later be taught new categories using the other method.

Participant – please complete the following (Circle Yes or No for each question)

I have read the Information Sheet (or had it read to me)	*Yes/No*
I understand the information provided	*Yes/No*
I have had an opportunity to ask questions and discuss this study	*Yes/No*
I have received satisfactory answers to all my questions	*Yes/No*
I give permission for video footage to be taken of my child during the research for data verification only. Footage will not show my child's face nor will my child's voice be recorded Your child can still participate in this study even if you do not wish to give permission for video footage to be taken.	*Yes/No*
My child has not attended a Montessori specific school.	*Yes/No*

Confirmation that involvement in the Research Study is voluntary

I understand that this participation is entirely voluntary; I or my child can withdraw consent at any time during the study without penalty and have the results of the participation, to the extent that it can be identified as my child's, returned to me, removed from the research records, or destroyed.	*Yes/No*
I understand that once my child has completed taking part in the study and data has been analysed that this data cannot be removed.	*Yes/No*

Confidentiality

All participant information will be treated as confidential, and in no case will it be possible to identify participants either during the study or from the final written report. Data collection will include written reports, and computerized responding on the learning task. In all cases, children will be given a participant code (e.g. P1) and real names will not be used. If you consent to video footage being taken of your child during parts of the research, your child's footage will be given the same participant code e.g. P1. This footage will be used only to verify data collection by another member of the research team whom will only know your child by his or her code. This participant information will be store separately from the signed consent form. Data will be held on a password protected computer stored in a locked office at DCU, backup of data and any written material will be stored in a filing cabinet. Data will be destroyed following a six year period.

The experimenter will have direct contact with your child and will know them by name. This means that your child will not be anonymous to the experimenter. However, as outlined your child's identify will not be revealed to anyone other than the experimenter and chief investigator.

Participant confidentiality will be protected to the extent permitted by laws & regulations such as those described under The Child Protection Act. While it is not anticipated that any concerns could arise from participation is the study the procedures set out by your child facility/school under their policies will be followed under any such instance.

I have read and understood the information in this form. My questions and concerns have been answered by the researchers, and I have a copy of this consent form. Therefore, I consent to take part in this research project

Participants/Parents Signature: ________________________________

Name in Block Capitals: ________________________________

Witness: ________________________________

Date: ________________________________

If participants have further questions about this study or their rights, or if they wish to lodge a complaint or concern, they may contact:

The Chief Investigator, Dr. Sinead Smyth, School of Nursing and Human Sciences, Dublin City University, Dublin 9. Ph: 01 700 5000 EXT: 7422

If participants have concerns about this study and wish to contact an independent person, please contact:

The Secretary, Dublin City University Research Ethics Committee, c/o Office of the Vice-President for Research, Dublin City University, Dublin 9. Tel 01-7008000

References

Barron, R., Smyth, S., & Leslie, J. C., (under preparation). An individualised programme of real world category training in preschool children with autism spectrum disorder.

Kazdin, A. E. (2010). *Single-Case Research Designs: Methods for Clinical and Applied Settings.* USA: Oxford University Press.

Lovett S, Rehfeldt R, Garcia Y, Dunning J. Comparison of a stimulus equivalence protocol and traditional lecture for teaching single-subject designs. *Journal of Applied Behavior Analysis.* 2011;44:819–833.

Miguel, C. F., Petursdottir, A. I., Carr, J. E., & Michael, J. E. (2008). The role of naming in stimulus categorization by preschool children. *Journal of the Experimental Analysis of Behavior, 89,* 383-405.

Moran, L., Stewart, I., McElwee, J., & Ming, S. (2010). The Training and Assessment of Relational Precursors and Abilities (TARPA): a preliminary analysis. *Journal of autism and developmental disorders, 40*(9), 1149-53. doi:10.1007/s10803-010-0968-0

Rehfeldt, R. A. (2011). Toward a technology of derived stimulus relations: an analysis of articles published in the journal of applied behavior analysis, 1992-2009. *Journal of Applied Behavior Analysis,, 44*(1), 109-19. doi:10.1901/jaba.2011.44-109

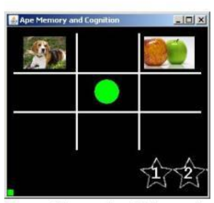
Ungerer, J., &Sigman, M. (1987). Categorization skills and receptive language development in autistic children. *Journal of Autism and Developmental Disorders, 17,* 3-16

Appendix 2: A sample of a visual textual board which will be used to explain the experimental sessions to the participants and section whereby participants can indicate participation.

When it is time for computer work, I will see this picture or my teacher will tell me “It’s time for computer work”.

We will go to the room where the computer is.

I will sit on a chair to do my computer work.



Sometimes I will be asked to sort pictures, sometimes to match pictures on the computer or to show pictures. I can get points for matching and showing pictures.

If I feel upset or need to take a break I can ask for a break or show my teacher this break card. My teacher will stop computer work until later.

When I am finished my computer work I can swop my tokens for some toys to play with for a little while.

If I have no tokens I can play with some other toys for one minute.

If I do not want to take part, I can say so by saying so or telling my teacher I'm finished. I may want to try another time or not. It is okay not to take part and all I have to do is tell my teacher.

You can tick the box or write your name if you would like to take part.

I would like to take part ☐ I do NOT want to take part ☐

You can video me ☐ Do NOT video me ☐

Signed: ______________________________________

19-03-2013

Ronda Barron/Dr. Sinead Smyth, Prof. Pamela Gallagher, Prof. Julian Leslie
School of Nursing and Human Sciences
DCU

Dear Ronda,

The School of Nursing and Human Sciences (SNHS) Ethics Advisory Committee (EAC) reviewed your ethics application form for the project: **Derived Categorisation in Young Children 2.**

The approach that the SNHS EAC takes is to make recommendations on your submission. These should be discussed with your supervisor(s) and taken into account in preparing your final submission to DCU Research Ethics Committee (REC). Please note that the comments from the SNHS EAC *do not* constitute ethics approval. The following comments are given to help facilitate your application through the DCU REC. The EAC recommends that you address the following points prior to submitting your application to DCU REC. You do not need to reply to the EAC about these points.

- **Section 1.2**. Given that the current study is an extension to one already approved by DCU REC/2012/208, please clarify if DCU REC will need to know the names of off-campus research locations (e.g. educational settings, primary schools, special education facitilies, creche or afterschool facilities) where research will be undertaken; and also confirm if ethical approval from these sites should be appended (or confirmed on receipt) to DCU REC (Please also see **Section 2.5,** page 11 'once ethical approval has been granted [by DCU REC], these facilities will take the research protocol to their board or director and a letter of acceptance will be made available'; and **Section 2.7** under 'other ethical approvals' required) .
- **Sections 2 and section 2.4.** Please clarify the final sample size of typically developing children (section 2 states n = 5 from two sites; section 2.4 states n = 10 for two sites). Additionally, please clarify how many participants will be 'screened' during the recruitment phase according to the established exclusion criteria, and is the *final* proposed sample size 10 (5 from each site)?
- **Section 2.3**. The word count (c.990) appears to exceed the guidelines of no more than 400 words in this section. The information presented in this section focuses on the teaching protocols and what children will be asked to do etc.; as well as an emphasis on language testing pre/post etc. However, the PLS for parents clearly and succinctly communicates the above in 4 points (What will participation involve?) regarding testing and implementation of the teaching protocols; so perhaps adopt this 4 pointed framework for use within the text of the application as well. Also, perhaps give more information about the actual language assessment / test (pre and post), as apart from including it in the appendix, it is not explained in detail in-text. Aslo, please briefly include a statement about the *optional* video recording of random chosen tasks for inter-reliability data checks.
- **Section 3.2**. Please clarify why 'observation of participants without their knowledge' is checked.
- **Section 3.6**. For the layperson or non-specialist on the REC panel, it may not be immediately clear what is meant by 'rewards' and also 'tokens' mentioned in the second paragraph in this section; however it is further defined in the information sheet. We suggest defining these concepts in section 3.6 as well. Additionally, please define for the non-specialist, what is meant by 'distress' (e.g. example of distress such as boredom, frustration etc.), and briefly explain why the threshold of five consecutive sessions is used in this protocol.

- **Section 3.7.** Please clarify whether the optional video recording of random chosen tasks for the purpose of inter-reliability data checks will include audio of the child plus the child's face (thus, making the child potentially identifiable).
- **Plain Language Statement (PLS):** this is very well written; however, please check for a few typographical errors. Under the confidentiality section, if a parent opts for video monitoring, then the participant is potentially identifiable (depending on use of audio, inclusion of participant's face etc.). Please also clarify if the child also signs an assent form (see **Section 2.4**)
- **PLS**: In terms of withdrawal of consent and removal of participant data, is there a point beyond which the participant's data cannot be removed, and should this be stated? That is, if the participant successfully enages with all 16 weeks, and the data are entered into SPSS for analyses, can the participant's data be removed beyond that point?

Please submit your revised application form to DCU REC (rec@dcu.ie) along with a copy of this letter. We wish you all the best with your application. For our records, please send the Vice Chairperson of the EAC a copy of the ethics approval letter when you obtain it.

Yours Sincerely,

Veronica Lambert, PhD
Chairperson
Ethics Advisory Committee
School of Nursing and Human Sciences
Dublin City University

Lorraine Boran, PhD
Vice Chairperson
Ethics Advisory Committee
School of Nursing and Human Sciences
Dublin City University

Appendix 7: Response letter to SNHS REC

Dear Sir/Madam,

Please see listed responses to issues and suggestions highlighted by the School of Nursing and Human Sciences (SNHS) Ethics Advisory Committee (EAC) in relation to the ethics application for the project: **Derived Categorisation in Young Children 2.**

1. Section 1.2. Given that the current study is an extension to one already approved by DCU REC/2012/208, please clarify if DCU REC will need to know the names of off-campus research locations (e.g. educational settings, primary schools, special education facitilies, creche or afterschool facilities) where research will be undertaken; and also confirm if ethical approval from these sites should be appended (or confirmed on receipt) to DCU REC (Please also see **Section 2.5,** page 11 'once ethical approval has been granted [by DCU REC], these facilities will take the research protocol to their board or director and a letter of acceptance will be made available'; and **Section 2.7** under 'other ethical approvals' required) .

Response

- 1.2. All facilities to be approached by the researcher are listed publically on the Department of Education and Sciences websites and also that of the Health Service Executive as discussed in Section 2.5.
- An amendment has been made to Section 1.2, 2.5 and 2.7 to include that a letter of approval will be appended to DCU REC.

2. Sections 2 and section 2.4. Please clarify the final sample size of typically developing children (section 2 states n = 5 from two sites; section 2.4 states n = 10 for two sites). Additionally, please clarify how many participants will be 'screened' during the recruitment phase according to the established exclusion criteria, and is the *final* proposed sample size 10 (5 from each site)?

Response

- A maximum number of 20 children will be screened for participation in this study. This has been amended in Section 2 and 2.4.
- The final sample size will be 10 children, and will be either situated as 10 (1 site) or 10 (5 from two sites). Until the facilities are approached there is no possible way to know if any one site has the number of children attending within the targeted age range of 3-6 years.

3. Section 2.3. The word count (c.990) appears to exceed the guidelines of no more than 400 words in this section. The information presented in this section focuses on the teaching protocols and what children will be asked to do etc.; as well as an emphasis on language testing pre/post etc. However, the PLS for parents clearly and succinctly communicates the above in 4 points (What will participation involve?) regarding testing and implementation of the teaching protocols; so perhaps adopt this 4 pointed framework for use within the text of the application as well. Also, perhaps give more information about the actual language assessment / test (pre and post), as apart from including it in the appendix, it is not explained in detail in-text. Aslo, please briefly include a statement about the *optional* video recording of random chosen tasks for inter-reliability data checks.

Response

- This section has been simplified using the above suggestion of laying out the procedure as it appears in the PLS for parents. The two protocols are now given in detail in the appendices. This has reduced to word count down 447 words.
- A short explanation has been given in regards to the use of the PLS.
- A brief sentence has been added to Section 2.3., page 9, under Data Analysis to include that were optional consent is given video footage will be used for data reliability checks.

4. **Section 3.2**. Please clarify why 'observation of participants without their knowledge' is checked.

Response

- This is an error in the application and participants will be fully aware of the experimenters observation.

4. **Section 3.6**. For the layperson or non-specialist on the REC panel, it may not be immediately clear what is meant by 'rewards' and also 'tokens' mentioned in the second paragraph in this section; however it is further defined in the information sheet. We suggest defining these concepts in section 3.6 as well. Additionally, please define for the non-specialist, what is meant by 'distress' (e.g. example of distress such as boredom, frustration etc.), and briefly explain why the threshold of five consecutive sessions is used in this protocol.

Response

- Amendment has been made to Section 3.6 to describe tokens as stars which are placed on a board giving the children a visual representation of correct responses.
- Distress has been clarified using the example (e.g. illness, tiredness, frustration or boredom).
- A section has been added to clarify the reasoning behind the exclusionary criteria and also other measures/steps that may be taken.

5. **Section 3.7.** Please clarify whether the optional video recording of random chosen tasks for the purpose of inter-reliability data checks will include audio of the child plus the child's face (thus, making the child potentially identifiable).

Response

- Section 3.7 has been clarified to include: The video footage will only show the participants hands working at the task; at no point will their face be shown. Additionally, no audio will be recorded as this study does not require the participants to make verbal responses. The video will not be used in any other way than to validate the data collected within session.

- This information has also been amended to the Informed Consent, Section 9.

6. Plain Language Statement (PLS): this is very well written; however, please check for a few typographical errors. Under the confidentiality section, if a parent opts for video monitoring, then the participant is potentially identifiable (depending on use of audio, inclusion of participant's face etc.). Please also clarify if the child also signs an assent form (see **Section 2.4**)

Response

- Typographical errors have been addressed.
- For children who are able to give consent to the study this has been accounted for in Appendix 2. Additionally for the children whereby parental consent for video footage is agreed to an additional tick box will be added to the consent form, Appendix 2.

You can video me ☐ Do NOT video me ☐

7. PLS: In terms of withdrawal of consent and removal of participant data, is there a point beyond which the participant's data cannot be removed, and should this be stated? That is, if the participant successfully engages with all 16 weeks, and the data are entered into SPSS for analyses, can the participant's data be removed beyond that point?

Response

- *The consent form has been amended to include the following:*
  1. *I understand that this participation is entirely voluntary; I or my child can withdraw consent at any time during the study without penalty and have the results of the participation, to the extent that it can be identified as my child's, returned to me, removed from the research records, or destroyed*
  2. *I understand that once my child has completed taking part in the study and data has been analysed that this data cannot be removed.*

This study is being conducted with the field of behavior analysis, and data will be in keeping with other single-subject research, data analysis will be descriptive and will compare within and across participants. Inferential statistical analyses will not be conducted. Data collection will include written reports, and recorded performance in order to compare participant's performance on the two teaching protocols. Data analysis will include 1) performance in the category sort testing and 2) speed of acquisition for each teaching protocol.

Ollscoil Chathair Bhaile Átha Cliath
Dublin City University

Dr. Sinéad Smyth
School of Nursing and Human Sciences

23rd May 2013

REC Reference: DCUREC/2013/134

Proposal Title: **Derived Categorisation in Young Children 2**

Applicants: Dr. Sinéad Smyth, Prof. Pamela Gallagher, Prof. Julian Leslie, Ms. Ronda Barron

Dear Sinéad,

Further to expedited review, the DCU Research Ethics Committee approves this research proposal. Materials used to recruit participants should note that ethical approval for this project has been obtained from the Dublin City University Research Ethics Committee. Should substantial modifications to the research protocol be required at a later stage, a further submission should be made to the REC.

Yours sincerely,

DCU
Research & Innovation

Dónal O'Mathúna

Dr. Donal O'Mathuna
Chairperson
DCU Research Ethics Committee

Taighde & Nuálaíocht Tacaíocht
Ollscoil Chathair Bhaile Átha Cliath,
Baile Átha Cliath, Éire

Research & Innovation Support
Dublin City University,
Dublin 9, Ireland

T +353 1 700 8000
F +353 1 700 8002
E research@dcu.ie
www.dcu.ie

Appendix D: Copy of ethical application and approval letter for Study 3 (Chapter 4).

Research and Innovation Support

Dublin City University
RESEARCH ETHICS COMMITTEE

APPLICATION FOR APPROVAL OF A PROJECT INVOLVING **HUMAN PARTICIPANTS**

Application No. *(office use only)* DCUREC/2014/____

This application form is to be used by researchers seeking ethics approval for individual projects and studies. Your application must be e-mailed to the DCU Research Ethics Committee at rec@dcu.ie –no hardcopy required. **Student applicants must cc their supervisor on that e-mail –** this applies to undergraduate, masters and postgraduate students.

NB - The application should consist of one electronic file only, with an electronic signature from the PI. The completed application must incorporate all supplementary documentation, especially that being given to the proposed participants. It must be proofread and spellchecked before submission to the REC.

All sections of the application form must be answered – please consult the Guidelines to Applicants on page 2 where directed. Applications which do not adhere to these requirements will not be accepted for review and will be returned directly to the applicant.

Applications must be completed on the form; answers in the form of attachments will not be accepted, except where indicated. No hardcopy applications will be accepted. **Research must not commence until written approval has been received from the Research Ethics Committee.**

Note: If your research requires approval from the Biosafety Committee, this approval should be in place prior to REC submission. Please attach the approval from the BSC to this submission.

PROJECT TITLE	Derived Categorisation in Young Children 3
PRINCIPAL INVESTIGATOR(S)	Dr. Sinéad Smyth
START AND END DATE	March 2014 – October 2015

Please confirm that all supplementary information is included in your application (in electronic copy). If questionnaire or interview questions are submitted in draft form, please indicate this by putting (draft) after YES. A copy of the final documentation must be submitted for final approval when available.

	INCLUDED (mark as YES)	NOT APPLICABLE
Bibliography	Y	
Recruitment advertisement		N/A
Plain language statement/Information Statement	Y	
Informed Consent form	Y	
Evidence of external approvals related to the research	Y	
Questionnaire/Survey		N/A
Interview/Focus Group Questions		N/A
Debriefing material		N/A
Other (INSERT TYPE)	Appendices	

Please note:

1. Any amendments to the original approved proposal must receive prior REC approval.
2. As a condition of approval investigators are required to document and report immediately to the Secretary of the Research Ethics Committee any adverse events, any issues which might negatively impact on the conduct of the research and/or any complaint from a participant relating to their participation in the study

Last updated December 2013 Page 1

Please submit the electronic copy of your completed application to rec@dcu.ie

Guidelines to Applicants

1.1 PRINCIPAL INVESTIGATOR(S): *The named Principal Investigator is the person with primary responsibility for the research project. Doctoral researchers and Research Masters or their supervisors may be listed as Principal Investigators, depending on the conventions of the discipline and on the individual case. It should be made clear, in subsequent sections of this application, who is carrying out the research procedures. In the case of Taught Masters and undergraduate student projects the supervisors are Principal Investigators.*

2.0 PROJECT OUTLINE: *Provide a brief outline of the project, aims, methods, duration, funding, profile of participants and proposed interaction with them. This description must be in everyday language that is free from jargon. Please explain any technical terms or discipline-specific phrases.*

2.1 LAY DESCRIPTION: *Provide a brief outline of the project, including what participants will be required to do. This description must be in everyday language which is free from jargon. Please explain any technical terms or discipline-specific phrases. (No more than 300 words).*

2.2 AIMS OF AND JUSTIFICATION FOR THE RESEARCH: *State the aims and significance of the project (approx. 400 words). Where relevant, state the specific hypothesis to be tested. Also please provide a brief description of background research, a justification as to why this research project should proceed in that context and an explanation of any expected benefits to the community.* ***NB – all references cited should be listed in an attached bibliography.***

2.3 PROPOSED METHOD: *Provide an outline of the proposed method, including details of data collection techniques, tasks participants will be asked to do, the estimated time commitment involved, and how data will be analysed. If the project includes any procedure which is beyond already established and accepted techniques please include a description of it. There should be enough detail provided to facilitate ethical review, but applicants are encouraged to keep it as succinct as possible.*

2.4 PARTICIPANT PROFILE: *Provide number, age range and source of participants. Please provide a justification of your proposed sample size. Please provide a justification for selecting a specific gender.*

2.5 MEANS BY WHICH PARTICIPANTS ARE TO BE RECRUITED: *Please provide specific details as to how you will be recruiting participants. How will people be told you are doing this research? How will they be approached and asked if they are willing to participate? If you are mailing to or phoning people, please explain how you have obtained their names and contact details. This information will need to be included in the plain language statement. If a recruitment advertisement is to be used, please ensure you attach a copy to this application.*

3.3 POTENTIAL RISKS TO PARTICIPANTS AND RISK MANAGEMENT PROCEDURES: *Identify, as far as possible, all potential risks to participants (physical, psychological, social, legal or economic etc.), associated with the proposed research. Please explain what risk management procedures will be put in place.*

3.6 ADVERSE/UNEXPECTED OUTCOMES: *Please describe what measures you have in place in the event that there are any unexpected outcomes or adverse effects to participants arising from involvement in the project.*

3.7 MONITORING: *Please explain how you propose to monitor the conduct of the project (especially where several people are involved in recruiting or interviewing, administering procedures) to ensure that it conforms with the procedures set out in this application. In the case of student projects please give details of how the supervisor(s) will monitor the conduct of the project.*

3.8 SUPPORT FOR PARTICIPANTS: *Depending on risks to participants you may need to consider having additional support for participants during/after the study. Consider whether your project would require additional support, e.g., external counselling available to participants. Please advise what support will be available.*

4.0 INVESTIGATORS' QUALIFICATIONS, EXPERIENCE AND SKILLS: *List the academic qualifications and outline the experience and skills relevant to this project that the PI, other researchers and any supporting staff have in carrying out the research and in dealing with any emergencies, unexpected outcomes, or contingencies that may arise.*

5.2 HOW WILL THE ANONYMITY OF THE PARTICIPANTS BE RESPECTED? *Please bear in mind that where the sample size is very small, it may be impossible to guarantee anonymity/confidentiality of participant identity. Participants involved in such projects need to be advised of this limitation in the Plain Language Statement/Information Sheet.*

5.3 LEGAL LIMITATIONS TO DATA CONFIDENTIALITY: *Participants need to be aware that confidentiality of information provided can only be protected within the limitations of the law - i.e., it is possible for data to be subject to subpoena, freedom of information claim or mandated reporting by some professions. Depending on the research proposal you may need to specifically state these limitations.*

6.0 DATA/SAMPLE STORAGE, SECURITY AND DISPOSAL: *For the purpose of this section, "Data" includes that in a raw or processed state (e.g. interview audiotape, transcript or analysis). "Samples" include body fluids or tissue samples.*

8.0 PLAIN LANGUAGE STATEMENT: *This is written information in plain language that you will be providing to participants, outlining the phases and nature of their involvement in the project and inviting their participation. Please note that the language used must reflect the participant age group and corresponding comprehension level. See link to sample template below.*

9.0 INFORMED CONSENT FORM: *This is a very important document that should be addressed by participants to researchers, requiring participants to indicate their consent to specific statements, and give their signature. See link to sample template below.*

FOR FURTHER INFORMATION AND NOTES ON THE DEVELOPMENT OF PLAIN LANGUAGE STATEMENTS AND INFORMED CONSENT FORMS, PLEASE CONSULT THE DCU REC WEBSITE: *HTTP://WWW4.DCU.IE/RESEARCH/RESEARCH_ETHICS/REC_FORMS.SHTML*

1. ADMINISTRATIVE DETAILS

PROJECT TYPE: *(mark Y to as many as apply)*	Research Project	…	Funded Consultancy	…
	Practical Class	…	Clinical Trial	…
	Student Research Project *(please state level, e.g. PhD/MSc Research/MSc Taught)*	Y PhD …	Other - *Please Describe:*	…

1.1 INVESTIGATOR CONTACT DETAILS *(see pg. 2 Guidelines)*

PRINCIPAL INVESTIGATOR(S):

NAME	*SCHOOL/UNIT*	*EMAIL*
Dr. Sinead Smyth	SNHS	sinead.smyth@dcu.ie

(NB – if the applicant is from the School of Nursing and Human Sciences, please note all students including PhD's must attach the letter from the NHS Ethics Advisory Committee to this application)

OTHER INVESTIGATORS:

NAME	*SCHOOL/UNIT*	*EMAIL*
Prof Pamela Gallagher	SNHS	pamela.gallagher@dcu.ie
Prof Julian Leslie	University of Ulster	jc.leslie@ulster.ac.uk
Ms Ronda Barron	SNHS	barron.r2@mail.dcu.ie

1.2 WILL THE RESEARCH BE UNDERTAKEN ON-SITE AT DUBLIN CITY UNIVERSITY? /No

Research will take place within educational settings, specifically primary schools. A number of schools in Dublin and surrounding areas will be approached and exact sites have not yet been identified. A letter of acceptance from the participating schools will be amended to DCU REC, please see Section 2.5.

1.3 IS THIS PROTOCOL BEING SUBMITTED TO ANOTHER ETHICS COMMITTEE, OR HAS IT BEEN PREVIOUSLY SUBMITTED TO AN ETHICS COMMITTEE?) Yes

DCUREC/2012/208 Derived Categorisation in Young Children 1 and
DCUREC/2013/134 Derived Categorisation 2 (Teaching Protocol 1)

The protocol has previously been used to establish category membership with two populations the first typically developing and secondly children with a diagnosis of autistic Spectrum Disorder. In addition the protocol has been employed in a separate study as a comparison to traditional teaching methods (See Appendix 1 for copies of DCUREC approval letters).

(If YES, please provide details and copies of approval(s) received etc.)

DECLARATION BY PRINCIPAL INVESTIGATOR(S)

The information contained herein is, to the best of my knowledge and belief, accurate. I have read the University's current research ethics guidelines, and accept responsibility for the conduct of the procedures set out in the attached application in accordance with the form guidelines, the REC guidelines (https://www4.dcu.ie/researchsupport/research_ethics/guidelines.shtml), *the University's policy on Conflict of Interest, Code of Good Research Practice and any other condition laid down by the Dublin City University Research Ethics Committee or its Sub-Committees. I have attempted to identify all risks related to the* *research that may arise in conducting this research and acknowledge my obligations and the rights of the participants.*

If there any affiliation or financial interest for researcher(s) in this research or its outcomes or any other circumstances which might represent a perceived, potential or actual conflict of interest this should be declared in accordance with Dublin City University policy on Conflicts of Interest.

I and my co-investigators or supporting staff have the appropriate qualifications, experience and facilities to conduct the research set out in the attached application and to deal with any emergencies and contingencies related to the research that may arise.

Electronic Signature(s):

Principal investigator(s): ____

Print Name(s) here:_____ Sinéad Smyth ____

Date: 28/02/14______

2. PROJECT OUTLINE

2.1 LAY DESCRIPTION *(No more than 300 words - see pg. 2 Guidelines)*

Categorisation is a skill typically learned in childhood. Categories learned initially are usually simple and develop through day-to-day interaction. Complex categories, such as knowledge of elements in the periodic table, generally need to be directly taught because the natural environment often does not present the opportunity to learn complex categories and in some contexts may not be appropriate. The current study will extend our previous work by attempting to determine if this computerised behaviour analytic teaching protocol is effective within a group setting. The objects/concepts to be categorised will be chosen from within the primary school curriculum and will therefore have relevance to the children's lives and educational goals. A simple test will be conducted prior to the lesson commencing which will establish the children's prior level of knowledge. The lesson will be delivered via a computerised program which will be linked to either an interactive whiteboard or projector. The program will display pictures that are matched to a comparison (e.g. a sample Dublin followed by three comparisons Cork, Galway and Meath). The children as a group will be required to look at one object/word and then choose from an array of three the object/word that they believe best goes with the first object. Pupils will be asked to respond either by raising a coloured card to indicate their choice or electronically (pressing a button). Upon completion of the 30 minute lesson an additional test will be administered. Performance and progression on the training phases will be group dependent (the choice of the majority). Upon completion of the 30 minute lesson an additional test will be administered. This will allow a direct comparison of the children's knowledge of the categories before and following the lesson. Performance between pre- and post intervention category sort scores, and group means for the lesson will be assessed. It is assumed that not all children in a class will take part and so the study will take place in a separate room on site during a time identified as convenient by the school so as to minimise any potential disruption.

2.2 AIMS OF AND JUSTIFICATION FOR THE RESEARCH *(Approx. 400 words - see pg. 2 Guidelines)*

This study aims to establish if a behaviour analytic teaching protocol is effective when delivered within a group setting in a mainstream teaching environment. No known research to date has attempted to directly employ this methodology to a young population within a mainstream group setting using group instruction and responding.

The study therefore has three aims

1. To establish if the behaviour analytic protocol is effective at an individual basis, pre and post testing phases.
2. To examine group responding during the teaching protocol.
3. To determine if the protocol is effective across different school settings.

Justification

Categorisation is a skill typically learned in childhood. Categories learned initially are usually simple and develop through day to day interaction. Complex categories, such as knowledge of elements in the periodic table, generally need to be directly taught because the natural environment often does not present the opportunity to learn complex categories and in some contexts may not be appropriate.

The current study will extend our previous work by attempting to determine if this behaviour analytic teaching protocol is effective within a group setting. The teaching protocol has been tested experimentally in teaching a variety of skills to a cross-section of populations (e.g., Miguel, Petursdottir, Carr, & Michael, 2008; Moran, Stewart, McElwee, & Ming, 2010), however, Rehfeldt,(2011) highlighted the importance of programmes of applied research in testing assumptions that education approaches under laboratory conditions will transfer to the real world. Although our previous studies have indicated that the protocol is effective on a one-to-one basis, much structured childhood teaching takes place in group settings. It is therefore a very important part of the current programme of research to test the protocol for use in a classroom setting. Previous research Fields et al. (2009); Fienup, Hamelin, Reyes-Giordano, & Falcomata, (2011) has employed the protocol in group settings with university level students. However, responding was on an individual basis. The current study will extend this work by using both group instruction and group responding.

2.3 PROPOSED METHOD *(see pg. 2 Guidelines)*

Materials

Three sets of three pictures representing objects or words to be categorised (e.g., Dublin, Wicklow and Meath = Leinster; Galway, Mayo, Roscommon = Connaught; Cork, Tipperary, Kerry = Munster).

Procedure

1. Participation will initially involve a test asking children to match or sort items into groups (10 minutes duration). This test is used to determine the child's existing knowledge of the items to be categorised (see Appendix 2).

2. Once this has been completed, the computerised lesson will begin (see Appendix 2 for a sample of how stimuli appear on the screen). Phase 1 of the lesson involves asking the participants which one they believe goes together (If you have Dublin, which one would you choose, A) Cork B) Galway or C) Wicklow. In order to ensure that all participants respond, they will be asked to raise a coloured card to indicate their preference of which object they believe to be the correct comparison (e.g., blue for object on the left, yellow in the middle, white on the right) or electronically by pressing a coordinating button (e.g. left, middle and right).The comparison which yields the majority of cards raised will determine which object is selected for the group. The duration of the lesson is estimated at 15 minutes but will not exceed 30 minutes. The second phase of the lesson involves testing the items from Phase 1 using the same computerised matching program (see Appendix 4 for a schematic representative of the phases of the lesson.)

During training, feedback will be provided by the computer programme. Majority responses that are correct are followed by a green symbol and incorrect by a red symbol which will appear on screen following selection. Reinforcement will be given to the group as a whole for correct responses (see Appendix 2).

3. Category training will take place last. The category label (Leinster) will be trained to the C stimuli the object/word the children had last exposure to. For example if e.g. A1 (Dublin), B1 (Wicklow) and C1, (Meath) are one class, the children will be taught that C1 (Meath) is in Leinster. It is anticipated that category training will take using the same computerised matching program. However,

following the pilot study minor modifications may be made to this phase of the protocol. Modifications may include the objects being paired together on the screen, or children being asked to select a corresponding picture from an array of three following hearing the category label.

4. Finally, post testing will involve the re-administration of the pre-test in order to determine if learning has taken place (10 Minutes).

2.4 PARTICIPANT PROFILE *(see pg. 2 Guidelines)*

The population to be sampled during the study will be typically developing children aged between 6 and 12 years. That is children whom do not have a diagnosed disorder such as autistic spectrum disorder or a specific speech and language disorder. If, for example, children in second class are recruited in one school, children from the same year group will then be recruited from the second school. The age range will not affect the study because the stimuli chosen will be age appropriate and so the age range is being left open so as to better our chances to recruit the required numbers.

The population to be sampled are classed as a vulnerable group due to their age. However, a number of steps will be taken to ensure the safety of this group. Written informed consent will be sought from the parents of the children and the children themselves will also be given information about the study (verbally and/or in picture form as is deemed appropriate). The children will be asked to indicate before the first session if they wish to take part and will be able to ask for a break or to terminate the session at any point. The short length of the total experiment (approximately 1 hour) means that boredom and frustration are unlikely. The researcher will look for signs of these (e.g. physically not participating, not making any response) and will terminate the sessions as appropriate. Previous research has indicated that the teaching protocol is effective and efficient. The material to be taught will be chosen from the school curriculum and pre-testing will ensure that the majority of children do not already know these categories. It is therefore anticipated that the sessions will be beneficial for the children by teaching categories that were previously unknown through a very quick and efficient method. Nonetheless, parents and teachers will be made aware that this is a short test of a teaching method and so large gains will not be expected.

Participants: Children aged 6-12 (n=90) will be sampled from across 3 Dublin based primary school settings. The wide age range 6-12 years old is to allow us to gain ethical approval to approach schools and recruit from within. Once contact has been made and approval gained the age bands will be reduced to a specified band. The actual age range of participants will be much smaller for example 7-8 years old and therefore will be loosely age matched across schools. That is, all participants from each school will be within the age range of 7-8 years old. This is necessary to ensure that the skills targeted (chosen from the national school curriculum) are age appropriate for each group of participants. Three schools will be approached in the first instance and additional schools will subsequently approached where a school does not express interest in the study. Therefore if three schools are approached and two express interest, one additional school will be approached until three have given approval. The initial sties will be schools where the researchers have existing contacts.

The schools approached will be mixed boys and girls. A maximum number of 30 children will be recruited for participation in this study from each of the three schools. Department of education and science primary school pupil to teacher ratios are minimally 28 students to one teacher (Circular 0007/2014).

The study will be focusing on group responding as an outcome so it is not imperative that numbers of participants are exact across locations. Parents will be sent an information sheet through the school and their child will be invited to take part in the study. Informed consent will be sought from parents/guardians and the children. The Children will have an opportunity to consent when the instructions are given to them prior to the research commencing. It is anticipated that all sessions will take place within a room separate to the children's classroom. This will allow the teacher to engage with other students whom may not have consented to take part. However, until contact and approval has been sought it is impossible to clarify exact locations. People present will include the researcher and participants. It is possible that the teacher may be present but clarification on this will only be given when schools are approached.

All participants will be given a break card this will act as a visual cue and also a means for them to communicate wish to withdraw or any distress during any of the experimental sessions (e.g. Tiredness, illness, frustration or boredom). However, verbal communication will be accepted during the experiment.

If a participant wishes to withdraw they can do so at any stage and the experimental session will continue for all other participants. If a participant communicates distress the experiment will be stopped for all participants briefly and resumed at a later stage. The duration of the break will be no longer than one day. Exclusions may be made following discussion with a supervising member of the research team. Supervisors will be informed in the first instance of distress.

2.5 MEANS BY WHICH PARTICIPANTS ARE TO BE RECRUITED *(see pg. 2 Guidelines)*

All facilities to be approached by the researcher are listed publically on the Department of Education and Sciences websites. The researcher has worked within the preschool and primary level education sector for over 11 years. Research contacts are already available within primary schools where the researcher has previously collaborated. Other facilities will be recruited as necessary. Once ethical approval has been granted these schools will take the research proposal to their principal or board and a letter of acceptance will be made available, a copy of this letter will be **forwarded to** DCU REC. Where new facilities are to be recruited the researcher will make initial contact via telephone identifying herself and will request to speak to the principal of the school. If unavailable an appointment or return call will be requested. The researcher will establish if the school is willing to participate in research studies. If the school is one which is will to accept researchers into their facilities then a brief description of the project will be given. The researcher will offer to send the information packs and consent by either mailing electronically or via postal service. Three schools will be approached in the first instance and additional schools will subsequently approached where a school does not express interest in the study. Therefore if three schools are approached and two express interest, one additional school will be approached until three have given approval.

Parents will be approached by the school and an information pack given, where appropriate the researcher will organize a site visit to meet parents and answer any questions they may have. A deadline for returning of pack will be agreed with the school such as a two week period. Only children whose parents return a signed form with the specified period will be included in the study. The study will take place in a separate room in the school so only those children participating will be present.

2.6 PLEASE EXPLAIN WHEN, HOW, WHERE, AND TO WHOM RESULTS WILL BE DISSEMINATED, INCLUDING WHETHER PARTICIPANTS WILL BE PROVIDED WITH ANY INFORMATION AS TO THE FINDINGS OR OUTCOMES OF THE PROJECT?

The proposed research will form one part of the researcher's PhD research area (Study 3) and will therefore be subject to examination in the form of a thesis. The proposed will be written up for publication in peer reviewed flagship journals in the area such as the Journal of Applied Behaviour Analysis, and the Journal of the Experimental Analysis of Behaviour. Dissemination of the findings will also take place at national and international conferences including those of the Psychological Society of Ireland (including the Division of Behaviour Analysis), the Association for Behaviour Analysis (International).

2.7 ARE OTHER APPROVALS REQUIRED TO GAIN ACCESS TO ANOTHER LOCATION, ORGANISATION ETC.? Y

(If YES, please specify from whom and attach a copy of the approval documentation. If this is not yet available, please explain when this will be obtained.)

ONCE ETHICAL APPROVAL HAS BEEN GRANTED, FACILITIES IDENTIFIED WILL TAKE THE RESEARCH PROPOSAL TO THEIR BOARD OR DIRECTOR AND A LETTER OF ACCEPTANCE WILL BE MADE AVAILABLE, A COPY OF THIS LETTER WILL BE APPENDED TO DCU REC.

2.8 HAS A SIMILAR PROPOSAL BEEN PREVIOUSLY APPROVED BY THE REC? Y

(If YES, please state both the REC Application Number and Project Title)

DCUREC/2012/208 Derived Categorisation in Young Children 1

DCUREC/2013/134 Derived Categorisation in Young Children 2

3. RISK AND RISK MANAGEMENT

3.1 ARE THE RISKS TO SUBJECTS AND/OR RESEARCHERS ASSOCIATED WITH YOUR PROJECT GREATER THAN THOSE ENCOUNTERED IN EVERYDAY LIFE? No

NB - YOU MUST ALSO PROVIDE A JUSTIFICATION FOR YOUR ANSWER

Children will be engaging in learning activities and using equipment that are commonly used in the school day. The topics to be taught, although previously unknown to the children, are on the primary school curriculum and would be taught at a later stage through traditional teaching methods.

3.2 DOES THE RESEARCH INVOLVE:

	YES or NO
• use of a questionnaire? (attach copy)?	No
• interviews (attach interview questions)?	No
• observation of participants without their knowledge?	No
• participant observation (provide details in section 2)?	No
• audio- or video-taping interviewees or events?	No
• access to personal and/or confidential data (including student, patient or client data) without the participant's specific consent?	No
• administration of any stimuli, tasks, investigations or procedures which may be experienced by participants as physically or mentally painful, stressful or unpleasant during or after the research process?	No
• performance of any acts which might diminish the self-esteem of participants or cause them to experience embarrassment, regret or depression?	No
• investigation of participants involved in illegal activities?	No
• procedures that involve deception of participants?	No
• administration of any substance or agent?	No
• use of non-treatment of placebo control conditions?	No
• collection of body tissues or fluid samples?	No
• collection and/or testing of DNA samples?	No

• participation in a clinical trial?	No
• administration of ionising radiation to participants?	No

3.3 POTENTIAL RISKS TO PARTICIPANTS AND RISK MANAGEMENT PROCEDURES *(see pg. 2 - Guidelines)*

No adverse effects expected. There is a possibility of frustration but the short duration of the study in addition to the novelty of the methodology is designed to minimise this risk.

3.4 ARE THERE LIKELY TO BE ANY BENEFITS (DIRECT OR INDIRECT) TO PARTICIPANTS FROM THIS RESEARCH? *Yes*

Possible benefits for participants involved if successful will be acquired knowledge of categories which are relevant to their daily and educational lives. The use of a procedure as designed here may direct other research in methods for teaching children.

3.5 ARE THERE ANY SPECIFIC RISKS TO RESEARCHERS? *(e.g. where research is undertaken at an off-campus location)* ***No***
(If YES, please describe)

3.6 DEALING WITH ADVERSE/UNEXPECTED OUTCOMES *(see pg. 2 - Guidelines)*

The study has been designed to account for the population and ages of the participants. The sessions are designed to be short, the longest session being 30 minutes, ensuring that participant's access rewards frequently and eliminating frustration due to boredom or repetition. Following each learning trial the participants will see how they performed as a group (not individual scores) and a marble will be placed into the jar (see Appendix 3).

All participants will be given a break card this will act as a visual cue and also a means for them to communicate wish to withdraw or any distress during any of the experimental sessions (e.g. Tiredness, illness, frustration or boredom). However, verbal communication will be accepted during the experiment.

If a participant wishes to withdraw they can do so at any stage and the experimental session will continue for all other participants. If a participant communicates distress the experiment will be stopped for all participants briefly and resumed at a later stage. The duration of the break will be no longer than one day. Exclusion will be made following discussion with a supervising member of the research team. Supervisors will be informed in the first instance of distress.

3.7 HOW WILL THE CONDUCT OF THE PROJECT BE MONITORED? *(see pg. 2 - Guidelines)*

All phases of the study will be run by the experimenter. All data will be recorded either electronically or manually. Data will be checked and verified by the researcher following the experiment. All participants follow the same instructions which are laid out in a visual and textual instruction board so there would be no change in the instructions participants receive. Meetings will take place on a regular basis and weekly updates will be given to the principal investigator and others as necessary.

Following implementation of the protocol in School 1, the data will be analysed and the protocol may be revised on this basis. Small changes such as the number of trials presented or the means of responding will then be tested in the second/third school. Changes may reflect participants demonstrating an unwillingness or lack of interest to participate in the study. It is anticipated that the pilot study will inform the research team of any possible behavioural issues such as boredom, and highlight issues such as difficulty of material, the need for shorter duration prior to commencing the study with the first school.

Supervision will be given by the Chief Investigator weekly or more frequently if deemed necessary. In the absence of the Chief Investigator monitoring will pass to other Investigators.

3.8 SUPPORT FOR PARTICIPANTS *(see pg. 2 - Guidelines)*

Although positive outcomes are expected, the current protocol has not previously been tested in this type of group setting. It is therefore possible, though unlikely that none of the participants will demonstrate increased knowledge as evidenced following post testing. Performance on pre and post testing is not indicative of any need for additional support any one individual may require. The researcher will however be vigilant to note any children who appear to be responding in considerably different manner from their peers. The materials to be used will be unfamiliar to the children but will be consistent with those outlined in the schools systems curriculum. Any concerns regarding performance or behaviour of any participant will be brought to the attention of the class teacher in a confidential manner. The teacher will have access to additional services and supports via the Department of Education and Science.

3.9 DO YOU PROPOSE TO OFFER PAYMENTS OR INCENTIVES TO PARTICIPANTS? *N*
(If YES, please provide further details.)

3.10 DO ANY OF THE RESEARCHERS ON THIS PROJECT HAVE A PERSONAL, FINANCIAL OR COMMERCIAL INTEREST IN ITS OUTCOME THAT MIGHT INFLUENCE THE INTEGRITY OF THE RESEARCH, OR BIAS THE CONDUCT OR RESULTS OF THE RESEARCH, OR UNDULY DELAY OR OTHERWISE AFFECT THEIR PUBLICATION? *N*
(If YES, please specify how this conflict of interest will be addressed.)

4. INVESTIGATORS' QUALIFICATIONS, EXPERIENCE AND SKILLS *(Approx. **200 words** – see pg. 2 - Guidelines)*

The project will be managed by Dr Sinéad Smyth. Dr Smyth has previous experience managing projects at undergraduate, MSc and PhD level. The researcher Ronda Barron who will undertake the research has already completed a taught MSc in the area and has over eleven years' experience working with children with and without developmental delay. Co-supervision of the PhD student will be undertaken by Prof Julian Leslie (University of Ulster) and Prof Pamela Gallagher (DCU), who have extensive experience in the areas of Derived Relational Responding (DRR) (Prof Leslie) and psychological research more generally (both Prof Leslie & Prof Gallagher).

5. CONFIDENTIALITY/ANONYMITY

5.1 WILL THE IDENTITY OF THE PARTICIPANTS BE PROTECTED? *Y*
(If NO, please explain)

IF YOU ANSWERED YES TO 5.1, PLEASE ANSWER THE FOLLOWING QUESTIONS:

5.2 HOW WILL THE ANONYMITY OF THE PARTICIPANTS BE RESPECTED? *(see pg. 2 - Guidelines)*

The emphasis of the study is on group performance and therefore individual performance will not be discussed with the participants. Performance and progression on the training phases will be group dependent (the choice of the majority). Upon completion of the 30 minute lesson an additional test will be administered.

This will allow a direct comparison of the children's knowledge of the categories before and following the lesson. Performance between pre- and post intervention category sort scores, and group means for the lesson will be assessed.

Confidentially of all participants will be respected and each participant will be given a participant identification number e.g. P1. Participation will take place within a group setting therefore participants will be aware of fellow classmates participation or non-participation and will know each other by name. Additionally, the participants will know the researcher by name and the researcher will know the participants by name therefore anonymity cannot be respected in this circumstance.

All information including that of the participants or school will not be identifiable in any written reports.

5.3 LEGAL LIMITATIONS TO DATA CONFIDENTIALITY: HAVE YOU INCLUDED APPROPRIATE INFORMATION IN THE PLAIN LANGUAGE STATEMENT AND CONSENT FORM? *(see pg. 2 - Guidelines)*
Yes
(If NO, please advise how participants will be advised.)

6 DATA/SAMPLE STORAGE, SECURITY AND DISPOSAL *(see Guidelines)*

6.1 HOW AND WHERE WILL THE DATA/SAMPLES BE STORED? *(Note that the REC recommends that all data be stored on campus – please justify any off-site storage)*

All data will be stored on campus at DCU on password protected computers (in the case of electronic data files) and in a locked filing cabinet in the Principle Investigators office (in the case of hard copies and consent forms),

6.2 WHO WILL HAVE ACCESS TO DATA/SAMPLES?
(If people other than the main researchers have access, please also explain for what purpose)

The named researchers will have access to the data and the data will also be made available to PhD examiners.

6.3 IF DATA/SAMPLES ARE TO BE DISPOSED OF, PLEASE EXPLAIN <u>HOW</u>, <u>WHEN</u> AND <u>BY WHOM</u> THIS WILL BE DONE?
(If data/samples are NOT being disposed of, please justify this decision)

All data will be destroyed in DCU after six years. . Disposal of data will be conducted under DCU policies by the researcher and/or the Principal Investigator. Electronic files will be fully deleted and paper copies will be securely destroyed as confidential waste.

7. FUNDING

7.1 HOW IS THIS WORK BEING FUNDED?

The experimenter Ronda Barron is a full time PhD student in the School of Nursing and Human Sciences currently being funded through the School of Nursing and Human Sciences Post Doctoral staff grant awarded to Dr. Sinead Smyth.

7.2 PROJECT GRANT NUMBER (If relevant and/or known – otherwise mark as N/A)
N/A

7.3 **DOES THE PROJECT REQUIRE APPROVAL BEFORE CONSIDERATION FOR FUNDING BY A GRANTING BODY?** ***N o***

7.4 **HOW WILL PARTICIPANTS BE INFORMED OF THE SOURCE OF THE FUNDING?**

This information will be provided on the information sheet given to participants' parents/guardians.

7.5 **DO THE FUNDERS OF THIS PROJECT HAVE A PERSONAL, FINANCIAL OR COMMERCIAL INTEREST IN ITS OUTCOME THAT MIGHT COMPROMISE THE INDEPENDENCE AND INTEGRITY OF THE RESEARCH, OR BIAS THE CONDUCT OR RESULTS OF THE RESEARCH, OR UNDULY DELAY OR OTHERWISE AFFECT THEIR PUBLICATION?** ***No***

If Yes, please specify how this conflict of interest will be addressed.

8. PLAIN LANGUAGE STATEMENT *(Attach as appendix to this document. Approx. 400 words – see pg. 2 - Guidelines)*

PLEASE CONFIRM WHETHER THE FOLLOWING ISSUES HAVE BEEN ADDRESSED IN YOUR PLAIN LANGUAGE STATEMENT/ INFORMATION SHEET FOR PARTICIPANTS:

	YES/NO
Introductory Statement (PI and researcher names, school, title of the research)	**Yes**
What is this research about?	**Yes**
Why is this research being conducted?	**Yes**
How will the data be used and subsequently disposed of?	**Yes**
What will happen if the person decides to participate in the research study?	**Yes**
How will their privacy be protected?	**Yes**
What are the legal limitations to data confidentiality?	**Yes**
What are the benefits of taking part in the research study?	**Yes**
What are the risks of taking part in the research study?	**Yes**
Can participants change their mind at any stage and withdraw from the study?	**Yes**
How will participants find out what happens with the project?	**Yes**
Contact details for further information (including REC contact details)	**Yes**

If any of these issues are marked NO, please justify their exclusion:

Parents will receive a plain language statement and written informed consent will be sought from the parents of the children and also the children. The children themselves will also be given information about the study verbally and/or in picture form as is deemed appropriate, and an opportunity to give consent is built into this form (see appendix2). The sample given here may be modified to reflect changes in response forms and other minor modifications made following the pilot study.

Introduction to the Research Study

You are being asked to allow your child to take part in a research study designed to teach category membership to young children. The study entitled "Derived Categorisation in Young children 3" is being conducted by Ronda Barron a PhD student in the School of Nursing and Human Sciences, Dublin City University and is supervised by Principal Investigator, Dr Sinéad Smyth of the School of Nursing and Human Sciences, Dublin City University. This study is being funded through the School of Nursing and Human Sciences Post Doctoral staff grant awarded to Dr. Sinéad Smyth. This study has been granted ethical approval by Dublin City University Research Ethics Committee.

Purpose

The purpose of this study is to look at how children learn categorise objects without direct training. Previous research conducted by our group has found this method of teaching to be very effective on a one-to-one basis. However, we now want to determine its effectiveness in a class or group setting.

Categorisation skills in young children begin with simple ideas such as that men, woman, children and babies are all people. However as we age categories become more complex. If a child is taught that Dublin is a county and later taught Meath belong in the same category Leinster, the child may identify without being directly taught that Wicklow also belongs in that category. Importantly, the categories used will have relevance to your child's education (areas will be taken for the Department of Education and Skills curriculum) and will teach categories previously unknown to him/her.

Benefits

The categories that we are going to teach will be chosen from the curriculum and will have relevance to your child's education. No research of this kind has been conducted within a group setting with this age group and therefore the experience for the children will be novel. Previous research has indicated that this method of teaching helps to increase the skills of the children involved on an individual basis, and so we have reason to believe that your child will have a positive learning experience. Importantly it may also help in the development of current teaching procedures.

Confidentiality

All participant information will be treated as confidential, and in no case will it be possible for anyone outside our research group to identify participants either during the study or from the final written report. In all cases, children will be given a participant code (e.g. P1) and real names will not be used. The data collected from your child will include his/her age, sex, any written, oral work they complete during the lesson as well as making a choice by pointing, pressing a button or showing a colour coded card. This participant information will be stored separately from the signed consent form. Data will be held on a password protected computer stored in a locked office at DCU, with backup of data and any written material will be stored in a locked filing cabinet. Data will be destroyed following a six year period.

The researcher will have direct contact with your child and will know them by name. This means that your child will not be anonymous to the researcher. Your child will also know the other participants involved by name and vice versa. However, as outlined your child's identify will not be revealed to anyone other than the experimenter and chief investigator. The emphasis of the study is on group performance and therefore individual performance will not be discussed with the participants.

Participant confidentiality will be protected to the extent permitted by laws & regulations such as those described under The Child Protection Act. While it is not anticipated that any concerns could arise from participation is the study the procedures set out by your child facility/school under their policies will be followed under any such instance.

What will participation involve?

Before the research takes place, the children will go through the instructions as a group, these instructions will explain what is involved for the students, how to make responses and the group reward will be chosen for the class from a selection of activities already predetermined for example, computer time, a football game etc.

1. Participation will initially involve a test asking children to match or sort items into groups (10 minutes duration). This test is used to determine the child's existing knowledge of the items to be categorised.

2. Once this has been completed, the computerised lesson will begin. The duration of the lesson is estimated at 15 minutes but will not exceed 30 minutes

Phase 1 of the lesson involves asking the participants which one they believe goes together (If you have Dublin, which one would you choose, A) Cork B) Galway or C) Wicklow.

Phase 2 and 3 of the lesson involves testing the items from Phase 1 using the same computerised matching program. The duration of the lesson is estimated at 15 minutes but will not exceed 30 minutes

A jar will be present for the participants to see which has a line marked half way up. When the group makes a correct response a marble will be placed into a jar. If the marbles reach above the line students will access their chosen reward for 25 minutes and if below the line15 minutes.

Phase 4 consists of category training which will take place last. For example, the category label (Leinster) will be trained to the object/word the children had last exposure to (Meath).

3. Finally, post testing will involve the re-administration of the pencil and paper test (10 minutes duration).

How long will participation take?

The length of participation is 1 hour in total. Two sessions will be conducted the first the pre-test of category knowledge (10 minutes), the second session will involve the teaching (maximum 30 minutes) and the post-test (10 minutes).

Findings

You can request a brief summary of overall findings upon completion of the project by contacting the researcher via email.

The researchers will answer any further questions about the research, now or during the course of the project, and contact details are presented below:

Dr. Sinead Smyth
Rm H245D

Ronda Barron

School of Nursing and Human Sciences
Dublin City University
Dublin 9
Email: sinead.smyth@dcu.ie
Ph: 01 700 5000 EXT: 7422

School of Nursing and Human Sciences
Dublin City University
Dublin 9
Email: ronda.barron2@mail.dcu.ie

If participants have concerns about this study and wish to contact an independent person, please contact:

The Secretary, Dublin City University Research Ethics Committee, c/o Office of the Vice-President for Research, Dublin City University, Dublin 9. Tel 01-7008000

9. INFORMED CONSENT FORM *(Attach as appendix to this document. Approx. 300 words – see pg. 2 - Guidelines)*

NB – IF AN INFORMED CONSENT FORM IS NOT BEING USED, THE REASON FOR THIS MUST BE JUSTIFIED HERE

I give my consent for my child ___________________________ to participate in the research titled, "Derived Categorisation in Young children 3", being conducted by Ronda Barron a PhD student in the School of Nursing and Human Sciences, Dublin City University and Chief Investigator, Dr Sinéad Smyth of the School of Nursing and Human Sciences, Dublin City University. This study is being funded through the School of Nursing and Human Sciences Post Doctoral staff grant awarded to Dr. Sinead Smyth. This study has been granted ethical approval through Dublin City Universities Research Ethics Committee.

Participant/Parent – please complete the following (Circle Yes or No for each question)

Engish is the primary language spoken in our home	*Yes/No*
I have read the Information Sheet (or had it read to me)	*Yes/No*
I understand the information provided	*Yes/No*
I have had an opportunity to ask questions and discuss this study	*Yes/No*
I have received satisfactory answers to all my questions	*Yes/No*
I understand that scores will not be give	*Yes/No*

Confirmation that involvement in the Research Study is voluntary

I understand that this participation is entirely voluntary; I or my child can withdraw consent at any time during the study without penalty and have the results of the participation, to the extent that it can be identified as my child's, returned *Yes/No* *to me, removed from the research records, or destroyed.*

I understand that once my child has completed taking part in the study and data has been analysed that this data cannot be removed. *Yes/No*

Confidentiality

All participant information will be treated as confidential, and in no case will it be possible to identify participants either during the study or from the final written report. Data collection will include written reports, and computerized responding on the learning task. In all cases, children will be given a participant code (e.g. P1) and real names will not be used. This participant information will be store separately from the signed consent form. Data will be held on a password protected computer stored in a locked office at DCU, backup of data and any written material will be stored in a filing cabinet. Data will be destroyed following a six year period.

The experimenter will have direct contact with your child and will know them by name. This means that your child will not be anonymous to the experimenter. Your child will also know the other participants involved by name and vice versa. However, as outlined your child's identify will not be revealed to anyone other than the experimenter and chief investigator. The emphasis of the study is on group performance and therefore individual performance will not be discussed with the participants.

Participant confidentiality will be protected to the extent permitted by laws & regulations such as those described under The Child Protection Act. While it is not anticipated that any concerns could arise from participation is the study the procedures set out by your child facility/school under their policies will be followed under any such instance.

I have read and understood the information in this form. My questions and concerns have been answered by the researchers, and I have a copy of this consent form. Therefore, I consent to take part in this research project. Your child will be asked to give their consent on the day the study commences.

Participants Signature: ______________________________

Parent/Gaurdian Signature: ______________________________

Name in Block Capitals: ______________________________

Witness: ______________________________

Date: ______________________________

If participants have further questions about this study or their rights, or if they wish to lodge a complaint or concern, they may contact:

The Chief Investigator, Dr. Sinead Smyth, School of Nursing and Human Sciences, Dublin City University, Dublin 9. Ph: 01 700 5000 EXT: 7422

If participants have concerns about this study and wish to contact an independent person, please contact:

The Secretary, Dublin City University Research Ethics Committee, c/o Office of the Vice-President for Research, Dublin City University, Dublin 9. Tel 01-7008000

References

Fields, L., Travis, R., Roy, D., Yadlovker, E. D., Aguiar- Rocha, L., & Sturmey, P. (2009). Equivalence class formation: A method for teaching statistical interactions. *Journal of Applied Behavior Analysis, 42,* 575–593.

Fienup, D.M., Hamelin, J., Reyes-Giordano, K., & Falcomata, T. S. (2011). College-level instruction: Derived relations and programmed instruction. *Journal of Applied Behavior analysis, 44,* (2), 413-416.

Kazdin, A. E. (2010). *Single-Case Research Designs: Methods for Clinical and Applied Settings.* USA: Oxford University Press.

Miguel, C. F., Petursdottir, A. I., Carr, J. E., & Michael, J. E. (2008). The role of naming in stimulus categorization by preschool children. *Journal of the Experimental Analysis of Behavior, 89,* 383-405.

Moran, L., Stewart, I., McElwee, J., & Ming, S. (2010). The Training and Assessment of Relational Precursors and Abilities (TARPA): a preliminary analysis. *Journal of autism and developmental disorders*, *40*(9), 1149-53. doi:10.1007/s10803-010-0968-0

Rehfeldt, R. A. (2011). Toward a technology of derived stimulus relations: an analysis of articles published in the journal of applied behavior analysis, 1992-2009. *Journal of Applied Behavior Analysis,*, *44*(1), 109-19. doi:10.1901/jaba.2011.44-109

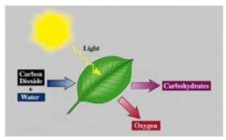
Appendix 2: A sample of a test which will be used both pre and post experimentally.

Place a tick in the box you think goes with the words or picture. Only put a mark in one box.

1. Has the largets number of species?

ANIMALIA ☒ PLANTAE ☐ FUNGI ☐

2. Which is an Autotroph (makes its own food)?]



PLANTAE ☒ FUNGI ☐ ANIMALIA ☐

3. Which one has over 250,000 species?

FUNGI ☐ ANIMALIA ☐ PLANTAE ☒

4. Which includes mushrooms, molds and yeast?

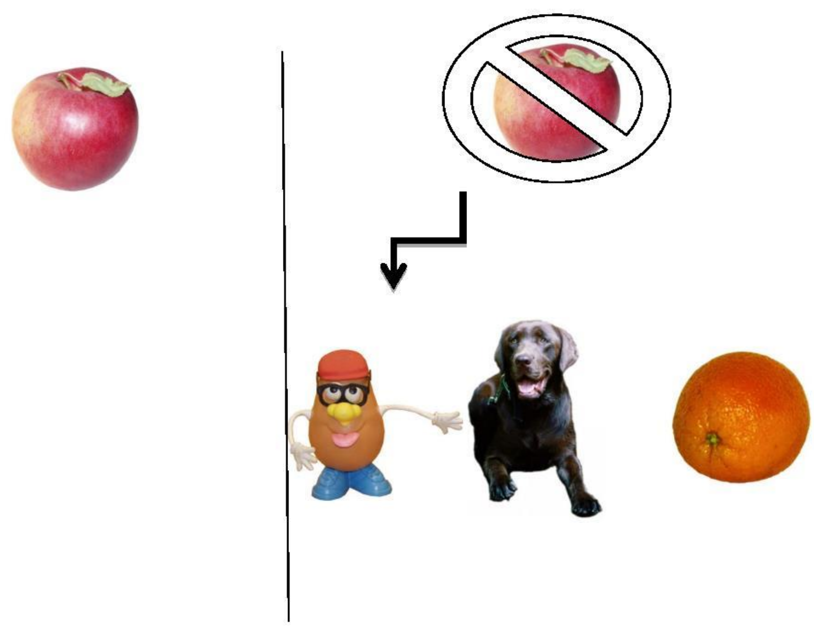
FUNGI ☒ ANIMALIA ☐ PLANTAE ☐

Appendix 3: A sample of a visual textual board which will be used to explain the experimental sessions to the participants and section whereby participants can indicate participation.

Today you are all going to take part in a lesson which will be different to the way that you normally learn in school.

As a group we will be looking at putting or matching things together.

An object will appear on the top of the screen. Once I press this object it will disappear and three objects will appear on the bottom of the screen.



You each have three coloured cards in front of you.

LEFT **MIDDLE** **RIGHT**

In the example above if you believe an apple goes with Mr. Potato Head you would choose the one on left **(BLUE CARD).**

In the example above if you believe an apple goes with dog you would choose the one on middle **(YELLOW CARD).**

In the example above if you believe an apple goes with orange you would choose the one on right (WHITE CARD).

You will be asked to raise one card up for each selection.

The colour card that most people hold up is the one we will choose. If it is correct a green symbol will appear and a marble will be placed into our jar. If it is incorrect a red symbol will appear but we do not put a marble in the jar.

We want to fill up the jar as much as possible.

There is a line on the jar.

If we can fill the jar past the line the whole class will earn 25 minutes play time.

If we do not fill the jar past the line it is okay and the whole class will still get 15 minutes play time.

We are going to choose what activity we would like now and practice using our cards.

Would you like to play

 or 

BLUE CARD YELLOW CARD

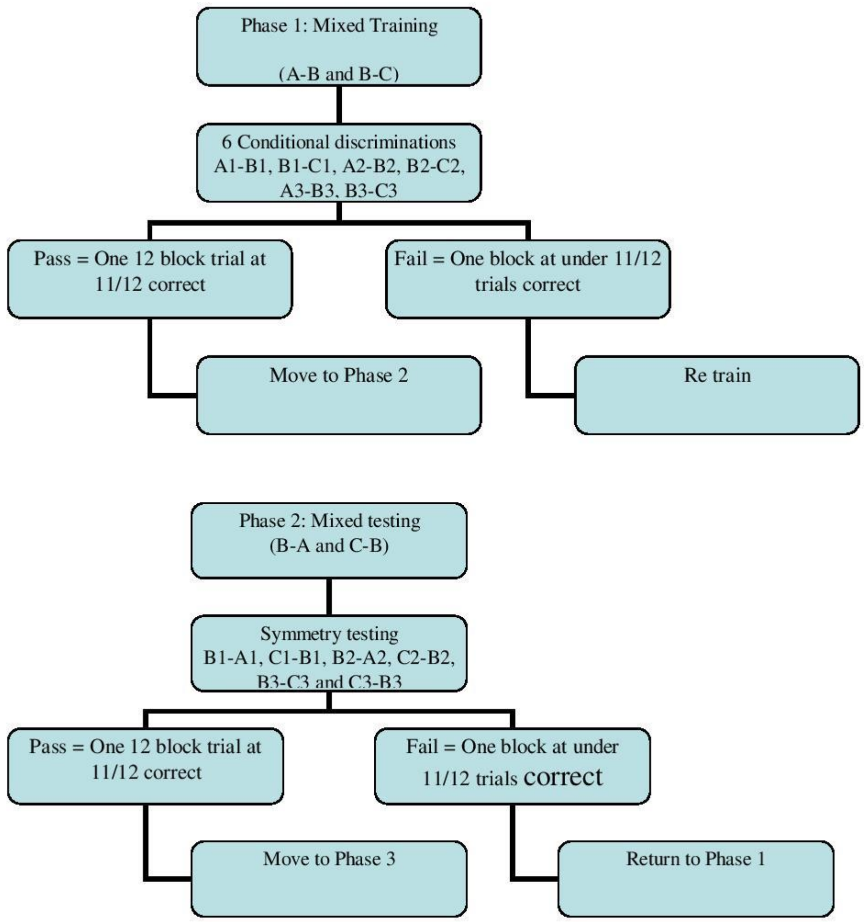
More people put up their XXX card for e.g. football. So we are going to earm marbles to play football.

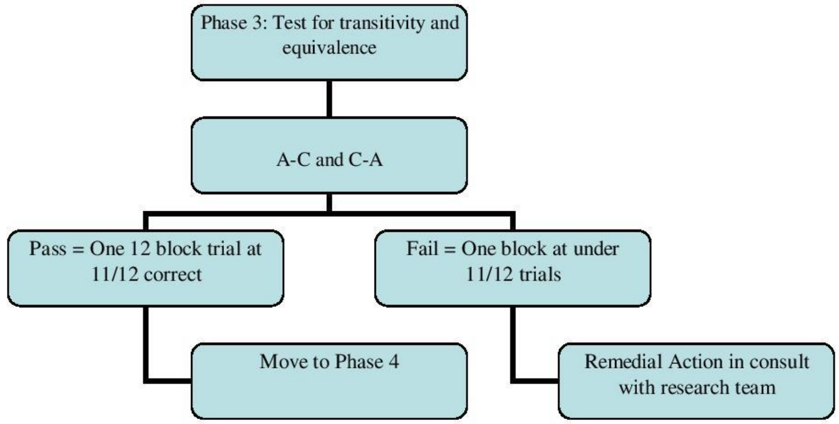
You also have a yellow card that says break on it. If you feel sick, or that you don't want to take part you can raise this and let me know. You can also raise your hand or call my name too.

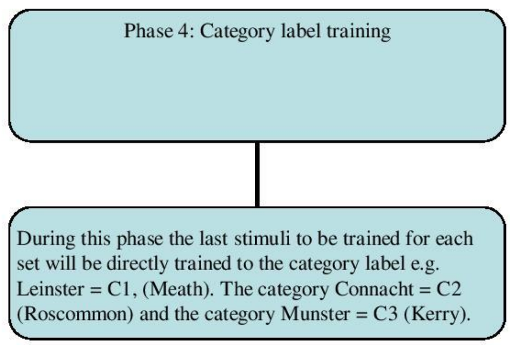
If you want to take part please sign your name below:

____

Appendix 4: Schematic representative of computerized experimental phasesIn Experimental Phases 1-4 all stimuli are representative objects/words of categories identified for training during the category sort test. The stimuli are represented alphanumerically (for example the category Leinster: A1 (Dublin), B1 (Wicklow) and C1, (Meath). The category Connacht is represented as A2 (Galway), B2 (Mayo) and C2 (Roscommon) and the category Munster A3 (Cork), B3 (Tipperary) and C3 (Kerry).




Phase 3: Test for transitivity and equivalence
A-C and C-A
Pass = One 12 block trial at 11/12 correct
Fail = One block at under 11/12 trials
Move to Phase 4
Remedial Action in consult with research team


Phase 4: Category label training
During this phase the last stimuli to be trained for each set will be directly trained to the category label e.g. Leinster = C1, (Meath). The category Connacht = C2 (Roscommon) and the category Munster = C3 (Kerry).

Appendix E: Specifications of the Q4 student response system and image of the infrared host device.

Q4

System Features:

- Supports 8 Question Types
- Use with Windows or Mac
- Automatically enter and score responses
- Works with existing PowerPoint presentations & paper-based resources
- All sets include Qwizdom Authoring software
- Signal Assistance Privately

Specifications:

- Two-way RF technology based on 802.15.4 IEEE standard
- Three-line custom LCD display with eight character input
- Right/wrong feedback capability
- FCC ID: SJB-Q4RF
- USB receiver (host)
- Dimensions: 5.5 x 12.5 x 3 (cm) (WxHxD)
- Supports the following question types: Multiple Mark, Numeric, Sequencing, Rating Scale, Yes/No, Fractional/Decimal, Multiple Choice, True/False

The infrared host simply plugs into a standalone or laptop device via a USB cable.

Appendix F: Sources for all picture stimuli (B, C and D) obtained from a variety of web sources.

B1 Stimulus sourced from:

Bobrovsky, M. (2015). cross-section of fungi with roots in ground. Retrieved from ttp://www.agefotostock.com/en/Stock-Images/Rights-Managed/NSA-005010008

B2 Stimulus sourced from:

Martin, D. (2015). Leaves Stem and Roots of Ivy. Retrieved from http://www.visualphotos.com/image/1x6470651/leaves-stem-and-roots-of-ivy

B3 Stimulus sourced from:

Hunter-Gatherer Diet. (2015). Retrieved from http://hunter-gatherers.org/a-hunter-gatherer-diet-for-all-of-us.html

C1 Stimulus sourced from:

Compost pile. (2015). Retrieved from https://cdn1.hometriangle.com/imagecache/media/2314/htrttpseedtofeedmeblogs potin-jpg.jpg/800x600-0

C2 Stimulus sourced from:

MEDIA SPOTLIGHT,. (2015). Kelp Holds Fast and Holds Up. Retrieved from http://education.nationalgeographic.com/education/media/kelp-holds-fast-holds-up/?ar_a=1

C3 Stimulus sourced from:

Harrington, B. (2015). Man running on a path with his dog along Tramway Boulevard, Albuquerque, New Mexico USA. Retrieved from http://blaineharrington.photoshelter.com/gallery-image/Albuquerque-Outdoor-Recreation/G0000PMDmfh9lJSQ/I00007Sqc_TSwF5c/C0000lWfxC0wuwR8

D1 Stimulus sourced from:

compassandcamera,. (2015). Fungi Pictures. Retrieved from http://forestry-learning.blogspot.ie/2013/06/fungi-definition-fungi-are-organisms.html

D2 Stimulus sourced from:

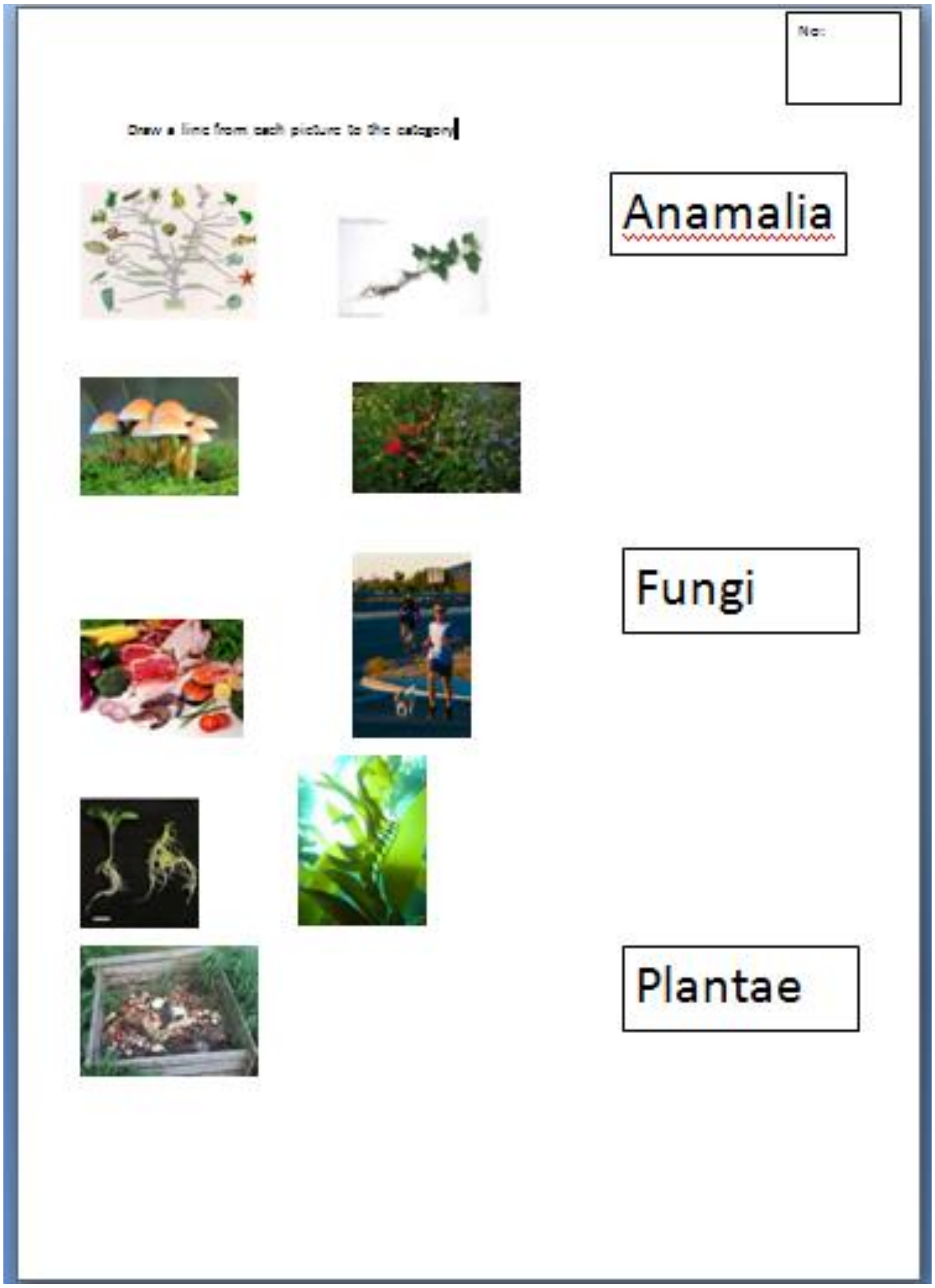
A PICTURE OF VANCOUVER A DAY,. (2015). In The Garden Again. Retrieved from https://apictureofvancouveraday.wordpress.com/2012/08/09/pov8812-in-the-garden-again/

D3 Stimulus sourced from:

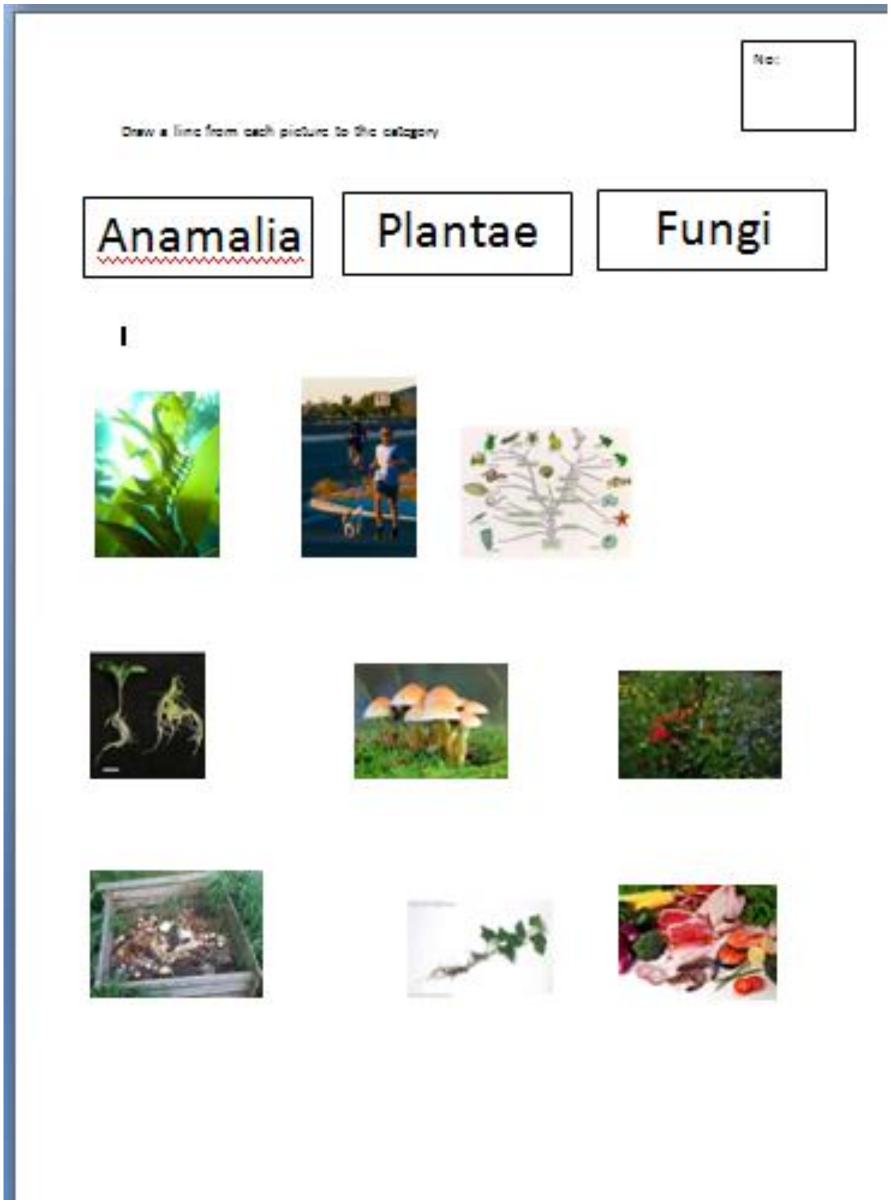
Klasifikasi kingdom animalia. (2015). Retrieved from http://imgbuddy.com/animalia-kingdom.asp

Appendix G: A sample of one pre and post-test used during Experiments 1 and 2 in Chapter 4.

Pre-Test Sample (text instruction, draw a line from each picture to the category)



Post-Test Sample (text instruction, draw a line from each picture to the category)



No:

Draw a line from each picture to the category

Anamalia

Plantae

Fungi

Appendix H: Instruction sheet that was given to each participant explaining what would happen in the study.

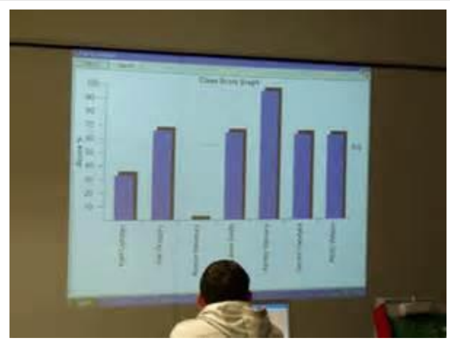
Today you are all going to take part in a lesson which will be different to the way that you normally learn in school.

As a group we will be looking at putting or matching things together.

A word will appear on the top of the screen. You will be given three options

A, B and C.   Look at your control pad, like in the picture below you will see the three buttons A is 1, B is 2 and C is 3.

Choose the answer you think is correct A, B or C.
Once everyone has made their choice we will see how everyone did as a group on the

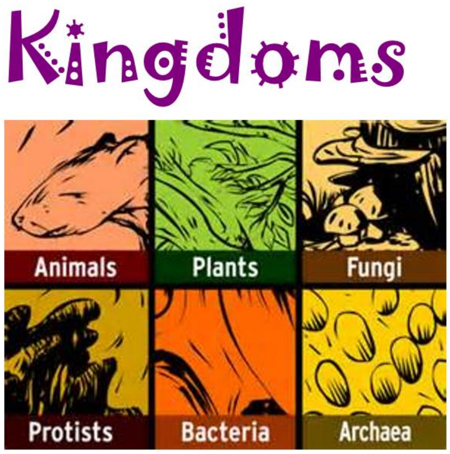


Every time the group makes a correct response a ball will be placed into our jar. If not one person makes the correct response then no marble will be placed in the jar.

We want to fill up the jar as much as possible.

If you feel sick, or that you don't want to take part you can raise your hand or call my name and let me know.

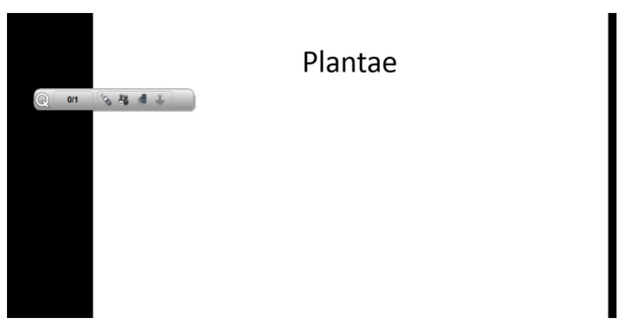
Appendix I: Visual representation (screen shots) demonstrating what the participants saw during training phases.



1. The first slide that participants saw did not require a response.

2. The Quizdom bar appeared on the top of the screen.

3. The Quizdom bar showed how many participants had been recognised by the host. This bar also allowed the instructor to see how many students had responded to each question. In addition the bar allowed the instructor to display a graph of how the group performed following a training trial.



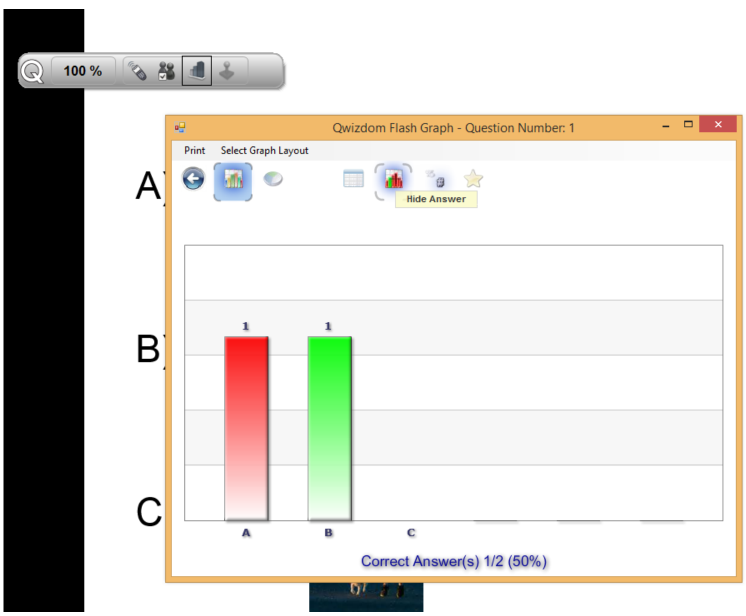
4. Once all participants had been recognised by the host the training started. The sample A stimulus (printed category name) appeared at the top centre of the screen. Following 3 second the mouse was pressed and the sample sissapeared.

A) 

B) 

C) 

5. Once the sample disappeared three comparision stimuli appeared in a linear manner and were prefixed as either A, B or C.



6. Once all participants had responding to the question as indicated by the Quizdom bar (top left corner). The instructor then clicked on the graph symbol and a bar chart appeared above. The bar chart showed how many people chose the correct answer (green bar) and the number of participants who chose the incorrect answer (red bar).