MASTER'S THESIS
Learning in Complex Systems
2013

On the Acquisition of Conditional Discrimination in Typically Developing Children: Effects of Training Procedures and Experimental Variables

Marita Kvia

Faculty of Health Sciences
Department of Behavioral Science

HØGSKOLEN I OSLO
OG AKERSHUS

Abstract

When training typically developing preschool children in the facilitation of conditional discrimination, several studies have implemented various training procedures. Experimental variables besides the training procedures may influence the acquisition of conditional discrimination, and are not always taken into account when discussing the need or effect of a training procedure. The two current articles presented different training procedures and experimental variables, and how they affect facilitation of conditional discrimination in typically developing preschool children.

Keywords: conditional discrimination, training procedures, arbitrary matching-to-sample, identity matching-to-sample, general and specific instructions, stimulus equivalence

Variables Affecting Acquisition of Conditional Discrimination in Typically Developing Preschool Children

Marita Kvia

Oslo and Akershus University College

Abstract

Various training procedures in experiments exposing typically developing preschool children to matching-to-sample (MTS) tasks may influence the establishment of conditional discrimination. Additional experimental variables may not been taken into account when discussing the effect of the training procedures in the facilitation of conditional discrimination. Furthermore, few studies training children in conditional discrimination are testing for derived relations, and testing should be encouraged to contribute finding a more effective teaching technology. The current article discusses the (1) use of various training procedures and their possible effect in the establishment of conditional discrimination, (2) experimental variables that have not been considered when discussing the effect of the training procedures, (3) the benefits of testing for derived relations and (4) and presents suggestions for future studies.

Keywords: conditional discrimination, training procedures, typically developing children, instructions, identity matching-to-sample, arbitrary matching-to-sample, experimental variables, stimulus equivalence

Conditional discrimination procedures are used when studying complex human behavior. Two examples of conditional discrimination procedures are arbitrary matching-to-sample (ArMTS) and identity matching-to-sample (IdMTS). Matching involves selection of a specific comparison stimulus in the presence of a sample stimulus, either when the relation between the sample and the comparison is identical or arbitrary. When training typically developing preschool children to facilitate conditional discrimination, training procedures might be implemented. Experimental variables, in addition to the training procedures, will affect the arrangements of the training procedures. Arntzen (2012b) argued that “Different result can be attributed to differences in how the training and testing procedures have been arranged” (p. 124). Moreover, knowledge in this area will be important when creating an effective teaching technology.

The research field of stimulus equivalence has provided evidence that derived relations can emerge and are demonstrated when showing the properties of reflexivity, symmetry and transitivity (Sidman, 1992, 2000). A major goal within research is to create a more effective teaching technology and an important contribution would be to take advantage of the possibilities of derived relations. Based on knowledge on this research area, more studies training typically developing preschool children in the facilitation of conditional discrimination should expose the participants to tests for derived relations in addition to ArMTS tasks.

The use of training procedures involving instructions in experiments has been controversial. Sidman (1992) stated that if instructions like “belong together” and “are the same” are used as a part of a procedure in experiments, the data may not be a result of the experimental operation but say more about the person’s verbal history. Training procedures can entail arrangements that do not include instructions. Implementing pre-training with IdMTS may make the conditional discrimination training more difficult for the participants due to that the participants might be looking for similarities between the sample and comparison (Sidman, 1994). IdMTS can be an effective arrangement in the facilitation of conditional discrimination with arbitrary stimuli in adults (Arntzen, 2012a) and children (Michael & Bernstein, 1991; Pilgrim, Jackson, & Galizio, 2000; Zygmont, Lazar, Dube, & McIlvane, 1992).

There are differences in the results of the facilitation of conditional discrimination depending on the age and functional level of the participants. As far as I am aware of, seven studies have been published on this matter where the participants are typically developing preschool children. Six studies performed with typically developing preschool children report on the use of training procedures (Arntzen, Vaidya, & Halstadtro, 2008; Augustson & Dougher, 1991; Michael & Bernstein, 1991; Pilgrim et al., 2000; Schilmoeller, Schilmoeller, Etzel, & Leblanc, 1979; Zygmont et al., 1992). In contrast, one study of Devany, Hayes, and Nelson (1986) report no need for training procedures when training preschool children in the acquisition of conditional discrimination. The basis for discussion in the current article will be on these seven studies. The seven studies were chosen because they present experiments who have implemented various special training procedures when training typically developing preschool children. Second, the studies have been published in international journals and are repeatedly referred to in articles, and must be considered to be of importance on the research concerning facilitation of conditional discrimination with typically developing preschool children. Studies containing research on the effect of naming are not included due to its own vast area of research and theoretical issues. See Table 1 for an overview of the studies and information on the various training procedures, experimental variables and test for derived relations.

When implementing a training procedure, it generates questions regarding the possible effect of the procedure. Also, arguments on whether or not the procedure is either necessary or the most effective may remain to be debated. In the seven studies, which are the basis of the current article, the children have been exposed to additional experimental variables that may not been taken into consideration when discussing the effect of the training procedures that are implemented to facilitate conditional discrimination. The experimental variables, that may influence the results in the acquisition of conditional discrimination, which will be discussed in the current article, are various reinforcement contingencies, corrections procedures containing either prompting procedures or additional instructions, whether the presentation of stimuli is manual or computer based, the number of comparison stimuli, different percentage mastery criterion in both training and testing, baseline trials or not before implementing a training procedure to test the effect of it and design and test for derived relations. Most of these experimental variables are related to the applied side of conditional discrimination training. However, the percentage of mastery criterion level and testing procedures are directly related to the definition of stimulus equivalence.

The seven studies entails many variations of how we can train typically developing preschool children to establish conditional discrimination. However, there is no unanimous way of how to do so most effectively to create an effective teaching technology. The areas of discussion in the current article are fourfold: (1) to discuss the implementation and content of various training procedures in conditional discrimination procedures when training typically developing preschool children and (2) to present experimental variables that may influence the effect of the training procedures that have been implemented, and point out the absence of ruling out these variables when discussing effects of the training procedures and (3) to argue for the implementation of test for stimulus equivalence when exposing participants to conditional discrimination training and (4) present possible improvements to be taken into consideration when future studies are to be conducted. A presentation of possible future studies would be of importance so researchers and practitioners can perform experiments that may lead to the finding of more effective ways of training children in this matter.

Discussion

General Instruction

Four of the seven studies have exposed the participants to a general instruction (Arntzen et al., 2008; Devany et al., 1986; Michael & Bernstein, 1991; Pilgrim et al., 2000). Three out of four studies argued that the general instruction were effective in the facilitation of conditional discrimination. There are additional experimental conditions which may have influenced the responding. The four studies will be presented and discussed separately. First, Michael and Bernstein (1991) tested the role of learning history in the acquisition of MTS tasks and three participants were exposed to the instruction at the beginning of each trial: "To help you play the game, I will show you the shapes that go together. They will appear together on the computer screen. When you think you can remember the two shapes that go together, touch the middle of the screen to see the next ones. After this you can play the game." Michael & Bernstein (1991) stated that the instruction was effective when establishing direct relation, and they suggested that instructions can be used for educational purposes.

The instructions that were used in Michael and Bernstein (1991) contained the word combination "go together" that Sidman (1992) questioned the use of in experimental operations. Moreover, Michael and Bernstein (1991) did not discuss or take into account the possible influence of the prompting procedure they used, in addition to the general instruction which contained a correction trial for each incorrect response. This is a limitation of the study, because it is impossible to state whether it was the instructions or prompting procedure, or combinations of them, who affected the facilitation. A question would be if instructions or prompting procedure alone would be sufficient in the acquisition of conditional discrimination. Prompting procedures will be further discussed under the headline of Correction procedures.

Devany et al. (1986) exposed four participants to the instruction “Touch the one that goes with this one”. Augustson and Dougher (1991) made a replication of Devany et al. (1986) and both studies focused on the training process and test results for stimulus equivalence. The study of Devany et al. (1986) will be discussed. Devany et al. (1986) exposed the participants occasionally to the instruction “See this?” and saying “Which one goes with that one?” Two out of three of the participants established the conditional discrimination. The participants were also exposed to physical or visual prompting “when necessary”. The focus of their discussion was not specifically on the implementation of instructions or prompting procedures, but on whether there was a difference in responding when comparing children with and without language skills. However, there are a couple of elements to highlight, which are some of the same as in the study of Michael and Bernstein (1991). The implementation of both a general instruction and a prompting procedures means that it cannot be ruled that either one of them may be sufficient in the facilitation of conditional discrimination. Furthermore, for future studies it is possible to conduct experiments with the implementation of only the general instruction without any prompting procedures. Data will tell whether or not a general instruction without a prompting procedure may be sufficient as a training procedure. Arntzen et al. (2008) was a contribution on this matter and should be further tested with variations of instructions.

Pilgrim et al. (2000) tested the effect of a general instruction among other training procedures. All participants were first given an ArMTS task. The use of baseline conditions before implementing a training procedure will be further discussed under the headline Baseline trials and design. Two participants received the general instruction. “Look at this one. This one will tell you where the prize is”. The instruction was presented for each of the first five trials of a session and also immediately after an incorrect trial. Pilgrim et al. (2000) argued that the general instruction was not effective in the acquisition of conditional discrimination. The instructed phase only lasted for only 80 and 64 trials before another training procedure was implemented. This raises questions on the criteria of number of trials trained before concluding that a training procedure is not effective. This is not discussed in Pilgrim et al. (2000). Also, they trained the children for only 16 trials a day and four to five sessions a week. This may have influenced their assessment saying that the mastery criterion was not reached rapidly enough due to at least one week of training without results, and decided to implement another training procedure. The content of the instructions did not contain words combinations mentioned by Sidman (1992) and could be tested for a number of trials that exceeds 64 – 80 trials.

Arntzen et al. (2008) exposed nine participants to the general instruction: "Some of the stimuli belong together and it is your task to find out which stimuli go together". They concluded that the instruction was effective in the facilitation for all nine participants. The instruction was implemented after baseline conditions and included circa 0 – 580 trials or 45 minutes without meeting the mastery criterion of the first conditional discrimination. The data from the baseline conditions may be an indication of the need for a training procedure for typically developing children. Arntzen et al. (2008) added to the discussion that they suggest instructions had an effect on the facilitation, but they cannot rule out other factors. They proposed that a presentation of a general instruction may have served as a general rule, and the rule has influenced the responding with novel stimuli. Furthermore, number of trials in the baseline conditions was higher than in the experiment of Pilgrim et al. (2000). A stable baseline over several sessions increases the likelihood that the responding would continue to be on a chance level if no other special training procedures were to be implemented. This increases the experimental control, and is demonstrated in Arntzen et al. (2008).

An extension of the study of Arntzen et al. (2008) would be to test several preschool children to find out if additional children will train for 200 – 900 trials before meeting the mastery criterion of the first conditional acquisition as they did in Arntzen et al. (2008). Moreover, if the number of trials needed are the same when implementing other instructions or other training procedures. Future studies could implement the same baseline conditions as in Pilgrim et al. (2000) and Arntzen et al. (2008) to get more data either confirming or disprove that typically developing preschool children need training procedures in the facilitation of conditional discrimination. Arntzen et al. (2008) exposed children to variables similar to the ones suggested for further studies. They implemented baseline trials with differential reinforcement and general instruction without any further prompting procedures which could have influenced the results. In addition, the children trained for many more training trials without changing the training procedure, like it was done in Pilgrim et al. (2000). More studies could test various numbers of training trials before implementing other experimental conditions.

Specific Instruction

Specific instructions are a training procedure used in the acquisition of conditional discrimination in typically developing preschool children. Arntzen et al. (2008) argued that there might be a difference in exposing children to general and specific instructions. A general instruction may serve as a general rule that could be followed with novel stimuli, and a specific instruction might narrow the instruction effect to one presentation of sample and comparison stimuli. Arntzen et al. (2008) also proposed to test more systematically the effects of word choices. A suggestion would be to test out even more specific instructions and different time delivery.

One of seven studies discussed in the current article have tested the effect of a specific instruction. Pilgrim et al. (2000) exposed seven participants in Experiment 1 to the specific instruction “When this one is in the middle, pick this one”. In addition to the instruction, the experimenter held up the sample and the right comparison. Five of the participants established conditional discrimination after they were exposed to the specific instruction. However, two of the five participants were exposed to a general instruction before the specific instruction. The two participants trained for only 64 or 80 trials when exposed to the general instruction before the specific instruction were implemented. A layover effect cannot be ruled out. By comparison, in the study of Arntzen et al. (2008) the participants trained for consecutive 220 – 900 trials before meeting the mastery criterion of the first conditional discrimination, and no other training procedure were implemented.

Pilgrim et al. (2000) exposed some of the participants to several conditions simultaneously. Consequently it cannot be said if one or the other could stand alone as a training procedure that would be effective in the acquisition. Moreover, when implementing a new training procedure after the participants have trained for 80 trials leads to questions whether 80 trials is sufficient enough or not to conclude that an instruction is not effective. The responding, of for example 80 trials, should be displayed in an experimental design, so the basis of deciding on implementing another special training procedures could be based on visual inspection. If the responding is at a chance level, a new training procedure or prompting procedure could be implemented. If there is an increase in number of correct trials, the participant could train several sessions without the arrangement of new procedures.

Two of the participants were exposed to both a specific instruction and naming after having being exposed only to the specific instruction without meeting the mastery criterion. Pilgrim et al. (2000) concluded that instruction and naming together was effective. However, they did not explain why they chose to test two different conditions at once, neither the consequences of doing so. This generates questions whether specific instruction could stand alone as a training procedure which can effect conditional discrimination. Experiments conducted with specific instructions could test variations of specific instructions, and with and without a correction procedure. Results on this matter could lead to the possibilities to compare the effect of general vs. specific instruction, and also test the argument of Arntzen et al. (2008) that a general instruction might serve as a rule for future responding and maybe a specific instructions is not sufficient.

Pre-training and IdMTS

Other training procedures, which has been implemented when training typically developing preschool children, are pre-training, IdMTS and variations of IdMTS. Pilgrim et al. (2000) exposed all the participants to pre-training in Experiment 1. The pre-training consisted of inviting the child to play a game where they should remove food bits from beneath a comparison stimulus from a well on an otherwise empty tray. Doing so resulted in the delivery of a food bit. The content taught the children what to do in order to get the potential reinforcement. The pre-training created a discussion on whether it had any effect on the acquisition on conditional discrimination, and if it can be an alternative to exposing the participants to instructions that may interfere with the experimental conditions. Other questions are whether the pre-training is necessary at all, or if the pre-training can replace other training procedures. Pilgrim et al. (2000) have not discussed this in their article.

IdMTS are a training procedure which involves the matching of identity stimuli. There are several arguments for exposing children to IdMTS training. Saunders and Spradlin (1989) suggested that participants who are failing to match arbitrary stimuli can easily learn identity matching. Even though the participants in their study were conducted with mentally retarded adults, it can be applied in training procedures with typically developing children. Dube, Lennaco, and Mcllvane (2009) also argued that generalized identity matching-to-sample might be a prerequisite for learning more advanced skills.

Two of the seven studies, discussed in the current article, exposed the participants to IdMTS (Michael & Bernstein, 1991; Zygmont et al., 1992). In Michael and Bernstein (1991) the first phase of training consisted of IdMTS. However, the effect of the IdMTS was not tested per se because the participants were also randomized into three conditions testing instructions, imitation and contingency shaped responding. The results do not provide evidence whether IdMTS is necessary or not in the acquisition of conditional discrimination of arbitrary stimuli and could be tested. A suggestion would be to first train baseline trials to rule out a possible effect of differential reinforcement in an ArMTS procedure. Also, to implement an IdMTS training phase before exposing the participants to a second ArMTS to check the effect of the IdMTS on ArMTS. Pilgrim et al. (2000) suggested to studying training procedures that do not involve the use of language. The suggestion is based upon the controversial role of language in stimulus equivalence research. IdMTS training could be furthered tested to might become a procedure alternatively replacing instructions. However, if a general instruction may serve as a rule for children when solving MTS tasks as Arntzen et al. (2008) proposed, then giving instructions to children may be less time consuming then having to train the children in IdMTS tasks before the implementation of conditional discrimination with arbitrary stimuli.

Shaping and Fading of Stimuli

A training procedure used in the acquisition of conditional discrimination is shaping and fading of stimuli and variations of them. Zygmont et al. (1992) suggested that it can be an effective procedure when training typically developing children. Zygmont et al. (1992) tested if a gradual transformation of identity stimuli to arbitrary where the physical features of the sample alters would have an effect on acquisition. They called this procedure stimulus-control shaping. They argued that stimulus-control shaping is different from stimulus-shaping in the sense that stimulus shaping has been referred to as a gradual transformation of topographical features of the controlling stimulus. IdMTS were a part of what they called preliminary pre-training. After the preliminary training, the participants were exposed to arbitrary matching with differential reinforcement. The result showed that two participants learned identity matching rapidly and given a simple stimulus-control program learned the task.

When comparing several special training procedures to one another, the shaping and fading procedure stands out on the amount of work having to be prepared for the training. For example, the stimuli presented on the screen were drawn by hand before implemented in the computer program. Also, the program could not back up earlier program steps and back up following errors lead to starting the computer again and restarting it in an earlier step of the program. In addition, the effect of IdMTS could not be clarified or said to be necessary because of the use of it in the preliminary training. The goal must be to find an easy procedure with less work involved, and which generates the most rapid acquisition of conditional discrimination. When comparing stimulus-control shaping to the use of training procedures like instructions, when it comes to amount of work that has to be prepared and directed, then stimulus-control shaping seems like a procedure that could be implemented if other ones are not effective.

Reinforcement Contingencies

Token economy systems affects a participants responding and is defined by Boerke and Reitman (2011) as "formal descriptions of contingency relations…that is intended to modify or influence behavior through the delivery of conditioned reinforces (p. 370). The seven studies discussed in the current article reported on the use of different reinforcement contingencies. Reinforcement contingencies may be an additional factor to consider in the evaluation when training children in conditional discrimination. The delivery of programmed consequences contingent on correct responding will be discussed here.

When training children challenges will occur on motivating the children to want to train for several sessions over several months. Little information in the seven articles is given regarding how questions and comment from the children are handled. Moreover, because the participants are preschool children they cannot train alone and consequently an experimenter´s involvement is inevitable. Information on how these variables are handled would be of importance due to replication purposes. The seven articles discussed in the current article have not been given much information on this matter.

For example, Devany et al. (1986) are the only study that explained in the procedure that they started out each session by talking to the child “in order to set a relaxed and pleasurable tone”. This study is somehow different from the others by giving some information on this matter. The children were told at the start of each session to help the experimenter with some things, and that they could play afterwards. For each correct response the children received one of several consequences like praise, blowing soap bubbles and singing. The consequences were thinned until the consequence was delivered every three or four correct responding.

In Augustson and Dougher (1991), a correct response was followed by a yellow truck appearing on the screen and music. The responses were also followed by verbal praise from the experimenter and a small bite of crackers, fruit or the opportunity to make soap bubbles. Due to the programmed consequences given by the computer the study are easier to replicate because the programmed consequences can be controlled to certain extend.

Zygmont et al. (1992) reported that programmed consequences that were used was either pennies or pieces of candy. No further information on the delivery of programmed consequences was given in the article. The lack of information regarding schedule of reinforcement and possible thinning of the programmed consequences weakens the study. Also, the programmed consequences involving giving pennies to children can be questioned.

Pilgrim et al. (2000) gave the participants a small piece of food in a well and praise at each correct response. In addition, the participants received a small toy from a “treasure chest” contingent on participation during each scheduled session. To give a toy after each session is different from the other studies. It can be assumed that giving a child the opportunity to earn a toy for each session would increase the chances of them wanting to train. Future studies should be implementing programmed consequences that do not involve giving the children pennies or toys for each session due to replication purposes.

Another study who gave the participants the opportunity to earn a toy for each session was Schilmoeller et al. (1979). They gave the participants the instruction to choose a toy before each session. Then the further instruction was “Whenever you point to the correct picture, I will put a token from my cup into your cup. If you get all of my tokens, you can take your toy home. Remember you need all my tokens too in order to earn your toy”. For each correct response, the child got a token and a verbal praise. Number of tokens acquired was different depending on the training procedure implemented. The difference from this study compared to Pilgrim et al. (2000) was that, in this study, the toy delivery of the toy was contingent on a number of correct responding. This difference may have influenced the correct responding because of the toy being contingent upon correct responding not just a number of trials each session.

Also, Arntzen et al. (2008) reported that when the participants chose the right comparison the word “Correct” came up on the screen, in addition to a sound. In addition, all participants received a small gift at the end of their participation. The participants varied in age, and some of them were school children, which may have affected how the programmed consequences influenced the participants.

There are several influencing contingencies which will influence not just responding but also the attending for many sessions and several months. The seven studies have not reported any challenges when it comes to making these children want to train for many sessions, and it can be assumed that the reinforcement contingencies were sufficient. However, there are some issues that can be raised based on the information given in these studies. First, the experimenter´s personal appearance and relation to each child will influence their participation. Yet, this variable is inevitable when training children. Second, is it reasonable to assume that challenges occurred regarding making the children want to train for so many sessions without any further instructions or programmed consequences other than the ones being reported in the study? For replication purposes, this information is of importance. Third, in some of the studies the children received a toy for each session based on correct responding. Future studies could test systematically whether that would be necessary or not.

Correction Procedures

Correction procedures, also involving prompting procedures, may also influence the acquisition of conditional discrimination. Examples of prompting procedures are physical guidance, modeling, gesture, proximity, intra stimulus prompts, exclusion, prompt fading procedures, least to most and most to least (Tarbox, Tarbox, & O´Hora, 2009). Because of the correction procedure are superimposed, in addition to a training procedure, it cannot be ruled out that one of them could be sufficient in the acquisition of conditional discrimination. Five of the seven studies report on the use of different correction procedures without discussing or ruling out the effect of using them in the procedure in the acquisition of conditional discrimination, and they used repetition of the same stimuli (Michael & Bernstein, 1991), expose the participants to a 2 second minimum intertribal interval (ITI) (Augustson & Dougher, 1991), adding verbal prompts (Pilgrim et al., 2000) or physical or visual prompts (Devany et al., 1986). Schilmoeller et al. (1979) used a correction procedure involving the presentation of a specific instruction contingent upon an incorrect response. The specific instruction delivered was “This is the correct picture. Now you point to the correct picture”. This can be an instruction that may have influenced the acquisition of conditional discrimination. However, the instruction is not taken into consideration when the effect of shaping and fading of stimuli were discussed.

Pilgrim et al. (2000) exposed the children to a special training procedure to test the effect of it, but did not include the possible effect of the physical and visual prompts when discussing the effect of the special training procedures. Future studies could test the effect of various prompting procedures. If correction procedures are necessary or may be a supplement to the training procedure, it would be of interest to know which correction procedure would be the less intrusive and effective. Future studies could expose the participants to hand guided prompts contingent on incorrect responses, and would answer questions whether additional instructions are necessary or not in order to establish conditional discrimination for typically developing preschool children.

Computer-Based or Manual Presentations of Stimuli

Whether stimuli is presented on a computer or manually is of importance in experimental studies when evaluating the contact the experimenter has had with the participants, and therefor also a part in the discussion of the degree of experimental control. In a MTS procedure, there are several ways of presenting the stimuli that may influence the responding. Either the stimuli can be presented on a computer and the computer record all responses or the experimenter present the stimuli manually and use manual registration. .

Four studies report on the use of different computer based programs (Arntzen et al., 2008; Augustson & Dougher, 1991; Michael & Bernstein, 1991; Zygmont et al., 1992). Computer-based programs have its benefits. It minimizes both the experimenters contact with the participants and the possible influence it will have on responding. A computer presents the sample stimuli and comparison stimuli randomly. The computer can record all responses, and the need for inter observer agreement (IOA) is not there, which makes the training less time consuming. Regarding questions of more practical issues, therapists training children may not have access to a computer with MTS applications, and making the necessary stimuli can be time-consuming. Future studies testing the effect of training procedures using a computer based presentation would lead to a higher degree of experimental control.

When working with preschool children there are most often a need for the experimenter to be in the same room when training. Ruling out signaling from the experimenter is not easy. Moreover, the possibilities that consequences has been given other than the programmed ones that are reported are also hard to rule out. This is because children will attempt to interact with the experimenter. Not all of the studies report the distance between the experimenter and the participant either. It is important to minimize the contact between the child and the experimenter. Michael and Bernstein (1991) reported that the experimenter sat 1.5 meter from the child to minimize interaction. In Augustson and Dougher (1991) the experimenter sat directly behind the participants. No other information on the interaction between the experimenter and the participant was given. A clear procedure which states what can be said or not will make the variables influencing acquisition more clearly.

Three of the seven studies had a manual presentation of the stimuli (Devany et al., 1986; Pilgrim et al., 2000; Schilmoeller et al., 1979). They were using various ways to present the stimuli. Choosing this way of training conditional discrimination is common in a non-experimental setting, and therefor do not entail the same level of experimental control. Computer programs with MTS programs, which are recording responses in a conditional discrimination procedure, may not be either available or not prioritized. The studies conducted with manual presentation of stimuli are not discussing the limitations of having a manual presentation.

Number of Comparison Stimuli and Percentage Mastery Criterion

The seven studies used various number of comparison stimuli. This affected the test scores, and how easy the children could facilitate the conditional discrimination, in addition to training procedures implemented, in the experiment. Also, the studies used different percentage mastery criterion and that again affected the results. If someone concludes that a training procedure is effective, the percentage mastery criterion might be lower than in the other studies. This leads to difficulties comparing studies to one another.

Number of comparison stimuli presented to the participants varied from 1 – 3 in the studies referred to in the current article. Five of the studies used only two comparison stimuli (Devany et al., 1986; Michael & Bernstein, 1991; Pilgrim et al., 2000; Schilmoeller et al., 1979; Zygmont et al., 1992). When having only two comparisons mean that the children have a 50 % chance of choosing the correct comparison stimuli. A mastery criterion of 90 % entails that a child may be performing on a chance level. To be sure that the child knows which sample goes with which comparison, the procedure can require more trials to ensure the learning process. Another way of making sure that the child knows how to solve the task is the use of experimental designs that show stable responding before moving on to the next phase of the experiment. A minimum of three comparison stimuli would increase the chances for securing correct responding.

For example, Augustson and Dougher (1991) exposed the children to both one, two and three comparison stimuli. On the other hand, Arntzen et al. (2008) exposed the participants to three comparison stimuli and the mastery criterion was 94 %. The difference in these studies leads to several consequences and considerations. First of all, exposing children to one comparison stimuli at the beginning of the training can probably be used with children with learning disabilities to enhance the chances of success. This might be a way to start training some children, but at some point in training the child needs to learn how to discriminate between two or more comparison stimuli. However, as mentioned earlier in this section, having two comparison stimuli will lead to a 50 % chance of choosing the correct stimuli and more trials are needed to make sure that the responding is not at a chance level. Second, exposing children to three comparison stimuli can also lead to responding at a chance level. A within-subject-design with stable performance before implementing other sets of stimuli would rule out chance level responding. In addition, a 94 % mastery criterion will secure that the children have learned the stimuli sets. The seven studies are using different mastery criterions. To be able to compare studies with one another, the number of stimuli used, and the percentage mastery criterion should be more similar.

Question regarding the use of the number of stimuli can be of experimental importance and not of practical ones. In experimental settings number of stimuli will be of importance due to one factor. Using three comparison stimuli will reduce the 50 % chance of choosing the correct comparison. In a three choice comparison procedure, the chance of choosing the correct stimuli will be 33, 33 %. In studies conducted for practical importance where the goal is to earn skills using matching-to-sample procedures, the number of comparison can be of less importance. Also, presenting three comparison stimuli in a practical setting may be too difficult for some children, and could lead to the use of more correction procedures which may not always be beneficial.

Baseline Trials and Design

Only two out of seven studies discussed in the current article are using an experimental design to show the results, and it raises questions of the possible effect of the procedures implemented in the other five studies. An idea within the area of behavior analysis is to use experimental designs in experiments which can display a certain level of experimental control. Stable baseline conditions are crucial before implementing conditions and then testing the effect of them. Sidman (1960) defined stable or steady state “as one in which the behavior in question does not change in a period of time” (p. 234). Also, baseline serves two functions. First of all, the baseline describes the present level of performing before a second condition is implemented. Second, the baseline has a predictive function meaning that it is the basis for predicting what behavior will occur in the future if a variable is not implemented (Kazdin, 2011).

In Arntzen et al. (2008) the participants were exposed to baseline conditions consisting of 45 – 50 minutes of conditional discrimination training with the children only exposed to differential reinforcement. Moreover, number of trials for each child varied from 0 – 580 trials. By presenting baseline conditions with only programmed reinforcement before implementing simpler training procedures confirmed that children need special training procedures in the facilitation of conditional discrimination. A question raised regarding baseline trials is to evaluate what number of trials trained is sufficient to proceed to the next condition. Steady state calculations or visual inspection can be applied. Checking data to see that responding is or is not at a chance level would be necessary, and doing so needs a set amount of trials.

Another study who presented baseline data was Pilgrim et al. (2000). In the baseline condition in Experiment 1, they reported of a various number of baseline trials. Six participants had trained 160-560 trials before simpler training procedures were implemented. However, two participants were exposed to both baseline conditions and specific instruction, and it cannot be said to have ruled out the effect of differential reinforcement or to conclude the effect of just the exposure to specific instruction. The result section of the study revealed the implementation of simpler procedures within baseline condition besides the use of differential reinforcement. The implementation was set in after 320 trials and included simple discrimination training and IdMTS, blocked-trial procedures and position prompts. This reduced the experimental control in the study because prompting procedures had been implemented within the baseline condition which was not taken into consideration in the result. In general, the level of experimental control in experiments conducted on humans cannot be of the same level as in experiments conducted in an animal laboratory. There are extra experimental variables influencing the experiment that we cannot control, and no one expects it to be otherwise (Critchfield & Fienup, 2013).

Test for Derived Relations

There is a practical value of getting some “free” learning. Everything may not have to be directly taught. To be able to compare studies where participants may have responded in accordance to stimulus equivalence, the mastery criterion should be on the same level. A difference in percentage mastery criterion leads to experimental questions on whether derived relations have emerged or not. There are differences in the way the tests are administered.

Out of the seven articles presented in the current study, only two studies tested for derived relations (Devany et al. (1986); Arntzen et al. (2008). This leads to few studies to compare results with, and should be encouraged to get more information on the chances of getting more effect out of training. In these two studies the percentage mastery criterion for stimulus equivalence varied from 83 – 94 %. Arntzen et al. (2008) tested all nine participants, and the results showed that all participants responded in according to symmetry, and two participants responded in accordance with stimulus equivalence. The mastery criterion in the test was set at 94 %. In contrast, Devany et al. (1986) had different criteria to conclude responding in accordance with stimulus equivalence. They calculated the percentages of correct responding divided by the responses in each block consisting of ten trials. The result showed that the average responding in the test for the typically developing children were 84, 5 %. Devany et al. (1986) also focused their result on percentage responding in the first and the second half of the test.

Summary

The presentation of the current article was based on seven articles and was fourfold. Firstly, the training procedures general and specific instructions, IdMTS and shaping and fading of stimuli were discussed. There are no unanimous data on which training procedures may be the most effective in the facilitation of conditional discrimination for typically developing preschool children. Future studies can gather more data on the possible effect of various training procedures when training typically developing preschool children. Secondly, experimental variables were presented due to their possible influence on the results. The variables were not considered when discussing the effect of a training procedure in the discussion section in the seven studies. Thirdly, the goal is to create a more effective teaching technology, and one way of achieving so, in addition to implement effective training procedures, is to test for derived relations. Fourthly, information based on the seven studies generated ideas for future studies. The suggestions entail most importantly the use of experimental designs with baseline conditions before the implementation of a training procedure or a prompting procedure. The use of an experimental design can increase the level of experimental control. However, McIlvane and Dube (2003) pointed out that it is impossible to control all variables in experiments conducted with humans. Multiple stimulus control topographies may be established because stimuli entails several features, for example location, shape, size and color. When analyzing data, McIlvane and Dube (2003) presented a theory called “Stimulus control topography coherence theory” which can be applied when analyzing conditional discrimination procedures. Stimulus control topography coherence entails the degree of compliance between the relevant stimuli properties, that an experimenter has decided are of importance, and the stimuli properties that come to control the behavior of the participant. Future application of this molecular level of analysis can be recommended when analyzing the compliance between relevant stimulus properties, that the experimenter has decided are essential, and the stimuli properties that come to control the participant´s behavior.

References

Arntzen, E. (2012a). The functions of meaningful stimuli disclosed by equivalence class formation II: conditional discriminative functions. Paper presented at the 10th International Congress on Behavior Studies, Lisboa, Portugal.

Arntzen, E. (2012b). Training and testing parameters in formation of stimulus equivalence: Methodological issues. *European Journal of Behavior Analysis*, 13(1), 123 - 135. Retrieved from: http://www.ejoba.org/

Arntzen, E., Vaidya, M., & Halstadtro, L. B. (2008). On the role of instruction in conditional discrimination training. *Experimental Analysis of Human Behavior Bulletion*, 29, 17 - 24. Retrieved from: http://www.eahb.org/

Augustson, K. G., & Dougher, M. J. (1991). Teaching conditional discrimination to young children: Some methodological successes and failures. *Experimental Analysis of Human Behavior Bulletin*, 9(2), 21 - 24. Retrieved from: http://www.eahb.org/

Boerke, K. W., & Reitman, D. (2011). Token economies. In W. F. Fisher (Ed.), Handbook of Applied Behavior Analysis. New york London: The guilford press.

Critchfield, T. S., & Fienup, D. M. (2013). A "happy hour" effect in translational stimulus relations research. *The Experimental Analysis of Human Behavior Bulletin,* 29, 2 – 7. Retrieved from: http://www.eahb.org/bulletin/

Devany, J. M., Hayes, S. C., & Nelson, R. O. (1986). Equivalence class formation in language-able and language-disabled children. *Journal of the Experimental Analysis of Behavior*, 46, 243 - 257. doi: 10.1901/jeab.1986.46-243

Dube, W. V., Lennaco, F. M., & Mcllvane, W. J. (2009). Generalized identity matching to sample of two-dimensional forms in individuals with intellectual disabilities. *Research in Developmental Disabilities*, 14, 457 - 477. doi: 10.1016/0891-4222(93)90038-L

Kazdin, A. E. (2011). *Single-Case Research Designs: Methods for Clinical and Applied Settings* (2nd ed.). New York: NY: Oxford University Press.

McIlvane, W. J., & Dube, W. V. (2003). Stimulus control topography coherence theory: Foundations and extensions. *The Behavior Analyst*, 26(No. 2, Fall), 195 - 213. Retrieved from: http://www.thebehavioranalyst.com/

Michael, R. L., & Bernstein, D. J. (1991). Transient effects of aquisition history on generalization in a matching to sample task. *Journal of the Experimental Analysis of Behavior*, 56, 155 - 166. doi: 10.1901/jeab.1991.56-155

Pilgrim, C., Jackson, J., & Galizio, M. (2000). Aquisition of arbitrary conditional discrimination by young normally developing children. *Journal of the Experimental Analysis of Behavior*, 73, 177 - 193. doi: 10.1901/jeab.2000.73-177

Saunders, K. J, & Spradlin, J. E. (1989). Conditional discrimination in mentally retarded adults: The effect of training the component simple discrimination. *Journal of the Experimental Analysis of Behavior*, 52(1), 1 - 2. doi: 10.1901/jeab.1989.52-1

Schilmoeller, G. L., Schilmoeller, K. J., Etzel, B. C., & Leblanc, J. M. (1979). Conditional discrimination responding after errorless and trial-and-error training. *Journal of the Experimental Analysis of Behavior*, 31, 405 - 420. Retrieved from: http://seab.envmed.rochester.edu/

Sidman, M. (1960). *Tactics of Scientific Research: Evaluating Experimental Data in Psychology*. New York: Basic Books.

Sidman, M. (1992). Equivalence relations: Some Basic Considerations. In S. C. Hayes & L. J. Hayes (Eds.), *Understanding Verbal Relations* (pp. 15 - 27). Reno: NV: Context Press.

Sidman, M. (1994). *Equivalence Relations and Behavior: A research story*. Boston: Authors Cooperative, Inc.

Sidman, M. (2000). Equivalence relations and the reinforcement contingency. *Journal of the Experimental Analysis of Behavior*, 74(1), 127 - 146. doi: 10.1901/jeab.2000.74-127

Tarbox, J., Tarbox, R. S. F., & O´Hora, D. (2009). Nonrelational and relational instructional control. In R. A. Rehfeldt & Y. Barnes-Holmes (Eds.), Derived Relational Responding: Application for Learners with Autism and other Developmental Disabilities (pp. 111 - 127). Canada: Raincoast books.

Zygmont, D. M., Lazar, R. M., Dube, W. V., & McIlvane, W. J. (1992). Teaching arbitrary matching via sample stimulus-control shaping to young children and mentally retarded individuals: A metodological note. *Journal of the Experimental Analysis of Behavior*, 57, 109 - 117. doi: 10.1901/jeab.1992.57-109

Table 1

Overview of seven articles: Training Procedures and Experimental Variables

	Schilmoeller & Etzel (1977)	Devany, Hayes & Nelson (1986)	Pilgrim, Jackson & Galizio (2000)	Michael & Bernstein (1991)	Augustson & Dougher (1991)	Zygmont, Lazar, Dube & McIlvane (1992)	Arntzen, Vaidya & Halstadtro (2008)
Participants	40	4	25 *	12 *	7	2	9
Age	4/ 2 – 5/ 9	2/ 1 – 2/ 11	3/ 3 – 6	4/ 5 – 5/ 5	2/ 3 – 6/ 4	4/ 7 and 5/ 10	5/ 3 – 11
Number of comparison	2	2	2	2	1 – 3	2	3
Manuel or data presentation	Manual	Manual	Manual	Data	Data	Data	Data
Percentage criterion (%)	Variable %	90 %	87,75/ stable performing	90 %	90 %	90 %	94 %
Baseline/ Differential reinforcement	YES	-	YES	YES	-	YES, after IdMTS	YES, from 0-580 trials
Correction procedures	Specific instruction	Physical prompt	Verbal prompt	Repetition of same stimuli	Inter trial interval 2 sec + physical/visual prompt	-	-
Pre-training	-	-	In ex. 3	-	-	-	-
General instruction	-	-	YES	YES	YES	-	YES
Specific instruction	-	-	YES	-	-	-	-
Imitation	-	-	-	YES	-	-	-
Stimulus shaping	YES	-	-	-	-	Gradual transformation	-
Stimulus fading	YES	-	-	-	-	-	-
Stimulus control shaping	-	-	-	-	-	YES	-
IdMTS	-	-	YES	YES	-	YES	-
Test for derived relations	-	YES	-	-	-	-	YES
Comments/ conclusion	Stimulus shaping were more effective than stimulus fading	Training procedures are not necessary	Specific instruction + naming was effective	The study tested effect of learning history	The study is a replication of Devany et al. (1986)	Gradual transformation of stimuli was effective	General instruction was effective

Note. IdMTS = identity matching-to-sample

On the Acquisition of Conditional Discriminations: Effects of Pre-training with Identity Matching-to-Sample and Different Instructions

Marita Kvia

Oslo and Akershus University College

Abstract

Training procedures can be implemented when typically developing children are exposed to conditional discrimination procedures. Two experiments investigated the effects of training procedures: pre-training with identity matching-to-sample (IdMTS) and general and specific instructions, in the facilitation of conditional discrimination with arbitrary stimuli in five year old typically developing children. In Experiment 1, three participants were exposed to an IdMTS task before they were reintroduced to an arbitrary matching-to-sample (ArMTS) task. The results showed that one out of three participants established conditional discrimination in the ArMTS task. In Experiment 2, eight participants were exposed to either a general or a specific instruction in an ArMTS task. The results showed that six out of eight participants established conditional discrimination after exposure to an instruction. All nine participants in both experiments were exposed to a stimulus equivalence test. Seven participants responded in accordance to symmetry and six participants responded in accordance with equivalence. The results in the current study suggest that instructions may be an effective arrangement in the facilitation of conditional discrimination for typically developing preschool children. The results are important for future application of conditional discrimination procedures with typically developing preschool children.

Keywords: stimulus equivalence, training procedures, general instruction, specific instruction, identity matching-to-sample (IdMTS), arbitrary matching-to-sample (ArMTS), typically developing children

The research area of stimulus equivalence has been an important field within the research of complex human behavior for 40 years. Conditional discrimination procedures, which entail matching-to-sample (MTS), are used when studying stimulus equivalence. By definition, MTS involves control by a sample stimulus over the selection of a specific comparison stimulus (Saunders & Spradlin, 1990). An example of MTS, entailing three classes with three stimuli in a class and with a Many to one (MTO) structure, is when a participant teaches to select A1 in the presence of C1 and not C2 or C3, and teaches to select B1 in the presence of C1 and not C2 and C3 and so on. Examples of MTS procedures are identity matching-to-sample (IdMTS) and arbitrary matching-to-sample (ArMTS), and the difference of the two of them is whether the stimuli are identical or arbitrary. Identical stimuli have the same properties, while arbitrary stimuli do not show the same properties. Stimulus equivalence entails mutual interchangeable stimuli (Arntzen, 2010). This means that when the stimuli in conditional relations show the properties of reflexivity, symmetry and transitivity, stimulus equivalence is demonstrated (Sidman, 2000), and the concept of the three properties comes from mathematical set theory. Reflexivity is demonstrated when a participant teaches to choose A1 in the presence of A1. Symmetry is demonstrated when the participant teaches to choose A1 in the presence of C1 and C1 in the presence of A1. Transitivity is demonstrated when a participant has taught to match A1 to C1 and B1 to C1 then will match A1 to B1 without additional training (Sidman & Tailby, 1982).

When training adults in MTS tasks, differential reinforcement can be given in the form of programmed consequences. On the other hand, when training typically developing preschool children some studies have inferred that differential reinforcement, also called trial and error training, may not be sufficient to meet the mastery criterion in a MTS task. Some studies report the use of training procedures in the facilitation of conditional discrimination for typically developing preschool children: General instruction, (Arntzen, Vaidya, & Halstadtro, 2008; Michael & Bernstein, 1991; Pilgrim, Jackson, & Galizio, 2000), specific instruction (Pilgrim et al., 2000), stimulus shaping and fading (Schilmoeller, Schilmoeller, Etzel, & Leblanc, 1979), IdMTS (Michael and Bernstein), gradual transformation of stimuli (Zygmont et al., 1992). Devany et al. (1986) argued that children do not need training procedures in order to facilitate conditional discrimination. A question remains on which training procedures are the most effective ones.

The use of instructions in conditional discrimination procedures is controversial. Sidman (1992) stated: "Until we have answered the question of whether rules give rise to equivalence, or equivalence makes rules possible, we are going to be very careful about our experimental procedures in investigation of equivalence. If we tell out subjects that stimuli "go with" each other (or that they "match each other", "belong together", "are the same", "go first", "go second", etc.), the data may tell more about the subject´s verbal history than about the effects of current experimental operations" (pp. 21-22).

Several studies have exposed children to various instructions. In Schilmoeller et al. (1979) the participants were exposed to the general instruction "Look at both of these pictures. Now point to the one that gets the token". Zygmont et al. (1992) exposed four typically developing children to the general instruction "Touch the one that goes with that one". Pilgrim et al. (2000) exposed preschool children to a general instruction "Look at this one. This one will tell you where the prize is". Pilgrim et al. (2000) also exposed seven children to a specific instruction "When this one is in the middle, pick this one". The experimenter held up the right comparison. Arntzen et al. (2008) exposed nine typically developing children to the general instruction "Some of the stimuli belong together and your task is to find out which stimuli go together".

Pilgrim et al. (2000) pronounced "Because of the controversial role of verbal processes in the stimulus equivalence literature, training procedures that do not rely on language would be of special interest" (p.186). Research has implied that IdMTS can be an effective arrangement when training conditional discriminations with adult participants (Arntzen, 2012a). Pre-training with IdMTS procedures are a training procedure that can be implemented when training typically developing preschool children. Sidman (1994) stated that identity matching is a prerequisite for learning arbitrary matching. He also discussed that some participants might have difficulties matching arbitrary stimuli after they have been exposed to identity matching. This is due to the participant might continue to look for similarities between the stimuli they are matching. Generalized identity matching can serve as a potential baseline for teaching more advanced symbolic skills, and a goal is to find an effective teaching technology to teach students with disabilities preliminary skills (Dube, Lennaco, & Mcllvane, 1993). Research on typically developing preschool children has implemented a training phase of IdMTS before conditional discrimination training with arbitrary stimuli (Zygmont, Lazar, Dube, & McIlvane, 1992).

Zygmont et al. (1992) used a gradual transformation of stimuli from identity matching to arbitrary matching when they trained two preschool children. The children received the instruction: "Look at the button in the middle. Find the other. Now, touch it". The idea of using a gradual transformation of stimuli is based on Saunders & Spradlin´s (1989) statement that participants who have difficulties in facilitating conditional discrimination of arbitrary matching can easily learn identity matching. Both participants in the experiment acquired arbitrary matching through the sample stimulus-control shaping program. Zygmont et al. (1992) pointed out that the result of the experiment was sufficient but not necessarily essential. Also, the instructions that were given to the participants were not discussed as a factor that might have influenced the establishment of conditional discrimination.

In Michael and Bernstein (1991) the first phase of training consisted of IdMTS. The effects of the IdMTS were not tested per se because the participants were randomized into three conditions testing instructions, imitation and contingency shaped responding. The results in this study do not provide evidence whether IdMTS is necessary or not in the acquisition of conditional discrimination in typically developing children.

In the current study, two experiments are presented. In Experiment 1, three children were exposed to an IdMTS task before they were reintroduced to ArMTS conditions to test for any effect of IdMTS on ArMTS. In Experiment 2, eight children were exposed to either a general instruction or a specific instruction to test for any effect of the instructions in the facilitation of conditional discrimination. Saunders and Spradlin (1989) proposed that participants who have difficulty acquiring arbitrary matching can learn identity matching. Studies on IdMTS (Michael & Bernstein, 1991; Zygmont et al., 1992) exposed the participants to IdMTS before testing whether or not it is necessary in the facilitation of conditional discrimination with arbitrary stimuli. Experiment 1 expanded the literature on IdMTS, and had two purposes: to (a) test if preschool children can facilitate conditional discrimination with arbitrary stimuli with differential reinforcement in the form of programmed consequences without any pre-training involving IdMTS, and to (b) study if IdMTS may influence the responding in ArMTS tasks.

GENERAL METHOD

Participants. The age and gender for each participant is presented in Table 1. The names of the participants were made-up to protect the participant’s identity. The participants were recruited from two divisions within a kindergarten. Prior to the experiment, the parents had to fill out a consent form (see Appendix). The parents were told that the task involved working on a computer, and computer skills were not necessary. They were told that the experimental sessions could last for several months, and the children were free to stop whenever they wanted. The children were informed that they could choose to stop whenever they wanted. The participants were debriefed when they were finished with the sessions, and received a small gift.

Apparatus, Instructions and Setting. In the current experiment, a HP Elite-book laptop computer, with Intel Core i5, Quad/2, 4 GHz processor with 3056 MB RAM, with a 17 –in. screen and an operative system Windows 7, was used to run the MTS program made by Cognitive Science Partners in collaboration with professor Erik Arntzen.

Stimulus set 1 and 4 were used in Experiment 1 and are presented in Figure 1. Stimulus set 1 consisted of black abstract letters. Stimulus set 4 were colored squares. The stimuli that were used in the experiment were between 1.1 – 2.3 x 1.2 – 3, 8 cm in size. The size depended on the shape of the stimulus itself.

A within subject design was used to present the participant´s results in each condition, and the responding in the phases of teaching the AC and BC relations (see Figure 4).

The experiment was conducted in a room at the kindergarten. The room was two by three square meters. The participants sat on a chair in front of a desk, which was placed against the wall. The experimenter sat on a chair which was seated about 40 centimeters behind the participant on the participant's right hand side. The involvement of the experimenter was kept at a minimum.

A day before the experiment started, the children was introduced to the experimenter. They saw the experimenter room, and were shown where they were going to sit, and that the sessions involved solving tasks on the computer. The experimenter showed them a book and stickers they could get in the sessions. In the child's first session, the participants were told by the experimenter that this was an experiment, and the experimenter was not allowed to help the children to solve the task. Furthermore, if the experimenter did not answer questions, or just said that they were doing a good job, it did not mean that the experimenter was annoyed. It was because the experimenter was not allowed to help due to the experiment was performed to see how children learn to solve a task. The following instruction was given by the experimenter:

> “A picture will appear in the middle of the screen. Click on the picture using the mouse pad. Three pictures will appear on the screen. Choose one of the pictures by clicking on one. If you choose the correct picture, positive feedback like “super” or “great” will appear on the screen. If you choose the wrong picture, the text “wrong” will appear on the screen. I will read this to you. The number of correct responses will appear at the low right corner of the screen. After a while, the computer will not tell if you have chosen the correct or wrong response. Based on what you have learned you can get all the responses right. Try your best to get all the responses correct. Good luck”.

If questions regarding how to solve the matching task came up during a session, the experimenter repeated parts of the start instructions, or said “You are working well. Keep up the good work”. If a participant asked for help, the experimenter gave the instruction “I am not allowed to help you. You are working well. Keep up the good work”.

A session lasted for a minimum of 50 trials. The computer presented a programmed break continuously every 25th trial. The participants trained at least four sessions a week, excepting Easter and winter break, and when absent due to sickness. Training and testing for eleven participants was completed in four months. The number of weeks of attending the sessions for each the participants varied from 5 to 15 weeks. Number of sessions each participant attended in the experiment varied from 15 to 44 (see Table 1).

Token economy systems. Two different token economy systems were used in the experiment. The first token system entailed that every time the participant got a positive programmed feedback presented on the screen, the experimenter drew a cross on a piece of paper with ten routes. Every time the participants had earned ten crosses they could choose a sticker and put it in a small book. When the participants were in the phases of 0 % thinning of programmed consequences and in test, the token economy system was not used. However, they earned a sticker for every break after each 25th trial. If a participant had 1 - 9 crosses on the paper when the phases with the 0 % thinning of consequences started, he or she received a sticker before the experimenter removed the token economy system.

The other token economy system was used to motivate the participants to attend at least four sessions a week for several months. It was challenging to make five year old children want to train four sessions per week over a longer period. On the door of the experimental room, there was a poster with the names of the participants. For every session a participant had trained at least 50 trials he could draw a cross in one of the five routes. If they had at least four crosses in one week, they could attend a party every Friday in the kindergarten arranged by the experimenter. The party lasted between an hour and two and entailed playing games and eating lunch.

Pre-categorization. To ensure that the participants did not have any knowledge of the stimuli prior to the experiment, the participants were asked to sort nine arbitrary stimuli in a pre-test. The stimuli were copied on nine pieces of paper. The following instruction was “Can you sort these pictures, and let me know when you are done doing so”. There was no programmed reinforcement delivered in this task.

EXPERIMENT 1

In experiment 1, the participants were three experimentally naive typically developing children who varied in age from five years and three months to six years.

Procedure.

Experimental conditions. There were two experimental conditions in Experiment 1; (1) IdMTS and (2) ArMTS. All sample stimuli were presented in the middle of the screen. When the participants had pressed the sample stimuli by using the mouse pad, three comparison stimuli appeared on the screen. The comparison stimuli were presented randomly and one in each corner, with one corner blank. In training and testing in the IdMTS task, the sample stimulus and the comparison stimuli was either presented simultaneously or there was a 2 second delay from the offset of the sample stimulus to the onset of the comparison stimuli. In training and testing in the ArMTS task, the sample stimulus and the comparison stimulus were presented simultaneously. The inter trial interval (ITI) was set to 2000 ms in both training and testing in both conditions. Programmed consequences were presented after 1500 ms. No programmed consequences were presented in the tests.

Experimental phases. If a child failed to meet the mastery criterion of the first conditional discrimination in an ArMTS task within 500 trials, the child served as participants in Experiment 1. If a child met the mastery criterion of the first conditional discrimination phase before 500 trials, the data were not presented in the current experiment.

There were two phases in the IdMTS condition, and four experimental phases in the ArMTS condition. In the first phase of IdMTS, all the relations were trained at the same time. The participants needed to get 23/24 correct to move on to the second phase. If the mastery criterion of 95 % was not met, the participant was exposed to a new block that consisted of 24 trials. If a participant did not reach the mastery criteria within 300 trials, a 2s delay was implemented. In the second phase of IdMTS, the participants were exposed to test conditions. The test consisted of 72 trials, and the mastery criterion was 95 %. If the participant got 67 or fewer correct, a new first phase was implemented.

In the first phase of IdMTS, programmed consequences were delivered for every correct trial. In the second phase of IdMTS there was no delivery of programmed consequences. All programmed consequences in both ArMTS and IdMTS were presented in the screen. When the response was correct, the words “fantastic”, “super” or “great” appeared on the screen. When the response was incorrect, the word “wrong” appeared. The experimenter read the programmed feedback out loud, because the children were unable to read. A Many to One (MTO) training structure was used when training the AC and the BC relations in both the ArMTS and IdMTS experimental conditions.

If a participant met the mastery criterion in the test in the IdMTS condition, he would be exposed to a ArMTS task. In the first phase of ArMTS, the participant needed to get 14/15 correct when being exposed to the AC relations, to move on to learn the BC relations. If 13 or fewer were correct, a following block of 15 trials were presented. When the mastery criterion of 95 % within a block of 15 trials were met, and the participant had learned both the AC and the BC relations, the participants moved on to the second phase.

The second phase consisted of 30 trials with a mix of AC and BC relations. The participant needed to get 29/30 correct to move on to the next phase. If the participant scored less than 95 %, a new block of 30 trials were presented. In both the first and second phase, programmed consequences were delivered for every correct response.

In the third phase, there was a gradual thinning of the consequences with consecutive 75 %, 25 %, and 0 %. Each block consisted of 30 trials as in phase two, and the participant needed to get 29/30 correct before each step of the thinning of the programmed consequence. In the fourth phase, the participants were exposed to a test entailing 90 trials, and consisted of 30 directly trained trials, 30 trials testing symmetry relations and 30 trails testing transitivity/equivalence. The participant had to get 87/90 correct to respond in accordance with stimulus equivalence. If the participant scored 86/90 or less, the participants were exposed to an additional third and fourth phase.

Results and Discussion

The purpose of the experiment was to test whether or not IdMTS had any effect on acquisition of conditional discrimination with arbitrary stimuli. The main results showed that one out of three participants acquired both the first and second conditional discrimination in the ArMTS task after being exposed to IdMTS tasks. Table 2 shows number of trials in all phases for the three participants.

Erik was the only participant who established conditional discrimination with arbitrary stimuli after being exposed to the IdMTS task (see upper panel in Figure 2). Ella and Emilie failed to meet the mastery criterion in the first conditional discrimination of arbitrary matching within 300 trials (see middle and lower panel in Figure 2), and no further experimental conditions were added. Both Ella and Emilie responded on a chance level in the ArMTS task in all 300 trials. Ella and Emilie were transferred to Experiment 2. Based on the result in current experiment, it cannot be confirmed that matching identical stimuli is a prerequisite for matching arbitrary stimuli. The results in the current experiment are a contribution to the research area on both IdMTS and ArMTS when training typically developing preschool children.

Five children were exposed to ArMTS conditions when selecting possible participants to Experiment 1. Three children did not meet the mastery criterion of the first conditional discrimination within 500 trials, and served as participants in Experiment 1. One participant met the mastery criterion of the first conditional discrimination within 180 trials, and the data was not included in the current study. Another participant failed to meet the mastery criterion in the IdMTS training and was not exposed to a subsequent phase of arbitrary matching. The participant´s results were not included in the current study.

Erik and Ella failed to get 23/24 correct in the first phase in IdMTS within 300 trials. The responding was at a chance level. A 2s delay was superimposed. When the 2s delay was implemented, both Erik and Ella meet the mastery criterion rapidly, as shown in the two upper panels in Figure 2. In contrast, Emilie scored with 100 % accuracy in both training and test in the IdMTS condition (see lower panel in Figure 2). When altering the IdMTS condition to include a 2s delay, Erik and Ella met the mastery criterion of the IdMTS training and testing. Arntzen and Vie (2013) argued that when presenting a delay in matching-to-sample tasks, mediating behaviors may occur after the sample is set off until the comparison stimuli are presented. Moreover, they emphasize that the mediating behaviors can affect or improve the upkeep of responding.

Erik did not meet the mastery criterion in the first test nor the second test, and did not respond in accordance with stimulus equivalence (see Table 3). In the second test, the only improvement after an additional training phase was the directly trained relations. The responding in test for symmetry and transitivity/equivalence was at the same level.

In almost every trial, Ella chose the comparison stimuli that were presented in the top right corner of the screen. If a comparison was not presented in the top right corner, Ella would choose the comparison on the bottom of the right corner. This indicated a different stimulus control. In experiments, multiple stimulus control topographies may be established because stimuli have multiple features such as location (McIlvane & Dube, 2003). After 100 trials of 2s delay in the IdMTS condition, the experimenter gave the instruction “Do not always choose the picture in the top right corner” and pointed at the stimuli in the top right corner. Ella then stopped to click only at the comparison stimuli in the top right corner.

Five children were tested to be possible participants in the current study. Four of them failed to meet the mastery criterion of the first conditional discrimination with ArMTS, and participated in Experiment 1. The baseline condition contained 500 trials, and the responding for all four children were on a chance level as shown in the panels in Figure 2. These data strongly suggests that children may need training procedures to establish conditional discrimination. This is consistent with other studies performed with typically developing children (Arntzen et al., 2008; Augustson & Dougher, 1991; Pilgrim et al., 2000; Zygmont et al., 1992).

Pilgrim et al. (2000) have encouraged performing studies with the use of training procedures that do not involve language, and the current experiment was a contribution to this proposal. Whether or not skills to match identical stimuli is a prerequisite to matching arbitrary stimuli, as stated by Sidman (1994), has not been either confirmed or rejected by the current experiment. IdMTS tasks could be tested in a larger scale with typically developing preschool children, to check its effect on conditional discrimination with arbitrary stimuli, and would answer questions whether to be able to solve IdMTS tasks is necessary or not in order to establish conditional discrimination with arbitrary stimuli.

Erik and Ella did not meet the mastery criterion in the IdMTS task before a 2s delay was implemented. Future studies could arrange for training phases which involves manipulations of various delay. Delay vs. no delay would be of interest. Also, delays expanding from 1s up to 4s to check for possible influence on acquisition, and also variation in the responding. This would entail a phase of pre-training for a longer period of time, to see if establishment of conditional discrimination with identity stimuli can influence acquisition of conditional discrimination of arbitrary stimuli.

Experiment 1 was a supplement to the literature on IdMTS and its possible influence on the establishment of conditional discrimination with arbitrary stimuli when training typically developing preschool children. It was not confirmed that IdMTS can be a pre-training that affects responding in ArMTS tasks.

EXPERIMENT 2

Instructions may be an effective training procedure when training typically developing preschool children in the facilitation of conditional discrimination (Arntzen et al. 2008; Michael & Bernstein 1991; Pilgrim et al. 2000; Schilmoeller et al. 1979). However, some studies have also implemented prompting procedures or other correction procedures, in addition to exposing children to an instruction in ArMTS tasks (Augustson & Dougher 1991; Devany et al. 1986; Michael and Bernstein 1991; Pilgrim et al. 2000). It cannot be ruled out that either the instruction or the prompting procedure alone would be sufficient in the establishment of conditional discrimination. Experiment 2 expanded the literature on training procedures and the use of various instructions when training typically developing preschool children in the facilitation of conditional discrimination. The experiment had two purposes: to (1) test if children can facilitate conditional discrimination with arbitrary stimuli with the implementation of a general instruction and to (b) test if children can facilitate conditional discrimination with arbitrary stimuli with the implementation of a specific instruction.

Method

Participants. There were eight participants in Experiment 2. Six participants were experimentally naive children who varied in age from five years and one month to six years and two months. They were randomized in two conditions. Two additional participants were Ella and Emilie, who failed to meet the mastery criterion of the first conditional discrimination with arbitrary stimuli within 300 trials in Experiment 1. Erik and Ella were exposed to the general instruction. The age, gender, stimulus set and number of sessions for each participant is presented in Table 1. Table 2 shows number of trials in each phase for all participants.

Stimuli and instructions. The method was as in Experiment 1. The new feature of Experiment 2 was the three stimulus sets (see Figure 1). Stimulus set 1 and 2 consisted of abstract letters with the color black. In stimulus set 3, the A and B stimuli were abstract letter, and the C stimuli were pictures which depicted a church, a crown or a postbox. .

Procedure.

Experimental conditions. The procedure was as described in Experiment 1. The new feature of Experiment 2 was the instructions that were implemented. In the first condition, the participants were given the general instruction “Some pictures belong together and it is your task to find out which one that go together”. The experimenter gave the instruction at trial number 1 and consequently after every 25th trial in the first conditional discrimination. If the children said they wanted the experimenter to stop repeating the instruction, the experimenter stopped doing so. No general instruction was given in the second conditional discrimination.

In the second condition, the participants were exposed to the specific instruction: “When this picture is in the middle, this is the one that is correct and these are wrong”. The experimenter pointed at the sample stimulus and the correct comparison stimulus and the incorrect sample stimuli. The first delivery of the instruction was at trial number one. The specific instruction was then delivered to the participants continuously after approximately three incorrect trials in a row.

Experimental phases. Six children were exposed to ArMTS training to see if they met the criterion for participating in the Experiment. If a child failed to meet the mastery criterion of the first conditional discrimination in an ArMTS task within 500 trials, the child served as participants in Experiment 2. If a child met the mastery criterion of the first conditional discrimination phase before 500 trials, the data were not presented in the current experiment. In addition, Ella and Emilie served as participants, due to failure to get 14/15 correct in the first phase of the ArMTS condition within 300 trials, in Experiment 1.

There were four experimental phases in both conditions (general instruction and specific instruction). In the first phase of the ArMTS task, the participant needed to get 14/15 correct when being exposed to the AC relations to move on to the BC relation. If 13 or fewer trials were correct, a following block of 15 trials were presented. When the mastery criteria of 95 % within a block of 15 trials were met, and the participant had learned both the AC and the BC relations, the participants moved on to the second phase.

The second phase consisted of 30 trials with a mix of AC and BC relations. The participant needed to get 29/30 correct to move on to the next phase. If the participant scored fewer than 95 %, a new block of 30 trials were presented. In both the first and second phase, programmed consequences were delivered for every correct response.

In the third phase, there was a gradual thinning of the consequences with consecutive 75 %, 25 %, and 0 %. Each block consisted of 30 trials, as in phase two, and the participant needed to get 29/30 correct before each step of the thinning of the programmed consequence. In the fourth phase, the participants were exposed to a test with 90 trials that consisted of 30 trials of directly trained relations, 30 trials testing symmetry relations and 30 trials testing transitivity/equivalence. The participants had to get 87/90 correct to respond in accordance to stimulus equivalence. If a participant got 86/90 or fewer correct, he was exposed to the third and fourth phase a second time.

Other phases and stimulus set were implemented if a participant did not meet the mastery criterion within each experimental phase within 300 or 500 trials. The phases in training and testing with stimulus set 1, 2 and 3 were the same in all conditions. If the first phase were not mastered within 500 trials, the participants would be exposed to stimulus set 3. If a participant got through all four phases of training and test with stimulus set 3, the participant were exposed to all four phases again with stimulus set 2. If a participant failed to get 14/15 correct, when learning the AC relations with stimulus set 3 within 300 trials, a specific instruction were implemented in addition to training with stimulus set 3.. If a participant failed to get 14/15 correct when learning the AC relations with stimulus set 3, and also were presented to the specific instruction within 300 trials, a general instruction were implemented again in addition to training with stimulus set 3. If a participant got through all four phases with stimulus set 3, new training and testing in all four phases were implemented with stimulus set 2. If a participant failed to meet the mastery criterion set in the phases of thinning of consequences, the participants started in the first phase again.

Results and Discussion

The purpose of Experiment 2 was to test whether or not a general or a specific instruction had any effect on acquisition of conditional discrimination with arbitrary stimuli. The main results showed that four out of five participants (Martin, Morten, Ella and Emilie) established conditional discrimination after being exposed to the general instruction (see Figure 3 – 4). Also, two out of three participants (Anne, Alva) established conditional discrimination after being exposed to the specific instruction (see the two lower panels in Figure 5). Like Pilgrim et al. (2000) and Arntzen et al. (2008), the results of this experiment indicate that instructions like “some of the stimuli belong together” and “when this one is in the middle, pick this one” may have an effect in the facilitation of conditional discrimination. The results of Arntzen et al. (2008) study are consistent with the results in this study, in terms of a rapid acquisition of the first conditional discrimination after being exposed to general instruction.

Mari and Anders failed to meet the mastery criterion of the first conditional discrimination, and trained four additional phases with stimulus set 3 before four new phases with stimulus set 2. The training with stimulus set 3 may have had an effect on the facilitation of ArMTS task for Mari (see middle panel in Figure 3) and for Anders (see upper panel in Figure 5). There is strong evidence the responding might was influenced by the training of stimulus set 3, and not due to the implementation of the conditions of either the general and specific instruction.

The results in a test for stimulus equivalence are influenced by whether the conditioned relations are established or not. Six out of eight participants (Ella, Emilie, Mari, Morten, Anders, Anne) responded in accordance with stimulus equivalence as shown in Table 3. Four participants (Mari, Morten, Anders, Anne) responded in accordance with stimulus equivalence in the first test and two participants (Ella, Emilie) responded in accordance with stimulus equivalence in the second test. Martin was exposed to two tests and scored with low accuracy in both of them. Also, Alva were exposed to three tests because she was so close to reach the mastery criterion (95%) but failed to do so. After the second test, Alva did not get any additional training before the third test. Eight participants (Erik (from Experiment 1), Ella, Emilie, Martin, Mari, Morten, Anders, Anne) responded above the criteria level of 95 % in the test for symmetry. Erik was the only participant who scored with high accuracy (30/30) in both tests for symmetry, but with very low accuracy in the test for transitivity/equivalence (11/30 and 11/30).

The results in the test for possible derived relations in the current study are consistent with other studies. Arntzen et al. (2008) reported similar results where the required accuracy in the test to meet the mastery criterion of both symmetry and equivalence was 94 %. In Arntzen et al. (2008) all nine participants responded in accordance with symmetry and two out of nine children responded in accordance with stimulus equivalence. One difference from the current study is that the average age of the children in Arntzen et al. (2008) was higher, which entails that their verbal repertoire was also different. In addition, the same stimulus sets were not the same as in the current study. Also, Devany et al. (1996) tested the participants for derived relations and presented an average result of 84, 5 %. However, these results presented an average percentage responding, and are not comparable with the current study due to the results being based on a lower percentage correct criterion of responding. Some studies are not testing for derived relations stimulus after having tested special training procedures in the acquisition of conditional discrimination (Pilgrim et al., 2000; Schilmoeller et al., 1979). It would be an advantage to be able to compare more studies on both training procedures in conditional discrimination procedures and tests for stimulus equivalence.

The results in Experiment 2 showed that both general and specific instruction may be an effective arrangement when establishing a 3-choice conditional discrimination performance. In addition, further instructions were not necessary to meet the mastery criterion of the second conditional discrimination. The number of trials, before the participants got 14/15 correct when learning the AC and BC relations varied, as shown in Table 2. As Arntzen et al. (2008) discussed, it cannot be ruled out other factors that might have contributed to the establishing of conditional discrimination. However, based on the results it is strongly suggested that instructions may have influenced the facilitation of conditional discrimination for the typically developing preschool children.

In Arntzen et al. (2008) the result showed there was no need for further instruction in the second conditional discrimination. The participants met the mastery criterion within 36 – 90 training trials in the second conditional discrimination and were more rapidly acquired than the first conditional discrimination training. These results are consistent with the results of the current study. Six of the participant showed the same training pattern and three participants had the same number of training trials or 15 trials more.

Future studies could test instructions that do not involve word combinations mentioned by Sidman (1992). Experiment 2 in the current study was arranged to study Sidman’s arguments regarding the implementation of instructions. Examples of general instruction that could be tested further would be the instruction that were used in Shilmoeller et al. (1979) “Look at both of these pictures. Now point to the one that gets the token”. However, in Schilmoeller et al. (1979) additional specific instructions and prompting procedures were also implemented that may have influenced the results in addition to the general instruction. Regarding specific instructions, even more specific instructions could be tested. Examples would be "When this is in the middle, this one is the correct one. They are not the same when a new sample is presented in the screen". However, this can be regarded as both a specific and a general instruction.

GENERAL DISCUSSION

The current study tested the effect of IdMTS when being exposed to an ArMTS task in Experiment 1, and tested the effect of general and specific instructions in Experiment 2, in the acquisition of conditional discrimination with arbitrary stimuli for typically developing preschool children. The results indicate that instructions can enhance the establishment of conditional discrimination. In addition, responding in accordance with stimulus equivalence was tested.

Several studies, testing the effect of instructions, pre-training and IdMTS, are not ruling out the effect of differential reinforcement before implementing training procedures (Augustson & Dougher, 1991; Devany, Hayes, & Nelson, 1986; Michael & Bernstein, 1991). The children in these studies may have been able to establish conditioned discrimination without the implementation of training procedures involving instructions or IdMTS. There are variations in experimental arrangements in experiments testing the effect of various training procedures. Arntzen (2012b) claim that "Different results can be attributed to differences in how the training and testing procedures have been arranged" (p. 124). He also suggested that knowledge in this area will be important when creating an effective teaching technology. The current study is a contribution to this matter.

A within subject design was used to both evaluate the responding and to make continuously decisions to either implement other stimulus sets or another instruction. The graphs are presented in Figure 2 – 5. All the participants had stable baseline conditions before the implementation of a condition. Furthermore, a new stimulus set or another instruction were not implemented before the responding showed stable responding on a chance level for 300 or 500 trials. The use of the within subject design in the decision making process was based on visual inspection and strengthens the current study.

A question that remains to be answered is how to determine how many trials are required to meet the mastery criterion of the first conditional discrimination before concluding that a training procedure is effective. There are no clear requirements or limitations as to when to conclude whether the acquisition of conditional discrimination is rapid or not. For example, the participants in the current study, who received the general instruction, required less training trials than those participants in the study of Arntzen et al. (2008). Future studies could obtain data for this unanswered question of how many trials a participant should train before concluding that the training procedure is effective. A suggestion would be to divide the results in sections with 50 trials a section and read the index numbers for any changes.

Another issue of discussion is how to decide the number of trials, without meeting the mastery criterion, before a new condition should be implemented. An implication of the current study is to discuss whether or not 300 or 500 trials are sufficient to rule out the effect of IdMTS or an instruction, and moreover implement other training procedures. Comparing these results with other studies has proven difficult due to the different use of criterion to precede or change conditions. Several studies are published where the participants are exposed to a lot less training trials before implementing other training procedures. For example, in Experiment 1 in Pilgrim et al. (2000), the criteria for implementing a simpler training procedure were set at 160 trials, which generates questions whether the insertion of a new training procedure was implemented to early or not. By comparison, in the current study the criteria for exposing a participant to a training procedure or a new stimulus set were 500 trials without meeting the mastery criterion of the first conditional discrimination, in addition to responding at a chance level.

Arntzen et al (2008) specified complications regarding the presentation of instructions. Different parameters can influence the training and the results. He pointed out two possible influential variables: variations of instructions and the time of delivery. Arntzen et al. (2008) wrote about the issues of timing and proposed that a given instruction can be most effective when given after a participant has already failed to meet the mastery criterion of the first conditional discrimination in ArMTS tasks. Other variables that can influence results include the content of the given instruction. Arntzen (2012) proposed that, it might be that general instructions are more effective in making sure that the participants are establishing a rule that increases the chances of meeting the mastery criterion in conditional discrimination procedures.

Questions have arisen based on the data of the current study. First, training procedures could be implemented after baseline condition with differential reinforcement, like it was done to select participants to the current study. More data on this matter would confirm or refute whether typically developing preschool children may need training procedures like instructions when facilitating conditional discrimination with arbitrary stimuli.

Second, the possible effect of IdMTS on ArMTS should be tested in the facilitation of conditional discrimination in typically developing preschool children in larger scales to see if IdMTS may be an effective training procedure or a prerequisite when facilitating conditional discrimination with arbitrary stimuli. Further, IdMTS training should be tested using various delays from the offset of the sample to the onset of the comparison stimuli, to find out the possible effect on the responding.

Third, experimental variables could be implemented in a more controlled manner. For example, a minimum of trials acquired in each condition before implementing a simpler training procedure would make the comparison between studies easier and would rule out possible layover effects. A suggestion based on the results of this study is to have a minimum of 300 trials in each condition.

Fourth, studies have exposed the participants to training procedures have also implemented various prompting procedures without taking them into account when discussing the effect of the special training procedure (Augustson & Dougher, 1991; Devany et al., 1986; Michael & Bernstein, 1991; Pilgrim et al., 2000; Schilmoeller et al., 1979). Future studies could test the effect of one training procedure at the time, using within subject design like in the current study. This will increase the level of experimental control and would minimize the risk of other variables influencing the results, due to continuous checks whether the responding is at chance level or not. Prompting procedures have been implemented when both training typically developing children and children with disabilities. Prompting procedures, like hand guidance, should be tested without any other experimental variables, and would answer questions regarding acquisition without the influence of instructions.

Fifth, future studies testing the effect of training procedures in the acquisition of conditional discrimination could also test for derived relations. This would lead to more comparison studies on the question whether rules give rise to novel relations or not. Another matter of interest would be an increase in the percentage criterion for responding in accordance with stimulus equivalence up to 95 % to reduce the chances of responding on a chance level.

In sum, the results from the current study strongly implies that typically developing preschool children may need additional training procedures in the establishment of conditional discrimination, and future research are needed in order to find procedures that do so most effectively.

References

Arntzen, E. (2010). Om Stimulusekvivalens. In S. Eikeseth & F. Svartdal (Eds.), *Anvendt Atferdsanalyse: Teori og praksis* (2nd ed.). Oslo: Gyldendal Norsk forlag AS.

Arntzen, E. (2012a). The functions of meaningful stimuli disclosed by equivalence class formation II: conditional discriminative functions. Paper presented at the 10th International Congress on Behavior Studies, Lisboa, Portugal.

Arntzen, E. (2012b). Training and testing parameters in formation of stimulus equivalence: Methodological Issues. *European Journal of Behavior Analysis*, 13(1), 123 - 135. Retrieved from http://www.ejoba.org/

Arntzen, E., Vaidya, M., & Halstadtro, L. B. (2008). On the role of instruction in conditional discrimination training. [Brief report]. *Experimental Analysis og Human Behavior Bulletion*, 29, 17 - 24. Retrieved from http://www.eahb.org/

Arntzen, E., & Vie, A. (2013). The Expression of equivalence classes influenced by distractors during DMTS test trials. *European Journal of Behavior Analysis* (14), 151 - 164. Retrieved from http://www.ejoba.org/

Augustson, K. G., & Dougher, M. J. (1991). Teaching conditional discrimination to young children: Some methodological successes and failures. *Experimental Analysis of Human Behavior Bulletin*, 9(2), 21 - 24. Retrieved from http://www.eahb.org/

Devany, J. M., Hayes, S. C., & Nelson, R. O. (1986). Equivalence class formation in language-able and language-disabled children. *Journal of the Experimental Analysis of Behavior*, 46, 243 - 257. doi: 10.1901/jeab.1986.46-243

Dube, W. V., Lennaco, F. M., & Mcllvane, W. J. (1993). Generalized identity matching to sample of two-dimensional forms in individuals with intellectual disabilities. *Research in Developmental Disabilities*, 14, 457 - 477. doi: 10.1016/0891-4222(93)90038-L

McIlvane, W. J. & Dube, W. V. (2003). Stimulus control topography coherence theory: Foundations and extensions. *The Behavior Analyst*, 26 (No. 2, Fall), 195 - 213. Retrieved from: http://www.thebehavioranalyst.com/

Michael, R. L., & Bernstein, D. J. (1991). Transient effects of aquisition history on generalization in a matching to sample task. *Journal of the Experimental Analysis of Behavior*, 56, 155 - 166. doi: 10.1901/jeab.1991.56-155

Pilgrim, C., Jackson, J., & Galizio, M. (2000). Aquisition of arbitrary conditional discrimination by young normally developing children. *Journal of the Experimental Analysis of Behavior*, 73, 177 - 193. doi: 10.1901/jeab.2000.73-177

Saunders, K. J., & Spradlin, J. E. (1990). Conditional discrimination in mentally retarded adults: The development of generalized skills. *Journal of the Experimental Analysis of Behavior*, 54, 239 - 250. doi: 10.1901/jeab.1990.54-239

Schilmoeller, G. L., Schilmoeller, K. J., Etzel, B. C., & Leblanc, J. M. (1979). Conditional discrimination responding after errorless and trial-and-error training. *Journal of the Experimental Analysis of Behavior*, 31, 405 - 420. Retrieved from http://seab.envmed.rochester.edu/

Sidman, M. (1992). Equivalence relations: Some Basic Considerations. In S. C. Hayes & L. J. Hayes (Eds.), *Understanding Verbal Relations* (pp. 15 - 27). Reno: NV: Context Press.

Sidman, M. (2000). Equivalence relations and the reinforcement contingency. *Journal of the Experimental Analysis of Behavior*, 74(1), 127 - 146. doi: 10.1901/jeab.2000.74-127

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, 5 - 22. doi: 10.1901/jeab.1982.37-5

Sidman, M. (1994). *Equivalence Relations and Behavior: A Research Story*. Boston: Authors Cooperative

Zygmont, D. M., Lazar, R. M., Dube, W. V., & McIlvane, W. J. (1992). Teaching arbitrary matching via sample stimulus-control shaping to young children and mentally retarded individuals: A metodological note. *Journal of the Experimental Analysis of Behavior*, 57, 109 - 117. doi: 10.1901/jeab.1992.57-109

Table 1

Children, Gender, Age (years/months), Stimuli, Experiment and Number of Sessions in Experiment 1 and 2

Participants	Gender	Age	Stimulus set	Experiment	Number of sessions
Erik	M	6/ 0	1 and 4	Ex. 1	37
Ella	F	5/ 7	1 and 4	Ex. 1 and 2	40
Emilie	F	5/ 3	1 and 4	Ex. 1 and 2	14
Martin	M	5/ 6	1	Ex 2	44
Mari	F	6/ 2	1, 2 and 3	Ex.2	28
Morten	M	5/ 10	1	Ex.2	15
Anders	M	5/ 2	1, 2 and 3	Ex.2	36
Anne	F	5/ 1	1	Ex.2	21
Alva	F	5/ 2	1	Ex.2	35

Table 2

Number of Trials in All Phases for Participants in Experiment 1 and 2

Conditions	Erik	Ella	Emilie	Martin	Mari	Morten	Anders	Anne	Alva
Baseline/set 1	501	492	500	507	501	500	501	504	508
AC+GI	-	-	-	270	-	30	-	-	-
BC+GI	-	-	-	165	-	45	-	-	-
AC+SI	-	-	-	-	-	-	501	225	465
BC+SI	-	-	-	-	-	-	-	30	120
IdMTS	314	314	96	-	-	-	-	-	-
IdMTS 2s delay	409	412	-	-	-	-	-	-	-
AC/set 1	135	300	300	-	-	-	-	-	-
BC/set 1	60	-	-	-	-	-	-	-	-
*AC/set 1	-	-	-	-	-	-	-	-	90
*BC/set 1	-	-	-	-	-	-	-	-	15
*AC/set 1	-	-	-	-	-	-	-	-	30
*BC/set 1	-	-	-	-	-	-	-	-	60
Mix	240	-	-	330	-	60	-	30	150
75 % fading	30	-	-	90	-	30	-	30	120
25 % fading	30	-	-	390	-	30	-	30	30
0 % fading	30	-	-	232	-	30	-	30	30
Test	67/90	-	-	-	-	**89/90**	-	85/90	70/90
AC/set 3	-	-	-	-	15	-	300	-	-
BC/set 3	-	-	-	-	15	-	-	-	-
*AC/set 3	-	-	-	-	30	-	-	-	-
*BC/set 3	-	-	-	-	30	-	-	-	-
AC/set 3+SI	-	-	-	-	-	-	300	-	-
AC/set 3+GI	-	-	-	-	-	-	135	-	-
BC/set 3+GI	-	-	-	-	-	-	60	-	-
AC+GI	-	90	225	-	-	-	-	-	-
BC+GI	-	30	45	-	-	-	-	-	-
*AC	-	15	-	-	-	-	-	-	-
*BC	-	30	-	-	-	-	-	-	-
Mix	-	60	90	-	-	-	-	-	-
Mix/set 3	-	-	-	-	30	-	30	-	-
*BC	-	-	-	-	-	-	-	-	-
75 % fading	-	30	120	-	30	-	30	-	-
25 % fading	-	30	30	-	30	-	30	-	-
0 % fading	-	30	60	-	30	-	30	-	-
Test/ set 3	-	-	-	-	90/90	-	89/90	-	-
Test	-	72/90	83/90	-	-	-	-	-	-
AC	-	-	-	165	30	-	15	-	-
BC	-	-	-	35	30	-	30	-	-
*AC	-	-	-	45	-	-	-	-	-
*BC	-	-	-	15	-	-	-	-	-
Mix	30	30	60	30	30	-	30	30	30
75 % fading	30	30	30	30	60	-	120	30	30
25 % fading	60	30	30	180	30	-	30	30	30
0 % fading	30	30	30	30	30	-	30	30	30
Test	71/90	**88/90**	**90/90**	68/90	87/90	-	**89/90**	**90/90**	82/90
Mix	-	-	-	120	30	-	-	-	-
75 % fading	-	-	-	60	60	-	-	-	-
25 % fading	-	-	-	30	30	-	-	-	-
0 % fading	-	-	-	60	30	-	-	-	-
Test	-	-	-	84/90	**89/90**	-	-	-	77/90

Note. Number of trials in all phases for all nine participants. Test results are in boldface. GI = General instruction; SI = specific instruction; IdMTS = identity matching-to-sample.

Table 3

Test Results for Directly Trained, Symmetry and Transitivity/Equivalence in Experiment 1 and 2.

	Test 1			Test 2			Test 3		
Participant	DT	SY	EQ	DT	SY	EQ	DT	SY	EQ
Erik	26	30	11	30	30	11			
Ella	26	25	21	**30**	**30**	**28**			
Emilie	29	27	27	**30**	**30**	**30**			
Martin	26	21	21	30	28	26			
Mari	**29**	**30**	**28**	**29**	**30**	**30**			
Morten	**30**	**29**	**30**						
Anders	**30**	**30**	**29**						
Anne	29	29	27	**30**	**30**	**30**			
Alva	26	28	16	30	25	28	27	24	26

Note. The table show the number of correct responses out of 30 trials in each test condition. The results for those participants who responded in accordance with stimulus equivalence are in boldface. DT = directly trained; SY = symmetry trials; EQ = equivalence trials.

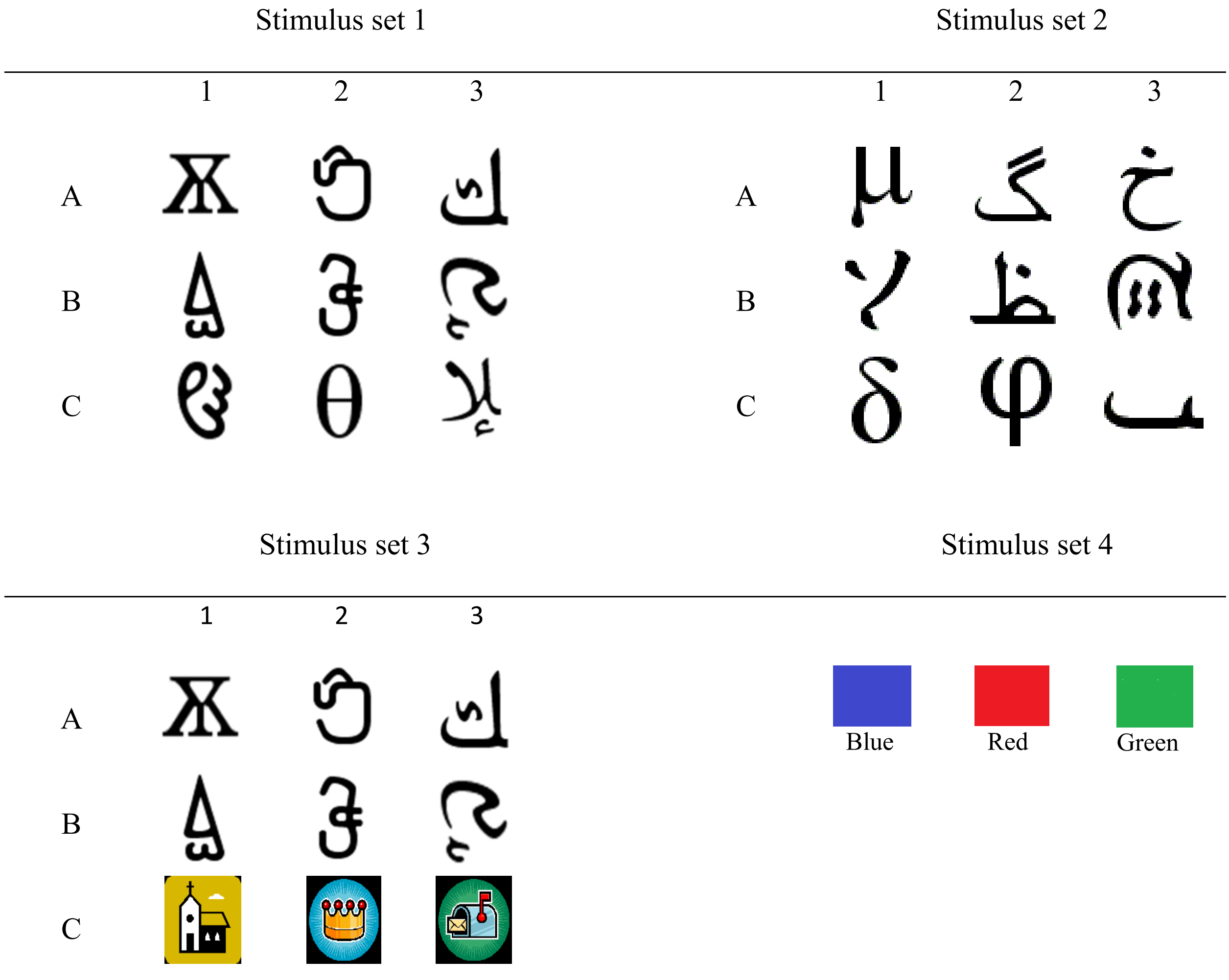


Figure 1. Stimulus Sets 1 - 4. The C – stimuli in Stimuli set 3 were colored. The colors of the stimuli in stimulus set 4 were the colors that are written underneath each stimulus.

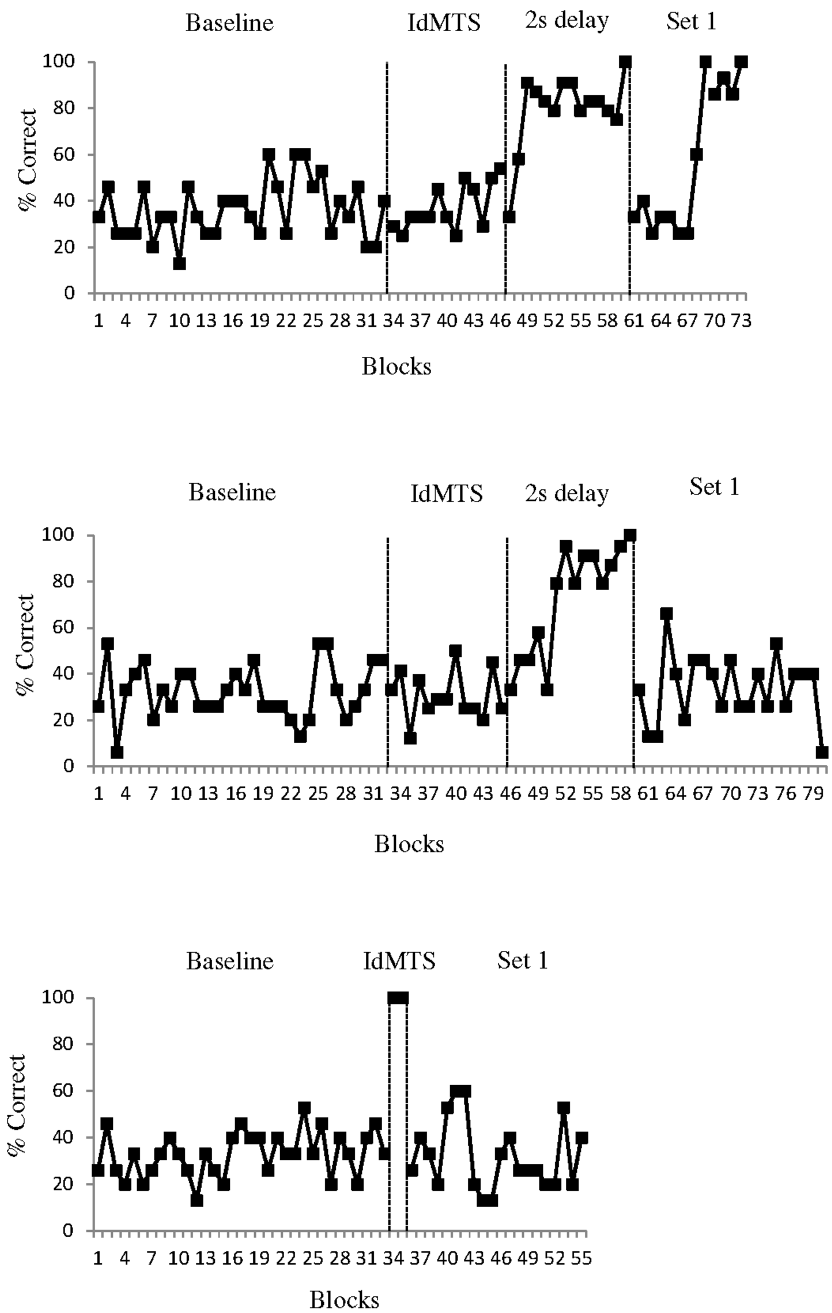


Figure 2. Within subject design presenting baseline conditions that consists of 500 trials of ArMTS, implementation of IdMTS and additional ArMTS for three participants in Experiment 1. The number of correct trials in each block is presented in percentage. Erik´s graph is at the top panel, Ella´s graph is in the middle panel and Emilie´s graph is at the lower panel. ArMTS = arbitrary matching-to-sample; IdMTS = identity matching-to-sample.

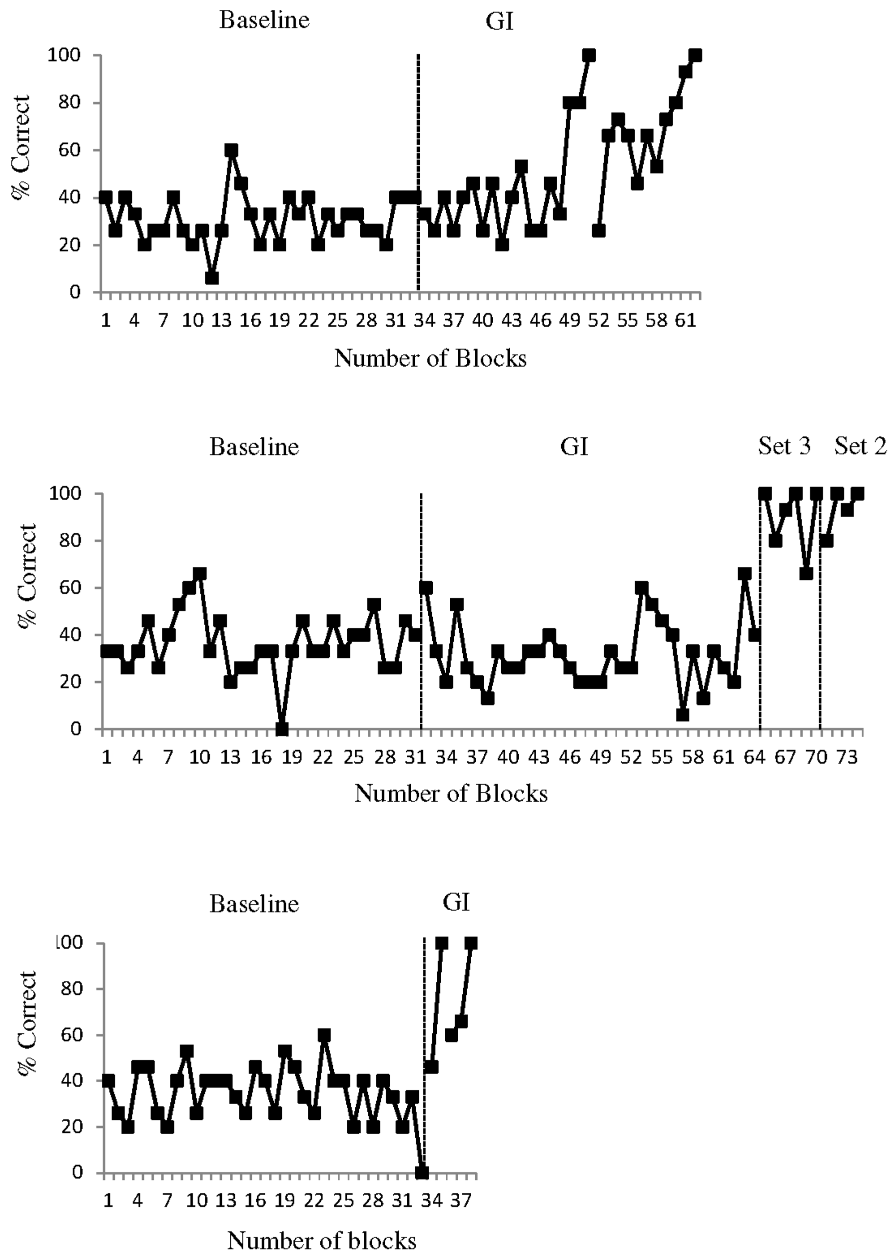
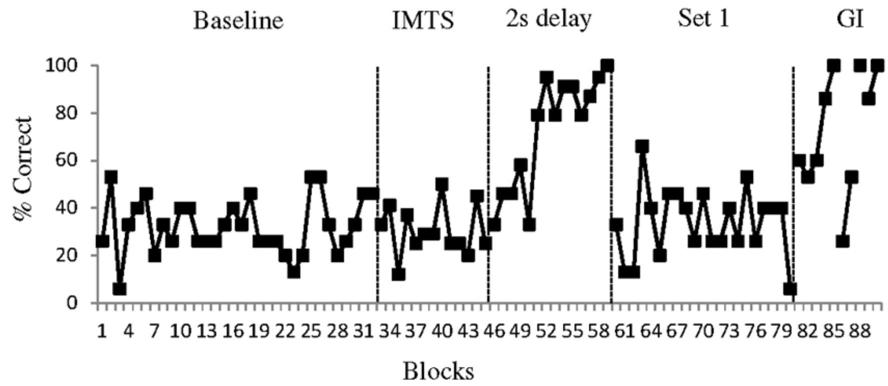


Figure 3. Within subject design presenting baseline conditions that consists of 500 trials of arbitrary matching-to-sample (ArMTS) and following the implementation of the general instruction in Experiment 2. The number of correct trials in each block is presented in percentage. Marius graph is in the top panel, Mari´s graph is in the middle panel and Martin´s graph at the lower panel. GI = general instruction.



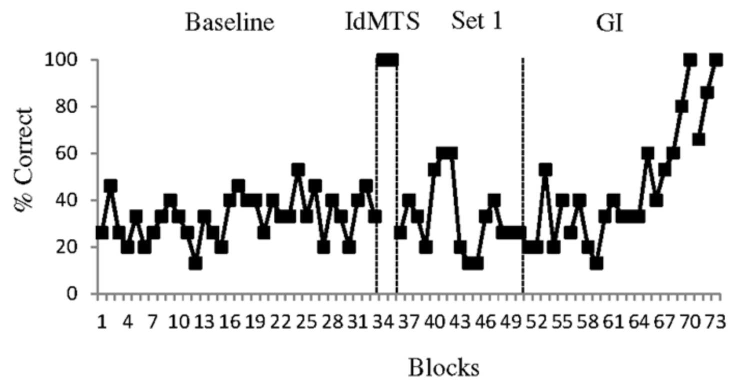


Figure 4. Within subject design presenting baseline conditions that consists of 500 trials of arbitrary matching-to-sample (ArMTS) and following the implementation of the general instruction in Experiment 2. The number of correct trials in each block is presented in percentage. Ella and Emilie were also participants in Experiment 1 and the data from Experiment 1 is presented in the graph, in addition to the responding in the first and second conditional discrimination in Experiment 2. Ella´s graph is at the top panel and Emilie´s graph is at the lower panel. GI = general instruction; ArMTS = arbitrary matching-to-sample; IdMTS = identity matching-to-sample.

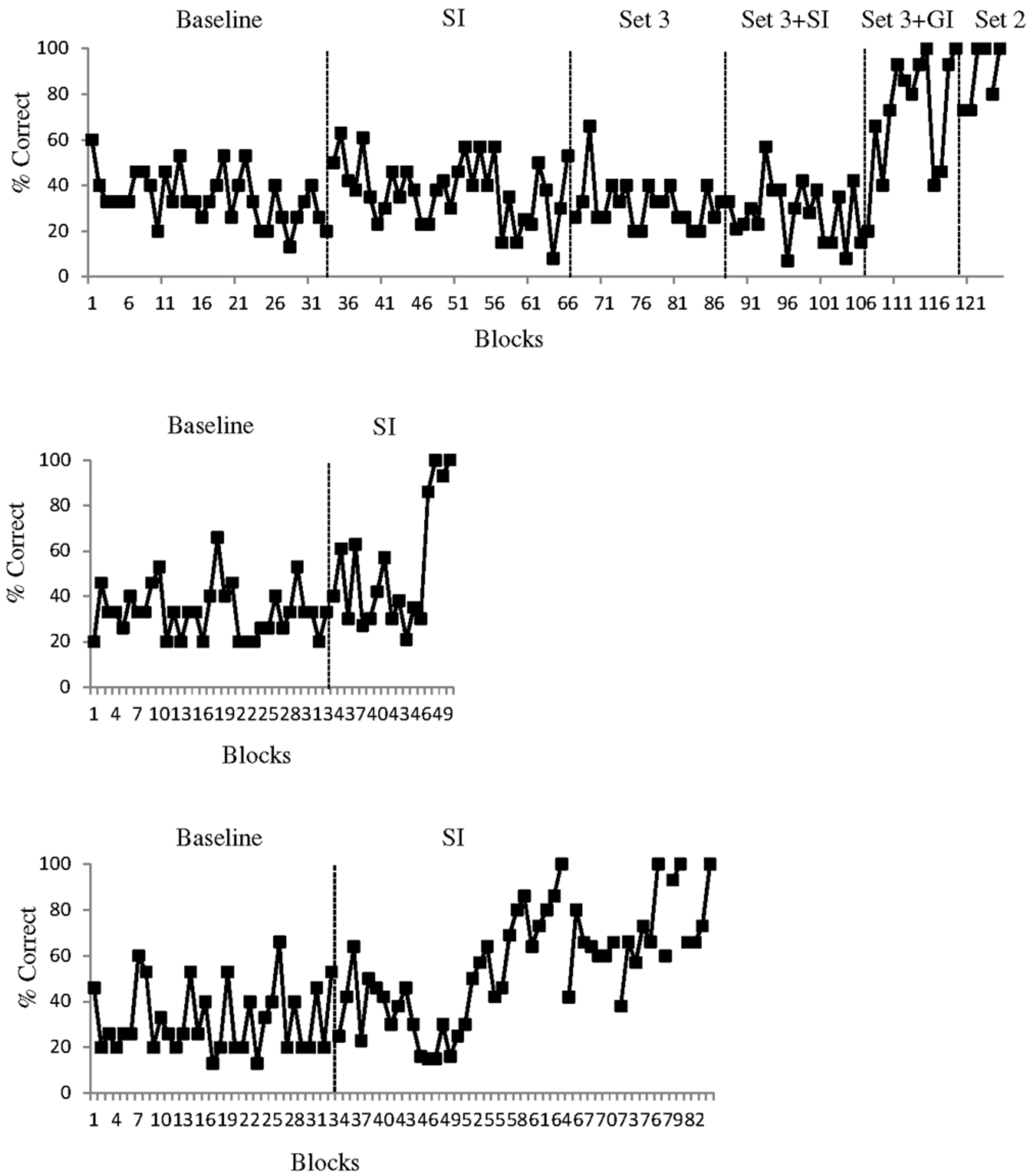


Figure 5. Within subject design presenting baseline conditions that consisted of 500 trials of arbitrary matching-to-sample (ArMTS) and following the implementation of the specific instruction in Experiment 2. The number of correct trials in each block is presented in percentage. Anders graph is in the top panel, Anne´s graph is in the middle panel and Alva´s graph at the lower panel. SI = specific instruction.

Appendix

Request for participation in research

Symbol functions in children

Background and purpose

This is a request for your child to participate in a research project on the study of symbolic functions or what is also called stimulus equivalence. The project will start in autumn 2012, and the data collection will be completed in spring 2013. The project will last for four years. The study will be based on existing research done in our research group and international research.

Stimulus equivalence is a research area within learning psychology which is relevant for the understanding of language, symbolic functions, memory and problem solving. A large proportion of the research in this area has so far been conducted with adults, but it is of considerable interest to identify the variables that affect these phenomena in children. In this study we want to investigate how learning processes can be affected in children.

Implementation of the experiment and the person responsible

Doctoral and Masters students from the University of Oslo and Akershus (HiOA) at the department of behavioral sciences want to collect data during the project period. Professor Erik Arntzen at HiOA will be responsible for the project which is also part of a larger research project at college. If parents have any questions about the test they can get in touch with Professor Erik Arntzen (erik.arntzen @ equivalence.net), PhD student Hanna Steinunn Steingrimsdottir phone 47 90 72 08 and e-mail hannasteinunn@simnet.is or graduate student Marie Moksness phone 41619278 and e-mail mariemoksness@hotmail.com.

What does the study entail?

The experimental situation means that the child solves tasks on a computer. It requires no prior knowledge of computer use for mastering tasks. The experiment has a training phase and a test phase. In the workout different symbols / characters will appear on the screen that the child should touch. Mastery of the task does not require any knowledge of the characters from before. The same characters are used in the testing phase, but with other locations on the screen. Test Manager will not be present with the child at all times to minimize disturbance, but will however be immediate availability and make regular trips back to see if the child are doing well and how tasks are. The duration of the test will vary depending on how the child solves problems, but estimated up to 3 hours. It will be allowed to take breaks along the way and/or split the experiments into shorter sessions over days.

Possible advantages and disadvantages

The experiment will be conducted in a calm and safe atmosphere in familiar surroundings, and it is not linked any discomfort to the completion of the experiment. Professor Erik Arntzen has extensive experience in implementation of similar studies and the ones performing the experiment are specifically trained to do so. After completing the test, the participant will receive a review of the responding and feedback on how he or she solved them. Parents can get a review of their child's performance and a Norwegian article about stimulus equivalence by contacting PhD student Hanna Steinunn Steingrimsdottir.

What happens to the information about you?

The information recorded on the child and the results is only to be used as described in the purpose of the study. All information will be treated without names or other direct recognition data. Consent Forms will be deleted no later than the end of the project. It will not be possible to identify the child in the results of the study if they get published.

Voluntary participation

It is voluntary to participate in the study. You may at any time and without giving any reason withdraw their consent to participate in the study. This will not have any consequences. If you agree to your child participating in the project, sign the consent form on the last page. Now, if you agree to participate, you can later withdraw your consent. If you at a later time want to retire or have questions about the project, contact

Hanna Steinunn Steingrimsdottir
Oslo and Akershus University College,
Departement of behavioral Science
Phone 47 90 72 08 or e-mail adresse hannasteinunn@simnet.is

Privacy policy

Information recorded on the child's
- age
- sex
- How the child solves tasks, including for example which symbols the participant pressed, how long it takes before he or she pressed the various symbols, number of repetitions, and whether the child has learned more than those trained directly.

The principal at the University of Oslo and Akershus is the data controller.

Right to access and deletion of information about the child

If you agree to participate in the study, you have the right to have access to the information that is recorded. You are also entitled to correct any errors in the information we registred. If you withdraw from the study, you can request to delete all the information, unless the information is already used in analyzes or used in scientific publications.

Economy

The study is funded by the University of Oslo and Akershus.

Information on the outcome of the study

Beyond information about each participant's results, the parents can receive a copy of any possible future publication of the results by contacting Hanna Steinunn Steingrimsdottir

Consent for participation in the study

I/ we agree that our child ______________________________________,
(the child´s name)

age ___ and _____, is participating in a research project on stimulus equivalence as described above.

I can confirm that I have received information on the study.

(date) (Signature)