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Stimulus Equivalence, Relational Frame Theory and Transfer of

Avoidance Stimulus Functions

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Publications on Transfer of Functions and Transformation of Functions from 1985 to 2018: A Review

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Abstract

The present study is a review of journal articles that addresses the topics of stimulus equivalence or relational frame theory, using the search terms “Transfer of Functions” and “Transformation of Functions” in the title, abstract, or both. The journal articles had to be published in English language peer-reviewed journals between 1985 and 2018 to be included in the analysis. A total of 350 publications were identified through searches of two electronic databases, PsycINFO and PubPsych. After applying the inclusion criteria to the results, 31 articles met the inclusion criteria, and 319 publications were excluded from the analysis. The included articles were sourced from eight different journals. The articles were categorized as either “Empirical papers” or “Non-Empirical papers”. “Non-Empirical papers” were further subcategorized into “Reviews” and “Other Non-Empirical papers”. All articles were analyzed in order to identify keywords, and “Empirical papers” were additional analyzed to identify number of studies, population parameters, and the experimental setting.

Keywords: transfer of functions, transformation of functions, stimulus equivalence, relational frame theory

Introduction

In modern psychology, the basic concept of stimulus equivalence (SE) has employed for investigation at various times and under different experimental paradigms (Barnes, 1994). For example, from the 1930's up until the 1960's stimulus-response (S-R) learning theorists examined the behavioral effect described as equivalence (e.g., Hull, 1934; Osgood, 1953). They used methods such as for example paired-associative learning in attempts to develop a mediated generalization model of the phenomenon. In the 1960`s (see Jenkins, 1963), the interest in mediation paradigms declined. In turn, this led to a period of stagnation in basic behavioral research in general. Early in the 1970's, Sidman began to develop the conceptual substructures, and the rigorous experimental methods, of the contemporary examination of stimulus equivalence, and the interest for basic behavioral research grew.

Barnes (1994) describes the phenomenon of SE as this: "When a verbally-able humans learn a series of related conditional discriminations, the stimuli involved in those discriminations often become related to each other in ways that were not explicitly trained." (p. 95). Human behaviors are usually controlled by many stimuli simultaneously. Therefore, humans learn conditional discriminations all the time (Pérez-González, Álvarez, Calleja, & Fernández, 2015). Complex human behavior, for example behavior such as language and remembering is often studied by using conditional discrimination procedures in a matching-to-sample (MTS) format (Sidman, 1994). MTS has for a long time been considered one of the most reliable and robust research methods. Conditional discriminations may involve many stimuli, but the simplest form of conditional discrimination involves four stimuli, whereas two of the stimuli are termed "samples" and the other two are termed "comparisons". The stimuli used as samples and comparisons in conditional discrimination procedures are most often visual forms, but they may also involve for example olfactory (e.g., Annett & Leslie, 1995) auditory (e.g., Sidman, 1971), haptic (e.g., Tierney, De Largy, & Bracken, 1995) or gustatory (e.g., L. J. Hayes, Tilley, & Hayes, 1988) modalities.

Normally, conditional discrimination training consists of reinforcing the choice of one comparison (for example B1) when presented with one of the samples (for example A1), and further, reinforcing the choice of the alternative comparison (B2) when presented with the other sample (A2). Subsequent to conditional discrimination training, if the subject is presented with B1 as a sample s/he will generally pick A1 as a comparison, and A2 as a comparison when presented with B2 as a sample. The two relations A1-B1 and A2-B2 are directly trained, but the relations B1-A1 and B2-A2 are derived without any further explicit training as a result of the trained relations. If the subject is then taught a second related conditional discrimination, for example B1-C1 and B2-C2, the number of relations that may be derived increase considerably. Training of the two related conditional discriminations (A1-B1/A2-B2 and B1-C1/B2-C2) has repeatedly resulted in the emergence of these eight derived relations: B1- A1, B2-A2, C1-B1, C2-B2, A1-C1, A2-C2, C1-A1, and C2-A2. If such derived relational responses are observed, the stimuli involved are said to participate in equivalence relations (Barnes, 1994; Sidman & Tailby, 1982).

Sidman (1990); (1992) consider equivalence as a basic stimulus function. In the same way as for example discrimination and reinforcement, equivalence is not derived from other behavioral processes. The explanation for equivalence is rather to be found in the phylogenetic history of the human species. S. C. Hayes, (1991) developed the theory known as Relational Frame Theory (RFT), where he expanded the concept of basic SE. The development of this theory provided a set of conceptual terms in which describe more accurately the specific types of behavior-environment interaction responsible for equivalence responding, in addition to other forms of human behavior. RFT does not consider SE as a basic stimulus function, rather as a result of the prolonged exposure to the contingencies of reinforcement operating in the verbal community. Equivalence responding and related phenomena require some form of prior learning, and RFT focuses most of the attention on this learning.

RFT is a theory, which, in addition to extend the theory of SE provided by Sidman (1971), expands on the core behavioral analytic viewpoint of language and cognition by providing a theory supportive of derived relational responding as an operant behavior. RFT proposes that words, and stimuli in general, form relational networks, from which they obtain their function, "meaning", and relationship to other words, or stimuli (Torneke, 2010). Derived relational responding and SE have created much excitement and considerable research activity within the behavior analytic community in the recent years (Barnes, 1994; Barnes, Healy, & Hayes, 2000). In the typical SE experiment, subjects are explicitly trained to select for example Stimulus B and Stimulus C in the presence of Stimulus A, and afterwards during testing most subjects often select Stimulus C in the presence of Stimulus B and Stimulus B in the presence of Stimulus C without further reinforcement (Barnes, 1994).

According to S. C. Hayes, Barnes-Holmes, and Roche (2001) and Dymond and Roche (2013) SE is a special case of derived relations. Humans may respond on the basis of other relations besides equivalence, such as for example difference, comparison, and opposition. These relations are arbitrarily applicable. Arbitrary stimuli may therefore be related not only by equivalence, but these other kinds of relations as well (Perez et al., 2015). The ability to relate stimuli to other stimuli is, according to RFT, learned behavior. Relational responding is a type of generalized operant that comes from a result of exposure to multiple exemplars. This responding in accordance with different relational frames involves three elements: (1) mutual entailment, (2) combinatorial entailment, and (3) transformation of functions (Arntzen, 2010).

The concept of mutual entailment refers to the bi-directionality of relationships between stimuli. To illustrate mutual entailment, if a given stimulus is related to another such that Stimulus A is the same as Stimulus B, then the derived relation - B is the same as A - is mutually entailed (S. C. Hayes, Gifford, & Wilson, 1996). The concept of combinatorial entailment refers to the combination of two mutually entailed relationships. In order to meet the criteria of combinatorial entailment, a relational network between at least three stimuli must develop. For example, if A is the opposite of B and B is the opposite of C, C the same as A and A the same as C, it is defined as combinatorially entailed relations (S. C. Hayes et al., 1996). There are a number of ways in which stimuli might be mutually or combinatorially entailed, and many of these might result in comparisons besides sameness. Mutually and combinatorially entailed relations still constitute a relational network in all cases. When such a network has specific stimulus functions, the functions of other events in that network may alter or transform in accordance with the derived relations (Ninness et al., 2006).

The phenomenon that is often referred to as transfer of functions or transformations of functions is one of the most interesting findings to emerge from the rapidly growing body of research on SE and derived stimulus relations (M. Dougher, Perkins, Greenway, Koons, & Chiasson, 2002; Rehfeldt & Dymond, 2005). Transfer of functions is also a special case of a more general phenomenon: namely transformation of functions (Perez et al., 2015). Research on derived stimulus relations has consistently shown that when people are exposed to a series of interrelated conditional discriminations, the stimuli can become related to each other in indirect and often complex ways (Rehfeldt & Dymond, 2005).

Transformation of functions occurs when the function of one stimulus in a derived relation alters the functions of another according to the derived relation between the two, without additional training. As a practical example of “transformation of functions”, consider an individual who derives an equivalence relation consisting of the spoken word “stop”, a stop sign, and a gesture from a crossing guard to stop. Later, she may learn that when her teacher says “stop”, it is time to stop and wait for oncoming traffic. Subsequently, the stop sign and the crossing guard`s gesture may case similar behavior on the part of the individual.

This transformation of functions is based on the behavioral function of “stop” and the derived relation between the spoken word and the gesture or the sign (Dymond & Rehfeldt, 2000). Transformation of functions has been reported in different contexts in the literature. Studies have been done with transformation of functions by the use of hierarchical relations (Gil, Luciano, Ruiz, & Valdivia-Salas, 2012; Gil, Luciano, Ruiz, & Valdivia-Salas, 2014), deictic relations (McHugh, Barnes-Holmes, & Barnes-Holmes, 2004), and opposite relations (Stewart et al., 2015).

M. Dougher et al. (2002) explain in their paper how procedures used in studies with transfer of functions and transformation of functions typically looks like. “First, some number of equivalence classes are established using match-to-sample (MTS) or other training procedures. Then, one or more members of one of the classes are selected and given some new behavioral function. Following this, the remaining members of all of the classes are tested to see if they also have acquired the novel function. If the other members of the class from which the subset was selected acquire the function but the members of the other classes do not, the novel function is said to have transferred within the equivalence class.” (p. 63).

Transfer of functions with a variety of different stimulus functions has been reported in the literature, including conditioned reinforcement and punishment (Greenway, Dougher, & Wulfert, 1996; S. C. Hayes, Kohlenberg, & Hayes, 1991), simple discriminative control (de Rose, McIlvane, Dube, Galpin, & Stoddard, 1988), respondent elicitation (Barnes & Roche, 1997; M. J. Dougher, Augustson, Markham, Greenway, & Wulfert, 1994; B. Roche & Barnes, 1997), ordinal stimulus control (Green, Sigurdardottir, & Saunders, 1991), and conditional stimulus control (Wulfert & Hayes, 1988). Research on transfer of functions and transformation of functions may have both clinical and applied significance. For example, in the often cited study by M. J. Dougher et al. (1994), they investigated the transfer of respondent elicitation through equivalence classes. In Experiment 1, they used a MTS procedure in the formation of two four-member equivalence classes. Then, one member from one class was paired with electric shock, and one member from another class was presented without electric shock. The remaining stimuli were then presented. They used skin conductance in order to measure the conditioning. Results from Experiment 1 showed that six out of the eight participants demonstrated transfer of conditioning. In Experiment 2, they used the same procedures as in Experiment 1, and investigated the transfer of extinction. One member from one class was presented in extinction, after equivalence training and conditioning to all members of one class. When the other stimuli from this class were presented they did not elicit skin conductance. The stimulus that was previously presented in extinction was reconditioned in the last phase of the experiment. Results from test trials with other members of the class showed that they regained elicitation function. These two experiments demonstrate that respondent elicitation and extinction can transfer through stimulus classes. These results are highly important in relation to both research and clinical settings with for example anxiety disorders and phobias.

A number of reviews on different topics have been published throughout the years. Palmer (2004) wrote a review of RFT, and Dymond, May, Munnelly, and Hoon (2010) published a citation analysis on RFT from 1991 until 2008. Montoya-Rodríguez, Molina, and McHugh (2017) published a review on RFT and deictic relational responding. To date, there are none published reviews regarding SE. Transfer of functions and transformation of functions are interesting phenomenon’s, which has contributed to important and, not least, relevant research. This current review aims to determine the amount of articles written on SE or RFT containing the search terms “Transfer of Functions” and “Transformations of Functions” successively in the title, abstract, or both, from 1985–2018.

Method

Inclusion criteria

Articles published in English language peer-reviewed journals between 1985 and 2018 that used the terms "Transfer of Functions" and "Transformation of Functions" either in the title or abstract, or both, were eligible for inclusion in the analysis. Another inclusion criteria were that the article had to revolve around SE or RFT.

Exclusion criteria

Articles published in other than English language peer-reviewed journals, and were published outside the actual timespan (1985–2018) were excluded from the analysis. Articles that were written about other themes besides "Stimulus Equivalence" and "Relational Frame Theory", and articles that did not contain the search terms "Transfer of Functions" or "Transformation of Functions" successively in the title, abstract, or both, was additionally excluded.

Search strategy

Articles were identified by searching the two selected electronic databases (PsycINFO and PubPsych) using the search terms "Transfer of Functions" and "Transformation of Functions". Filters in the databases were used in order to refine the scope of the search results. The full search strategies used for both PsycINFO and PubPsych are reported in Appendix A. The choice of databases was taken based on the field in regards to writing a review. Both of these databases publish literature within psychology and psychiatry.

Article categories

The articles are categorized as "Empirical papers", or "Non-Empirical papers". "Empirical papers" refer to articles that contain experiments. This category, however, encompassed a range of research designs, and some of the articles contained several experiments. For example, Dermot and Keenan (1993) conducted experiments on transfer of functions through derived arbitrary and nonarbitrary stimulus relations, and Gómez, López, Martín, Barnes-Holmes, and Barnes-Holmes (2007) used exemplar training to study derived transformation of functions in accordance with symmetry and equivalence. “Non-Empirical papers” did not contain experiments or research designs, but reviews and conceptual papers. For example Barnes (1994) addresses Murray Sidman and his view of SE as a basic stimulus function on the one hand and Steven Haye`s RFT on the other hand. Further, Dymond and Roche (2009) published “A contemporary behavior analysis of anxiety and avoidance” where they provide a review of the empirical literature on avoidance, and describe the implications of research on derived relational responding and the transformation of functions for a contemporary behavioral account of avoidance. “Non-Empirical papers” were subcategorized into “Reviews” and “Other Non-Empirical papers”.

Both “Empirical papers” and “Non-Empirical papers” were further analyzed to identify the keywords used. The keywords of interest were subcategorized into “Stimulus Equivalence”, “Equivalence Relations”, “Relational Frames” “Derived Relations”. Other key words used in the included papers were not taken into consideration in the current analysis.

“Empirical papers” were analyzed additional, to identify the population parameters, number of participants in the different experiments, and the experimental setting. Population parameters concerned the age and type (for example students, normally developed children, adults) of participants in each study. The population types were subcategorized into students (including students, university students and undergraduates), normally developed children, children with autism specter diagnoses, normally developed youths, youths with autism specter diagnoses, and adults. The experimental setting were analyzed in order to get an overview of different settings studies with “Transfer of Functions” and “Transformation of Functions” were conducted in.

Some of the “Empirical papers” included more than one experiment. For example, the paper published by M. Dougher et al. (2002) included four experiments. “Empirical papers” were therefore further reassessed to find how many experiments they contained.

Analysis of inter-rater agreement

An independent reviewer were employed in order to score inter-rater agreement (IRA) for the following categories and subcategories “Inclusion”, “Empirical papers”, “Non-Empirical papers”, “Reviews”, “Other Non-Empirical papers”, “Publication year”, “Journal”, and “Number of experiments” in 50% of the papers. IRA was defined as both reviewers independently assigned an article to an identical category or subcategory. The percentage of IRA for both categories and subcategories is listed in Table 1. The percentage of agreement for each category and subcategory was calculated by dividing the number of agreements within the respective category or subcategory by the sum of agreements and disagreements, and multiplying the product by 100. The percentage of IRA for the categories and subcategories ranged from 95,8% - 100%.

Results

A total of 350 publications were identified through searches of two electronic databases, PsycINFO and PubPsych (PsycINFO *n* = 334, and PubPsych *n* = 16). After applying the inclusion criteria to the results, 319 publications were excluded. Consequently, 31 articles met the inclusion criteria and were included in the analysis. Of these, 25 were categorized as “Empirical papers” (“Transfer of Functions” *n* = 17, “Transformation of Functions” *n* = 8), and six were categorized as “Non-Empirical papers” (“Transfer of Functions” *n* = 1, “Transformation of Functions” *n* = 5). “Non-Empirical papers” were subcategorized into “Reviews” and “Other Non-Empirical papers”. After analyzing the “Non-Empirical papers”, one paper was classified as “Review” (“Transfer of Functions” *n* = 0, “Transformation of Functions” *n* = 1), and the other five papers were classified as “Other

Non-Empirical papers" ("Transfer of Functions" *n* = 1, "Transformation of Functions" *n* = 4). See Figure 1 for flow diagram of the included papers.

Eighteen of the articles met the inclusion criteria for the search terms "Transfer of Functions". Table 1 show a complete list for the articles included in the analysis. Nine of the articles were retrieved from PsycINFO, one article was found in PubPsych, and eight articles were found in both of the databases. Three of the articles used the search terms in the title, twelve in the abstract, and three in both the title and the abstract. Thirteen of the articles, on the other hand, met the inclusion criteria for the search terms "Transformation of Functions". Table 2 show a complete list for the articles included in the analysis with the terms "Transformation of Functions". Ten of the articles were found in PsycINFO, and three articles were found in both PsycINFO and PubPsych. Two of the articles used the search terms in the title, eight in the abstract, and three in both the title and the abstract.

Publication year

An analysis of the publication year on the papers was conducted. Figure 2 shows an overview of the number of articles that were published in the different five years periods. None of the articles met the inclusion criteria in the first five year period, (1985 –1989), neither articles on "Transfer of Functions" nor "Transformation of Functions". In the next five-year period (1990 –1994), three publications met the inclusion criteria for the search terms "Transfer of Functions", and none of the publications met the inclusion criteria for "Transformation of Functions". From 1995 to 1999, one publication met the inclusion criteria for "Transfer of Functions", and none publications met the inclusion criteria for the terms "Transformation of Functions". Overall, five publications met the inclusion criteria in the five year period 2000–2004 ("Transfer of Functions" *n* = 1, "Transformation of Functions" *n* = 3). In the next five-year period (2005–2009), a total of nine publications met the inclusion criteria ("Transfer of Functions" *n* = 7, "Transformations of Functions" *n* = 4). From year 2010 to year 2014, five publications met the inclusion criteria ("Transfer of Functions" *n* = 1, "Transformation of Functions" *n* = 4). A total of seven publications met the inclusion criteria in from 2015 to 2018 ("Transfer of Functions" *n* = 5, "Transformation of Functions" *n* = 2).

Journals

An analysis was conducted to identify the different journals in which the 31 articles were published. The articles were sourced from eight different journals. As shown in Figure 3, the majority of the articles with the search terms were published in *The Psychological Record*. Respectively, 39% (*n* = 7) of the articles with the search terms "Transfer of Functions" and 38% (*n* = 5) of the articles with search terms "Transformation of Functions" were published in *The Psychological Record*. Further, 33% (n= 6) of the articles with the search terms "Transfer of Functions" and 15% (*n* = 2) of the articles with the search terms "Transformation of Functions" were published in the *Journal of the Experimental Analysis of Behavior*. In addition to *The Psychological Record* and *Journal of the Experimental Analysis of Behavior*, the journals was sourced from other journals, respectively *International Journal of Psychology & Psychological Therapy*, *The Behavior Analyst, Learning & Behavior, Behavioral Development Bulletin*, *Journal of Applied Behavior Analysis*, and *The Behaviorist Today*.

Keywords

The keywords of interest were subcategorized into "Stimulus equivalence", "Equivalence relations", "Relational Frames/Relational Frame Theory", and "Derived (stimulus) relations". An overview of how many papers included any of the keywords as mentioned earlier mentioned keywords is shown in Figure 4. Results show that eight of the papers used the keyword "Stimulus equivalence" ("Transfer of Functions" *n* = 6, "Transformation of Functions" *n* = 2). One of the papers used "Equivalence relations" ("Transfer of Functions" *n* = 1, "Transformation of Functions" *n* = 0). Seven of the included papers used “Relational frames/Relational Frame Theory” (“Transfer of Functions” *n* = 1, “Transformation of Functions” *n* = 6). Four of the papers used the keyword “Derived (stimulus) relations” (“Transfer of Functions” *n* = 1, “Transformation of Functions” *n* = 3). No keywords was provided for the article written by Roche (2002).

Articles including several experiments

Several of the “Empirical papers” included more than one experiment. Overall, the 25 “Empirical papers” included all in all 44 experiments (“Transfer of Functions, *n* = 30, “Transformation of Functions” *n* = 14). Six of the written papers on “Transfer of Functions” included more than one experiment. Dermot and Keenan (1993) conducted four experiments, Pérez-Gobzález and Serna (2003) conducted two experiments, Murphy, Barnes-Holmes, and Barnes-Holmes (2005) conducted three experiments, Smyth, Barnes-Holmes, and Forsyth (2006) conducted two experiments, Pérez-Gobzález and Martínez (2007) conducted five experiments, and Pérez-González et al. (2015) conducted two experiments. Four of the “Empirical papers” with “Transformation of Functions” also included more than one experiment. M. Dougher et al. (2002) conducted four experiments, Roche and Dymond (2008) conducted two experiments, Slattery and Stewart (2014) conducted two experiments, and Stewart et al. (2015) conducted three experiments.

Participants

An analysis was conducted in order to find out how many participants were employed in the different studies. The age spread and type of population in the different studies were also analyzed. Overall, there were 477 participants distributed on the 44 studies included in this analysis (“Transfer of Functions” *n* = 336, ”Transformation of Functions” *n* = 141). Figure 5 shows an overview of number of participants used in the included studies. The number of participants in the different experiments varied from three to 47, mean = 4. The lowest number of participants in the experiments on “Transfer of Functions” were three participants (Murphy et al., 2005; Pérez-Gobzález & Martínez, 2007; Smyth et al., 2006), and the highest number of participants were 36 (O'Toole, Barnes-Holmes, & Smyth, 2007). The number of participants in the experiments conducted on “Transformation of Functions” varied between three (Roche & Dymond, 2008) and 47 (Perez et al., 2015). The youngest participant were three years old when participating in the experiment done by Barnes, Browne, Smeets, and Roche (1995), and the oldest participant specified were 50 years old when participating in the experiment done by Stewart et al. (2015).

Population types in the different studies were analyzed. As can be seen in Table 4, 65,9% of the studies (*n* = 29) was conducted with students (“Transfer of Functions” 70%, *n* = 21, “Transformation of Functions” 57,2%, *n* = 8). Further, 9,1% of the studies (*n* = 4) used normally developed children as participants (“Transfer of Functions” 10% *n* = 3, “Transformation of Functions” 7,1%, *n* = 1). A total of 6,8% of the studies (*n* = 3) was conducted with children with autism specter diagnoses (“Transfer of Functions” 10%, *n* = 3, “Transformation of Functions” 0%, *n* = 0). Three studies (6,8%) conducted with “Transfer of Functions” used children and youths as participants. One study (2,3%) conducted with “Transformation of Functions” used a combination of youths with autism specter diagnoses and children as participants. A total of 9,1% of the studies (*n* = 4) was conducted with adults (“Transfer of Functions” 0%, *n* = 0, “Transformation of Functions” 28,6%, *n* = 4).

Setting

As shown in Figure 6, most of the experiments were conducted in experimental rooms/laboratories. A total of 35 studies stated that they used experimental rooms/laboratories in where they conducted their experiments (“Transfer of Functions” *n* = 25, “Transformation of Functions” *n* = 10). Furthermore, two studies conducted their experiments in schools (“Transfer of Functions” *n* = 1, “Transformation of Functions” *n* = 1). One experiment from the included articles with search terms “Transformation of Functions” stated that they conducted experiments both in school and private homes. The study was conducted by Murphy and Barnes-Holmes (2010). The experimental procedures for the boys with autism specter diagnose were conducted in the children`s general educational classroom. The three other participants (normally developed children) completed the experimental procedures in their private homes (Murphy & Barnes-Holmes, 2010).

The experimental setting was not specified in six of the studies ("Transfer of Functions", *n* = 4, "Transformation of Functions", *n* = 2). The experimental setting was not specified in the experiments conducted by Boelens (1990), Murphy et al. (2005), and Slattery and Stewart (2014).

Discussion

The current review aimed to determine the amount of papers containing the search terms "Transfer of Functions" and "Transformations of Functions" in the title, abstract, or both, from 1985 –2018. Another inclusion criteria was that the article had to be about SE or RFT. As can be seen from the current analysis over the past 33 years, 31 articles met the inclusion criteria and were included in the analysis. Of the included papers, 25 were Empirical papers, and six were Non-Empirical papers. Eighteen papers met the inclusion criteria for the search terms "Transfer of Functions" and 14 met the inclusion criteria for "Transformation of Functions". There were more articles in the databases on the search terms "Transfer of Functions" than "Transformation of Functions". As more of the articles included several studies, there were 44 experiments all in all. The number of studies in the Empirical papers ranged from one to five.

The included papers were retrieved from eight different journals. *The Psychological Record* published furthermost of the articles both on "Transfer of Functions" and "Transformation of Functions". Both Dymond et al. (2010) and O`Connor, Farrell, Munnelly, and McHugh (2017) made an citation analysis, to provide an overview of the "Empirical" and

“Non-Empirical” studies citing RFT-related search and the journal in which they were published. Dymond et al. (2010) included articles published between 1991 and 2008, whereas O`Connor et al. (2017) aimed to update their overview and included articles published between 2009 and 2016. Both of them found that the majority of the included articles were published in *The Psychological Record*. Results from their review correspond to the result for the current review, without it being directly comparable, since they were interested in studies citing RFT related studies, and the current review, on the other side, include articles that use the search terms “Transfer of Functions” and “Transformation of Functions”. Also, *Journal of the Experimental Analysis of Behavior* published many of the articles included on the search terms “Transfer of Functions”.

Keywords were analyzed in order to get a certain overview of how many articles were published within the different directions, either Sidman`s theory of SE or Hayes RFT. The keywords of interest were subcategorized into “Stimulus equivalence”, “Equivalence relations”, “Relational Frames/Relational Frame Theory”, and “Derived (stimulus) relations”. These keywords were keywords that reappeared in multiple of the papers. Some of the included papers used a mix of the subcategorized keywords of interest. For example Dymond and Ferguson (2007) used “Relational Frame of Equivalence” and Murphy and Barnes-Holmes (2010) used “Derived mands” as a keyword. Further, Gómez et al. (2007) used both “Equivalence”, “Equivalence Classes”, and “Stimuli”, whereas none of them matched the keywords of interest. An analysis of the keywords used in the included papers showed that most of the articles using “Stimulus Equivalence” and “Equivalence Relations” as keywords were publications that met the inclusion criteria for the search terms “Transfer of Functions”. Most of the papers using “Relational Frames/Relational Frame Theory”, and “Derived (stimulus) relations”, were on the other side, publications that met the inclusion criteria for the search terms “Transformation of Functions”.

Examination of the “Empirical papers” shows that the number of participants in the different studies varies to a large extent. The majority of the studies were conducted with a low number of participants. Eleven of the studies were conducted with four participants. It turned out that many of the studies conducted with a low number of participants were part of articles including more studies. For example, Smyth et al. (2006), conducted two experiments, whereas Experiment 1 included three participants, and Experiment 2 included 16 participants. Pérez-Gobzález and Martínez (2007) conducted five experiments, where they had three participants in two of the experiments and four participants in the other three experiments.

Even though many of the articles including more than one experiment had few participants, some of the articles including several experiment also used a higher number of participants in their studies. For example, Stewart et al. (2015), conducted two experiments with 11 participants in each experiment. The majority of the articles only containing one experiment had a higher number of participants in their experiments than the articles containing several experiments. For example, Luciano et al. (2014) used 23 participants in their study, Silveira et al. (2016) used 32 participants in their study, Silveira, Mackay, and de Rose (2017) used 17 participants in their study.

An analysis of population type showed that the majority of the studies used students (students were defined as students, undergraduates and university students in the studies) as participants in their experiments. Further, the analysis revealed that some of the studies were conducted with adults and normally developed children, and a few studies were conducted with children with autism specter diagnoses, children and youths, and youths with autism specter diagnoses and children.

Most of the studies conducted their experiments in experimental rooms/laboratories. This is probably related to the population type used in the different studies. Ever since the majority of the studies were conducted with students, it was most likely the easiest to use experimental rooms/laboratories. Nevertheless, some of the studies were conducted in other settings besides experimental rooms/laboratories. For example, Mizael, de Almeida, Silveira, and de Rose (2016) collected the data in the children’s school`s toy library. Murphy and Barnes-Holmes (2010) who used both children and youths with autism specter diagnoses as participants in their study collected the data with the youths with autism specter diagnoses in their general educational classroom, whereas the children completed the experimental procedures in their private homes.

Both “Transfer of Functions” and “Transformation of Functions” are exciting phenomenon’s, which has contributed to relevant and important research. Thirty-one articles met the inclusion criteria and were further analyzed in the current review. Further research, in addition to replications with a broader focus would be interesting.

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Table 1.

Results from the Inter-rater Agreement

Category	**Inter-rater agreement (%)**
Inclusion	97,1
Empirical papers	100
Non-Empirical papers	100
Reviews	100
Other Non-Empirical papers	96,3
Publication year	100
Journal	95,8
Number of experiments	100

Note. The table shows the results from the IRA from a selection of the categories and subcategories from 50 % of the articles. The percentage of IRA for the categories and subcategories ranged from 95,8% - 100%.

Table 2.

Included Articles with Search Terms "Transfer of Functions".

Publication year	Title, Author and Journal
1990	**Emergent simple discrimination in children: Role of contiguity** *Harrie Boelens* Behavioural Processes. Vol.22(1-2), 1990, pp. 13-21.
1993	**A transfer of functions through derived arbitrary and nonarbitrary stimulus relations** *Dermot Barnes and Michael Keenan* Journal of the Experimental Analysis of Behavior. Vol59 (1), 1993, pp. 61-81.
1994	**Stimulus equivalence and relational frame theory** *Dermot Barnes* The Psychological Record. Vol.44(1), 1994, pp. 91-124.
1995	**A transfer of functions and a conditional transfer of functions through equivalence relations in three- to six-year-old children** *Dermot Barnes, Mary Browne, Paul Smeets, and Bryan Roche* The Psychological Record. Vol.45(3), 1995, pp. 405-430.
2003	**Transfer of specific contextual functions to novel conditional discriminations**

Luis Antonio Pérez-Gobzález and Richard W. Serna
Journal of the Experimental Analysis of Behavior. Vol.79(3), 2003, pp. 395-408.

2005 **Derived manding in children with autism: Synthesizing Skinner's verbal behavior with relational frame theory**
Carol Murphy, Dermot Barnes-Holmes, and Yvonne Barnes-Holmes
Journal of Applied Behavior Analysis. Vol.38(4), 2005, pp. 445-462.
The effects of test order and nodal distance on the emergence and stability of derived discriminative stimulus functions
Ruth Anne Rehfeldt and Simon Dymond
The Psychological Record. Vol.55(2), 2005, pp. 179-196.

2006 **A derived transfer of simple discrimination and self-reported arousal functions in spider fearful and non-spider-fearful participants**
Sinéad Smyth, Dermot Barnes-Holmes, and John P. Forsyth
Journal of the Experimental Analysis of Behavior. Vol.85(2), 2006, pp. 223-246.

2007 **A derived transfer of functions and the Implicit Association Test**
Catriona O'Toole, Dermot Barnes-Holmes, and Sinead Smyth
Journal of the Experimental Analysis of Behavior. Vol.88(2), 2007, pp. 263-283.
Contextual control by function and form of transfer of functions
David R. Perkins, Michael J. Dougher, and David E. Greenway

Journal of the Experimental Analysis of Behavior. Vol.88(1), 2007, pp. 87-102.

Control by contextual stimuli in novel second-order conditional discriminations

Luis Antonio Pérez-Gobzález and Héctor Martínez

The Psychological Record. Vol.57(1), 2007, pp. 117-143.

Towards a behavioral analysis of humor: Derived transfer of self-reported humor ratings

Simon Dymond and Duncan Ferguson

The Behavior Analyst Today. Vol.8(4), 2007, pp. 500-511.

2014 **Effects of an acceptance/defusion intervention on experimentally induced generalized avoidance: a laboratory demonstration**

Carmen Luciano, Sonsoles Valdivia-Salas, Francisco J. Ruiz, Miguel Rodríguez-Valverde, Dermet Barnes-Holmes, Michael J. Dougher, Juan C. López-López, Yvonne Barnes-Holmes, and Olga Gutierrez-Martínez

Journal of the Experimental Analysis of Behavior. Vol.101(1), 2014, pp. 94-111.

2015 **Transfer of three functions of contextual stimuli in conditional discriminations**

Luis Antonio Pérez-González, Eva Álvarez, Alba Calleja, and Asunción Fernández

The Psychological Record. Vol.65(2), 2015, pp. 277-287.

2016 **Transfer of conditioned fear-potentiated startle across equivalence classes. An exploratory study**

Miguel Ángel López Medina, Miguel Rodríguez Valverde, and Mónica Hernández López

	International Journal of Psychology & Psychological Therapy. Vol.16(3), 2016, pp. 249-263.
	Changing racial bias by transfer of functions in equivalence classes
	Táhcita M. Mizael, João H. de Almeida, Carolina C. Silveira, and Julio C. de Rose
	The Psychological Record. Vol.66(3), 2016, pp. 451-462.
	Maintenance of equivalence classes and transfer of functions: The role of the nature of stimuli
	Marcelo V. Silveira, Natalia Maria Aggio, Mariéle Diniz Cortez, Renato Bortoloti, Viviane Verdu Rico, and Julio C. de Rose
	The Psychological Record. Vol.66(1), 2016, pp. 65-74.
2017	**Measuring the "transfer of meaning" through members of equivalence classes merged via a class-specific reinforcement procedure**
	Marcelo V. Silveira, Harry A. Mackay, and Julio C. de Rose
	Learning & Behavior. 2017, pp. 1-14.

Note. The table shows an overview of the 18 included articles met the including criteria for the search terms "Transfer of Functions". Publication year, title, author and journal are presented for all the articles.

Table 3.

Included Articles with Search Terms "Transformation of Functions".

Publication year	Title, Author and Journal
2002	**The development of sexual arousal patterns in humans: Implications arising from the derived transformation of functions** *Bryan Roche* Behavioral Development Bulletin. Vol.11(1), 2002, pp. 47-51. **Contextual control of equivalence-based transformation of functions** *Michael Dougher, David R. Perkins, David Greenway, Ashton Koons, and Carmenne Chiasson* Journal of the Experimental Analysis of Behavior. Vol.78(1), 2002, pp. 63-93.
2004	**A proposal for synthesizing verbal contexts in experiential avoidance disorder and acceptance and commitment therapy** *Carmen Luciano Soriano, Miguel Rodríguez Valverde, and Olga Gutiérrez Martínes* International Journal of Psychology & Psychological Therapy. Vol.4(2), 2004, pp. 377-394.
2007	**Exemplar training and a derived transformation of functions in accordance with symmetry and equivalence** *Serafín Gómez, Francisca López, Carmen Baños Martín, Yvonne Barnes-Holmes, and Dermot Barnes-Holmes* The Psychological Record. Vol.57(2), 2007, pp. 273-294.

2008 **A transformation of functions in accordance with the nonarbitrary relational properties of sexual stimuli**

Bryan Roche and Simon Dymond

The Psychological Record. Vol.58(1), 2008, pp. 71-90.

2009 **A behavior-analytic account of motivational interviewing**

Paulette J. Christopher and Michael J. Dougher

The Behavior Analyst. Vol.32(1), 2009, pp. 149-161.

A contemporary behavior analysis of anxiety and avoidance

Simon Dymond and Bryan Roche

The Behavior Analyst. Vol.32(1), 2009, pp. 7-27.

2010 **Establishing complex derived manding with children with and without a diagnosis of autism**

Carol Murphy and Dermot Barnes-Holmes

The Psychological Record. Vol.60(3), 2010, pp. 489-504.

2012 **A preliminary demonstration of transformation of functions through hierarchical relations**

Enrique Gil, Carmen Luciano, Francisco J. Ruiz, and Sonsoles Valdivia-Salas

International Journal of Psychology & Psychological Therapy. Vol.12(1), 2012, pp. 1-19.

2014	**A further experimental step in the analysis of hierarchical responding**
	Enrique Gil, Carmen Luciano, Francisco J. Ruiz, and Sonsoles Valdivia-Salas
	International Journal of Psychology & Psychological Therapy. Vol.14(2), 2014, pp. 137-153.
	Hierarchical classification as relational framing
	Brian Slattery and Ian Stewart
	Journal of the Experimental Analysis of Behavior. Vol.101(1), 2014, pp. 61-75.
2015	**Transformation of thought suppression functions via same and opposite relations**
	Ian Stewart, Nic Hooper, Paul Walsh, Ronan O'Keefe, Rachel Joyce, and Louise McHugh
	The Psychological Record. Vol.65(2), 2015, pp. 375-399.
	Transformation of meaning through relations of sameness and opposition
	William Ferreira Perez, João Henrique de Almedia, and Julio C. de Rose
	The Psychological Record. Vol.65(4), 2015, pp. 679-689.

Note. The table shows an overview of the 13 included articles met the including criteria for the search terms “Transformation of Functions”. Publication year, title, author and journal are presented for all the articles.

Table 4.

Population Types

	Transfer of Functions		Transformation of Functions		
Type of population	**Number of studies**	**%**	**Number of studies**	**%**	**Total (%)**
Students	21	70	8	57,2	65,9
Normally developed children	3	10	1	7,1	9,1
Children with autism specter diagnose	3	10	0	0	6,8
Children and youths	3	10	0	0	6,8
Youths with autism specter diagnose and children	0	0	1	7,1	2,3
Adults	0	0	4	28,6	9,1

Note. The table shows an overview of the population type in the different studies. Number of studies is shown to the left of each column, and the number of studies presented as percentage is shown to the right of each column. Total percentage is shown in the last column.

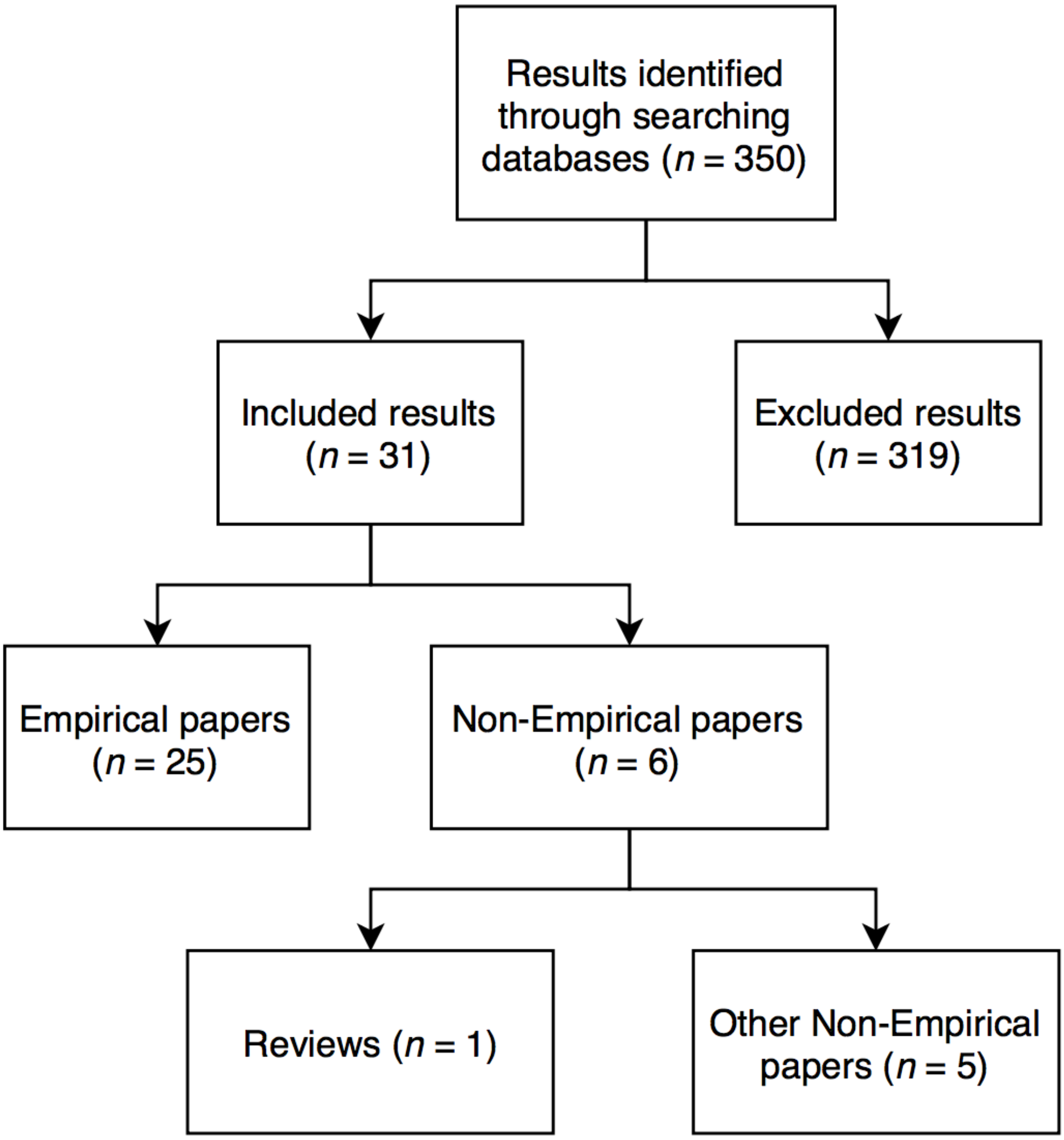

Figure 1.

Flow diagram showing the results from the database search. A total of 350 articles were identified through the database search. Thirty-one of the articles were included in the analysis, and 319 were excluded. The number of Empirical papers, Non-Empirical papers, Reviews and Other Non-Empirical papers are shown in the diagram.

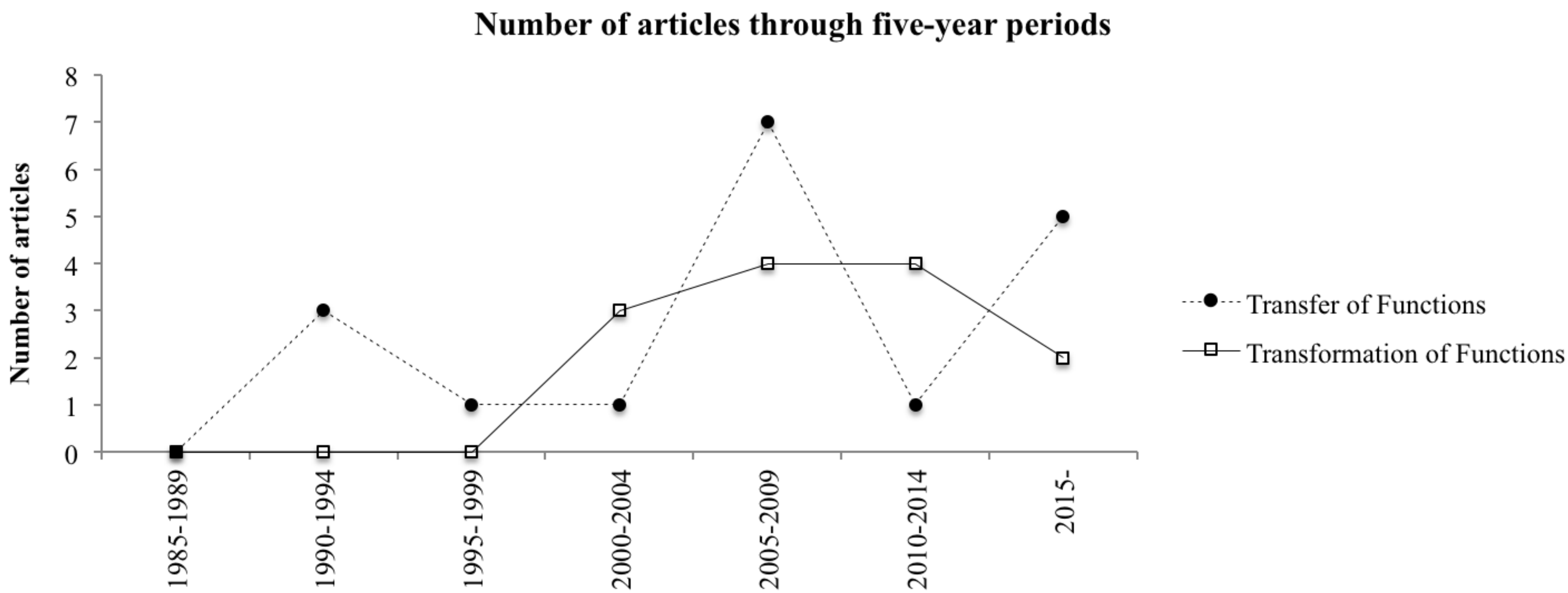

Figure 2. The diagram shows number of articles in each five-year period from 1985 included for the search terms ”Transfer of Functions” and ”Transformation of Functions”. The graph shows that there are more articles met the inclusion criteria for ”Transfer of Functions” than ”Transformation of Functions”.

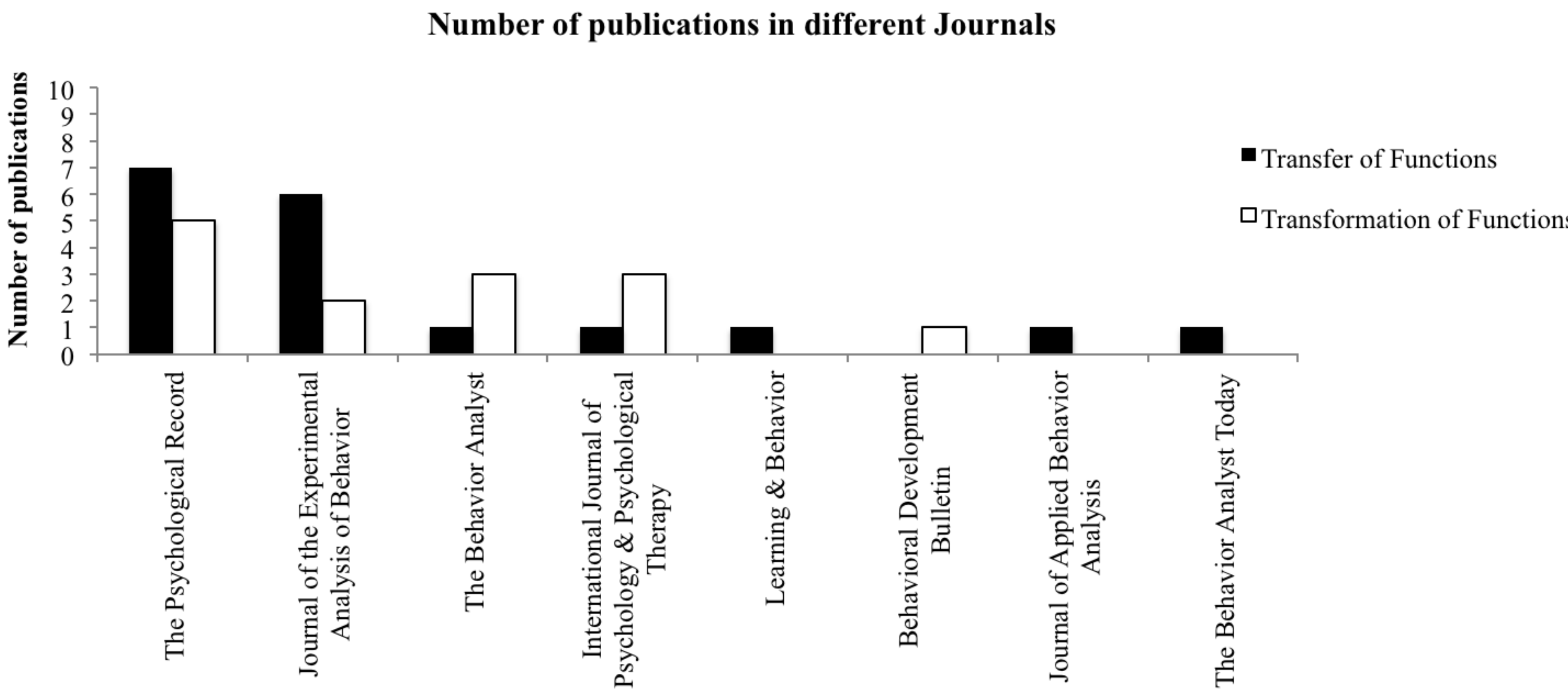

Figure 3. The figure shows the number of papers that were published in the various journals. *The Psychological Record* published the majority of the papers ("Transfer of Functions" n=7, "Transformation of Functions" n=5). *Journal of the Experimental Analysis of Behavior* also published many of the papers on "Transfer of Functions", while *The Behavior Analyst* and *International Journal of Psychology & Psychological Therapy* published many of the papers included on "Transformation of Functions".

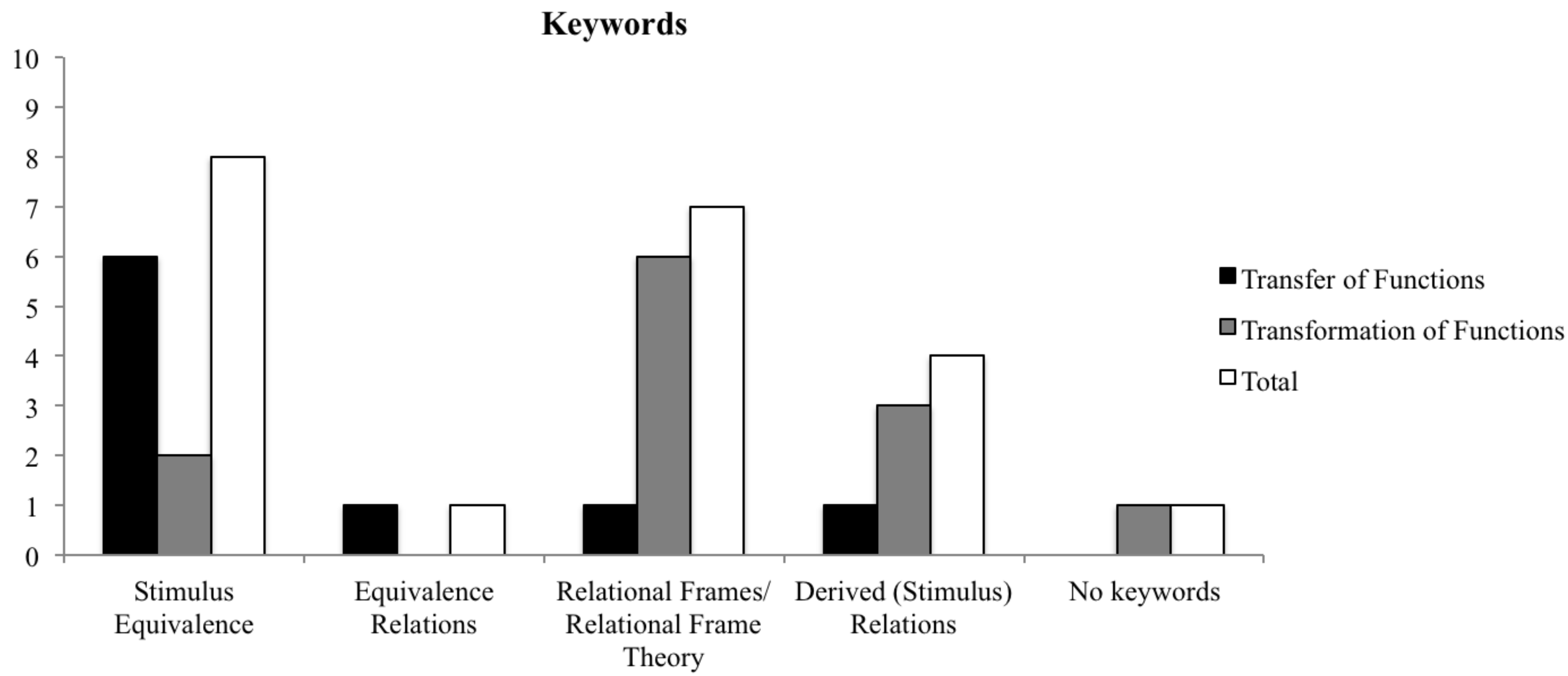

Figure 4. The keywords used in the various papers. The figure shows that "Stimulus Equivalence" was the most widely used keyword in the articles on "Transfer of Functions". Both "Relational Frames/Relational Frame Theory" and "Derived (Stimulus) Relations"

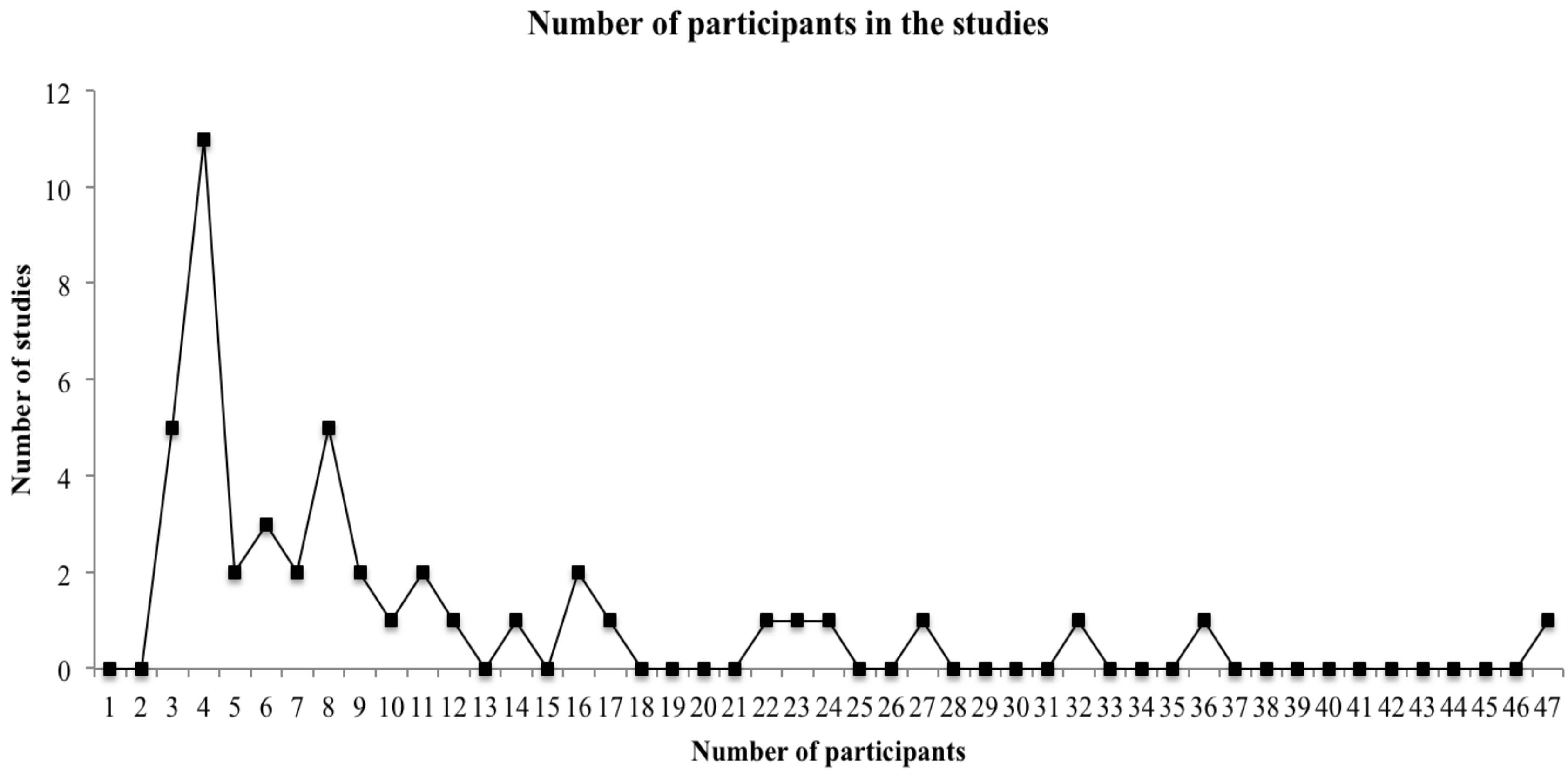

Figure 5. The figure shows the number of participants in the different studies. The number of participants is varying from three to forty-seven. The majority of the studies are collected with four participants.

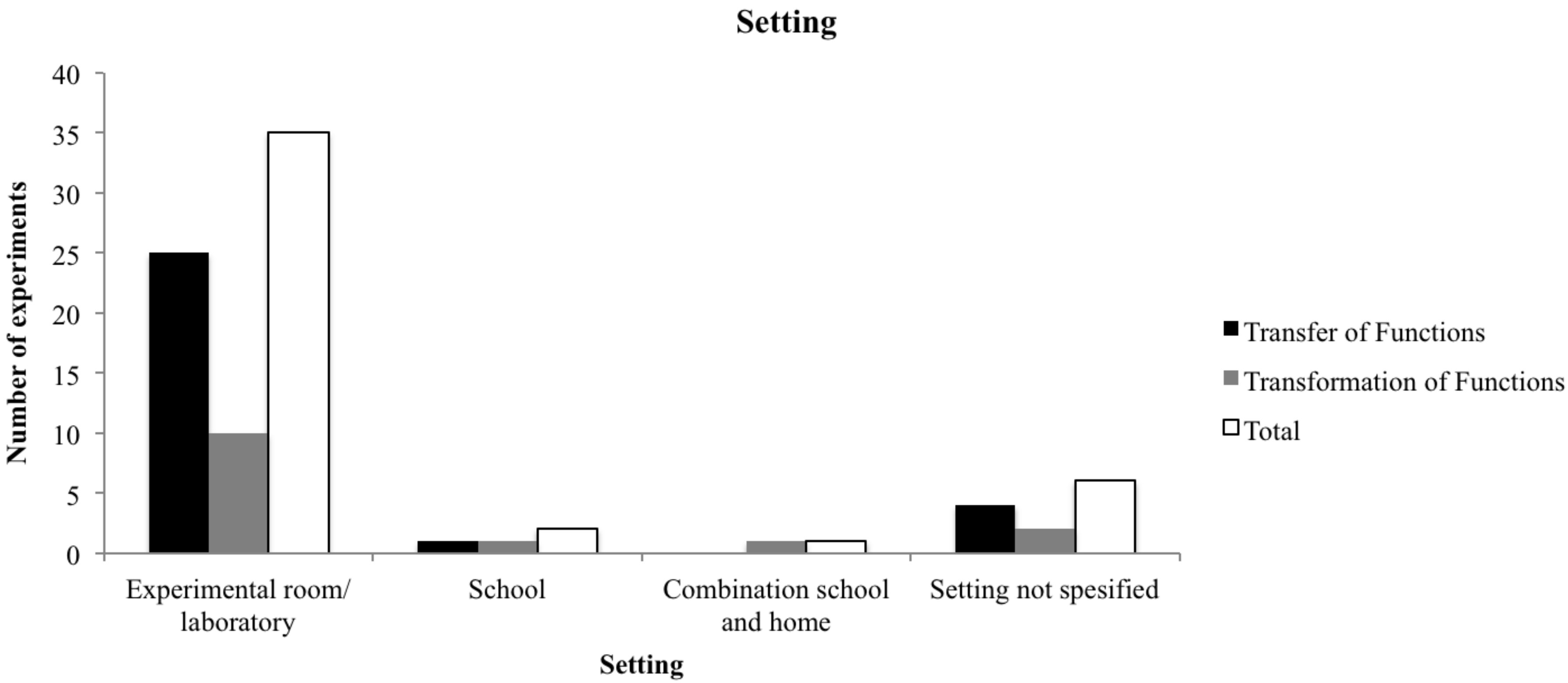

Figure 6. The figure shows an overview of the different settings in the various experiments. As the figure shows, most of the experiments were conducted in experimental rooms/laboratories. A few experiments were conducted in schools, and private homes. The experimental setting was not specified in six of the papers.

Appendix A

PsycINFO Search Strategy

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1 “transfer of functions” (all journals and English language and yr="1985 - 2018")

2 “transformation of functions” (all journals and English language and yr="1985 - 2018")

Timespan: 1985 - 2018

Filters: all journals, English language, and publication year

Results: 334

PubPsych Search Strategy

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1 "transfer of functions" PY>=1985 PY<=2018

2 "transformation of functions" PY>=1985 PY<=2018

Timespan: 1985-2018

Filters: publication year

Results: 16

Transfer of Conditioned Avoidance Stimulus Functions Through Equivalence Classes, Extinction and Verbal Estimations

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Abstract

This study examines (1) the transfer of conditioned avoidance functions through equivalence classes, (2) extinction of these functions using verbal prompts, and (3) if there is consistency between participants verbal estimations and avoidance responses. Thirty participants were randomly assigned into two groups (A and B). Participants in Group A received baseline conditional discrimination in front of a classical conditioning phase where stimulus B1 was paired with an aversive tone. Participants in Group B received classical conditioning in front of the baseline conditional discrimination. All participants had to respond in accordance with equivalence to continue further with the experiment. Twenty-four participants responded in accordance with equivalence and completed the experiment. The main results from the training showed that participants in Group A used fewer trials to complete the baseline discrimination training than participants in Group B. The general results from the experiment show that (1) a proportion of the participants in both groups demonstrated transfer of conditioned avoidance stimulus functions through equivalence classes, (2) extinction of these avoidance functions with verbal prompts were achievable for the majority of the participants, (3) it was partially consistency between the verbal estimations given by the participants and their avoidance behavior.

Keywords: avoidance, transfer of functions, extinction, classical conditioning

Introduction

Research on stimulus equivalence (SE) has gained increasing interest among behavior analysts the past forty years (Arntzen, 2010b; Dougher, Augustson, Markham, Greenway, & Wulfert, 1994). The main focus has essentially been on basic research, but SE has also, particularly in recent years, been used in applied research and training (Arntzen, 2010b). Much of the interest on SE stems from the contention that SE may provide the basis for a behavior-analytic account of language, symbolic behavior, and apparently novel behavior (Dougher et al., 1994).

The most commonly used analytic unit within behavior analysis, where behavior is studied as a functional relation between antecedent stimuli, the behavior, and the consequences that follow, is the three-term contingency (Skinner, 1938). Sidman (1986), on the other hand, proposed that the analytic unit might benefit from another antecedent stimulus being added to it, the *conditional stimulus* (Lashley, 1938). When the conditional stimulus is added to the analytic unit, the contingency is termed a four-term contingency (Sidman, 2000) and the procedure is called conditional discrimination (Cumming & Berryman, 1965).

Complex human behavior such as remembering and language is often studied by using conditional discrimination procedures in a matching-to-sample (MTS) format (Sidman, 1994). In an MTS procedure, a sample stimulus is presented, followed by two or more comparison stimuli. Programmed consequences are given to the participant, indicating a correct choice when choosing the right comparison, or indicating a wrong choice when choosing an incorrect comparison. Identity matching is when the correct comparison stimulus is identical to the sample stimulus, and arbitrary matching means that the stimuli used in the conditional discriminations do not share physical similarities (Sidman, 1992).

There are different procedural variables that may influence the probability of stimulus equivalence class establishment. There are, for example, different training structures that can be used in an MTS-procedure. These training structures are (1) many-to-one (MTO), also known as comparison-as-node, (2) one-to-many (OTM), also known as sample-as-node, and (3) linear series (LS) (Fields & Verhave, 1987; Green & Saunders, 1998). Both the structures MTO and OTM are in general more likely to lead to the formation of stimulus equivalence classes compared to the last training structure LS (e.g., Arntzen, Grondahl, & Eilifsen, 2010; Arntzen & Hansen, 2011; Arntzen & Holth, 2000). Training protocols is another procedural variable. There are three training protocols that can be used, and these are (1) simple-to-complex (STC), (2) complex-to-simple (CTS), and (3) simultaneous (SP) (e.g., Adams, Fields, & Verhave, 1993; Imam, 2006).

Equivalent classes are classes of stimuli with at least three members that are mutually interchangeable, and the relation between them are characterized by the mathematical properties of reflexivity, symmetry and transitivity (Arntzen, 2010b). Reflexivity refers to stimuli that are physically identical, also called generalized identity matching. When a subject has learned a conditional relation AB (if A, then B), the subject are also able to match A and B to itself (A=A, B=B) (Sidman, Willson-Morris, & Kirk, 1986). The next property of equivalence relation is called symmetry. If the relation between the sample and the comparison is symmetric, the samples will function as comparisons and the opposite (A=B, B=A). The third property of equivalence relation is transitivity. If A is related to B, and B is related to C, transitivity will cause A to be related to C (A=B, B=C, C=A) (Sidman, 1990).

There are a number of different forms of derived relational responding, and equivalence relations are one of them. Research has shown that it is possible for humans to respond in accordance with contextually controlled relations such as more than/less than, before/after and different, to mention some of the derived relational frames (Dymond & Whelan, 2010). Dymond and Rehfeldt (2000) writes; “Perhaps what is most interesting about derived stimulus relations such as equivalence is that the test outcomes are not readily predicted from the traditional concept of conditional discrimination; neither A nor C has a direct history of differential reinforcement with regard to the other, and, therefore, neither stimulus should control selection of the other" (p. 239).

Relational frame theory (RFT) can be considered as a modern behavioral account of human language and cognition (e.g., Hayes, Barnes-Holmes, & Roche, 2001). The ability to relate stimuli in ways that (1) not depend on the formal properties of the to-be-related stimuli and (2) are controlled by aspects of the context that have been abstracted so that they can be arbitrarily applied in many different ways is referred to the key behavioral process known as arbitrarily applicable relational responding (Hughes & Barnes-Holmes, 2014). Arbitrarily applicable relational responding, also called relational framing, is said to involve these three properties; (1) mutual entailment, (2) combinatorial entailment, and (3) transformation of stimulus functions (Barnes, Healy, & Hayes, 2000).

Much of the interesting data collected from research on SE and derived relational responding has been on the on the two phenomena "transfer of functions" and "transformation of functions" (Perkins, Dougher, & Greenway, 2007). When the functions of one stimulus alter or transform the functions of another stimulus in accordance with the derived relation between the two without additional training, this is referred to as transformation of stimulus functions (Dymond & Rehfeldt, 2000; Valverde, Luciano, & Barnes-Holmes, 2009). The term "transfer of function" is frequently used when the untrained function acquisition is based on SE, and "transformation of functions" is more often used when it is based on other relations other than equivalence (Dymond & Rehfeldt, 2000).

Equivalence class formation and transfer of functions are an alternative way to study variables influencing preferences in choice situations (e.g., Arntzen, Eilertsen, & Fagerstrøm, 2016; Arntzen, Fagerstrøm, & Foxall, 2016; Smeets & Barnes-Holmes, 2003). Smeets and Barnes-Holmes (2003) conducted two experiments, both of them with sixteen five-year old children. In the first experiment, the children were trained in two sets of MTS tasks. Stimuli A1 and A2 were a picture of a smiling cartoon character and a picture of a crying child. The B and C stimuli consisted of arbitrarily geometric shapes and symbols. After being tested for equivalence responding, the children were presented with two samples of the same soft drink. One soft drink was labeled C1 and the other was labeled C2. The children were asked to indicate which drink they would like to taste first, and after having tasted both of the drinks, they were encouraged to indicate which of the two drinks they preferred. The children were also asked which picture they preferred the most of A1 and A2. Except from the equivalence test, the same experimental procedure was used in Experiment 2. Results from both of their experiments showed that 91% of the children first wanted to taste the drink labeled C1 or C2, which was indirectly related to the preferred picture (A1 or A2). After tasting both of the drinks, most of the children (90%) indicated that they preferred that drink.

Arntzen, Fagerstrøm, et al. (2016) did an experiment with sixteen college students. They used an OTM training structure to train three three-member classes. Next, they tested if the participants responded in accordance with stimulus equivalence. Social meaningful stimuli (D) were trained to the nodal stimulus in the classes (A). Again, the participant was tested for responding in accordance with stimulus equivalence, this test included all 12 stimuli. In the end of the experiment, a preference test was arranged. In the preference test, the participants were asked to pick one out of three bottles of water. The bottles were labeled with printouts of the B1, B2 and B3. Results from their experiment showed that 81% of the participants chose the bottle with the B1-stimulus, which indicated that the transfer of function test had influenced the preference.

Arntzen, Eilertsen, et al. (2016) also did an experiment to study variables influencing preferences in choice situations through equivalence class formation and transfer of functions. They investigated how preference for one of three identical objects, water bottles, was influenced as a function of stimuli from the same equivalence class as different valenced stimuli. They used an OTM training structure in the formation of three three-member (A, B, and C) equivalence classes, followed by training of the D-stimuli to the A-stimuli, whereas D-stimuli were either valenced or non-valenced. The participants were tested for three four member classes (A,B,C, and D). Three identical bottles with pictures of B-stimuli were presented to the participants. Results from the study showed that participants chose B1 in 55% of the cases for the valenced stimuli. Results also showed that there was no preference among the B-stimuli for the non-valenced stimuli. In the post-experimental interview the participants were asked why they picked that respectively bottle.

Transfer of functions through equivalence relations and relational frames has also been demonstrated with respondent eliciting, avoidance behavior, extinction and sexual arousal stimulus functions, among other things (e.g., Augustson & Dougher, 1997; Barnes-Holmes, Barnes-Holmes, Smeets, & Luciano, 2004; Dougher et al., 1994; Dymond, Roche, Forsyth, Whelan, & Rhoden, 2007; Dymond, Roche, Forsyth, Whelan, & Rhoden, 2008; Garcia-Guerrero, Dickins, & Dickins, 2014; Valverde et al., 2009).

Organisms produce stimuli, and they also get rid of stimuli. A dog does not normally expose itself to shock for example, and if shock optionally should occur, the dog escapes from it given the opportunity. We escape from aversive circumstances that already exist, and we avoid potential aversive circumstances that have not yet happened. Both escape and avoidance are negative reinforcement (Catania, 2013). Avoidance is some of our most useful behavior, and we all have many kinds of levers for preventing various kinds of shocks. Avoidance behavior can, on the other hand, take bizarre or neurotic forms. Even though most of us adopt to coercion more or less effectively by either escape or avoidance, avoidance can sometimes preoccupy one that it interferes with everyday functioning (Sidman, 1989).

A defining feature of anxiety disorders is excessive avoidance behavior, in which an overt action postpones or prevents an upcoming aversive event (Cameron, Schlund, & Dymond, 2015). The avoidance behavior is an important reason for the anxiety being maintained, and can often cause the person to face challenges in everyday life. Anxiety often involves a variety of physical symptoms, in which some of them are nausea, palpitation and sweating (Helsedirektoratet, 2017). It is according to Barlow (2004), extensively known that persons which suffer from anxiety disorders do show pervasive patterns of avoidance behavior that goes beyond events that might be constructed in terms of direct conditioning.

The fear conditioning paradigm is often used in laboratory settings to investigate the behavioral processes underpinning anxiety (Boddez, Baeyens, Hermans, & Beckers, 2014). Cameron, Roche, Schlund, and Dymond (2016) describe the paradigm as this: a neutral stimulus (the conditioned stimulus; CS+), is repeatedly paired with an aversive, unconditioned stimulus (US), such as a loud sound, and comes to elicit a conditioned fear response (CR) in the absence of the US. Another cue (CS-) is never paired with the aversive unconditioned stimulus, in this case a loud sound, and therefore takes on the functions of safety relative to the threat properties of the CS+ (Cameron et al., 2016). The temporal relationship between the presentation of a CS and the US can be arranged in several ways. Both delayed, simultaneous, trace, and backwards conditioning are all procedures commonly used for simple respondent conditioning (Pierce & Cheney, 2013).

Both “transfer of functions” and “transformation of functions” makes equivalence relevant in clinical practice, especially when it comes to people with anxiety disorders and phobias (Arntzen, 2010b). Dougher et al. (1994) did two experiments where they investigated the transfer of respondent elicitation through equivalence classes. In the first experiment they used an MTS procedure to teach eight participants two four-member equivalence classes. Next, one member from one class (B1) was presented and paired with electric shock, and one member from the other class (B2) was presented without the shock. The remaining stimuli from both classes were then presented, and they used extra-dermal activity measure to measure conditioning. Results showed that transfer of conditioning was demonstrated in six of the eight participants. In the second experiment they used the same procedures to replicate the results from Experiment 1, and investigated the transfer of extinction. One member from one class was presented in extinction, after equivalence training and conditioning to all members of one class. When the other stimuli from this class were presented they did not elicit skin conductance. The stimulus that was previously presented in extinction was reconditioned in the last phase of the experiment. Results from test trials with other members of the class showed that they regained elicitation function. These two experiments demonstrate that respondent elicitation and extinction can transfer through stimulus classes (Dougher et al., 1994).

Augustson and Dougher (1997) also demonstrated that avoidance responding might transfer through equivalence classes. Similar to the earlier experiments (Dougher et al., 1994), eight participants were trained in two four-member equivalence classes using a MTS procedure. Electric shock was paired with one member of one class using a classical conditioning procedure. The participants were taught that they could avoid this member by repeatedly pressing a key. Subsequently, the participants were exposed to the other class members to test for a transfer of avoidance functions. Transfer of avoidance response functions was demonstrated for all eight participants (Augustson & Dougher, 1997).

Valverde et al. (2009) did an experiment in attempt to replicate Experiment 1 from the study Dougher et al. did in 1994. They used different temporal parameters in the aversive conditioning procedure, and transfer of conditioning was not achieved in this study. In Experiment 2 they had 30 participants. They used the same procedures as in Experiment 1, although small adjustments were introduced. Results from this study shows that more than 80% of the participants who had shown differential conditioning also showed the transfer of functions effect. This effect was replicated within subjects for three of the participants.

Barnes-Holmes et al. (2004) investigated the transfer of induced happy and sad functions through equivalence relations. Sixteen participants were trained in two conditional discriminations using a MTS procedure. The participants were tested for the formation of both symmetry and equivalence relations. Next, a musical mood induction procedure was employed to induce happy and sad mood states in the presence of the B-stimuli. Eight of the participants were exposed to happy music in the presence of B1, and sad music in the presence of B2. This mood induction was reversed for the other eight participants. To determine whether the appropriate mood functions had been established with the B-stimuli, the participants were exposed to a mood functions test. A transfer of mood functions test was applied to determine whether the appropriate happy and sad mood functions had transferred from the B-stimuli to the C-stimuli. Results showed that the specific mood functions established in the presence of the B-stimuli transferred to the C-stimuli for the majority of the participants.

Dymond et al. (2007); (2008) examined the transformation of avoidance response functions in accordance with the relational frames of “same” and “opposite” in a series of studies. First, participants were presented to a nonarbitrary training phase, with the purpose to establish contextual functions for the two contextual cues. Next, the contextual cues were presented with samples and comparisons that were not related to each other along any formal dimension, such as line drawings or nonsense syllables. Contextual functions established in the nonarbitrary phase were now arbitrarily applied, and participants would relationally respond to arbitrary, physically dissimilar stimuli as if they were the same and opposite. Then, participants were presented to a signaled avoidance task, where responding in the presence of B1 canceled the aversive tone and image. Stimulus B2 was never followed by tone or images. When this avoidance response was acquired, the participants were exposed to the phase where

C1 and C2 were presented in extinction. Results from their studies showed that the majority of the participants produced consistent avoidance responses in the presence of C1 but not C2. C1 was the same as B1, and C2 was the opposite. These results demonstrated the transformation of avoidance response functions in accordance with complex relational network. According to Dymond and Roche (2009), these findings in addition to show that avoidance functions may transform in accordance with same and opposite relations, the findings also support the use of non-shock-based conditioning procedures.

Garcia-Guerrero et al. (2014) examined whether avoidance responses to the original classically conditioned stimuli would be more resistant to extinction compared to the indirectly related, functionally equivalent, stimuli. This potential difference can be of significance for applied settings as well as basic research. They used verbal prompts in order to examine the extinction of derived stimulus functions. They were also interested in examining whether there was consistency between participants' avoidance behavior and verbal estimations or not. The participants had to respond in accordance with equivalence in the phase called "baseline conditional discrimination" in order to get to the next phase of the experiment. Six participants were removed from the study, due to the strict training criteria. The main findings from their study showed that all participants who received equivalence training prior to the classical conditioning demonstrated within-class transfer of avoidance functions, in contrast to the participants who did not get equivalence training in front of the classical conditioning procedure. Every prompted participant who demonstrated transfer showed gradual response extinction, even though there were differences in the gradient. Responding related to the indirectly related stimuli decreased more sharply than to those stimuli that were directly paired with the tone.

The present study is a systematic replication of the study done by Garcia-Guerrero et al. (2014). The purpose of the current study is threefold: (1) to study the transfer of conditioned avoidance functions through equivalence classes, (2) extinction of these functions using verbal prompts, and (3) if there is consistency between participants` verbal estimations and avoidance responses. Garcia-Guerrero et al. (2014) used baseline training consisting of two blocks. In hopes of getting more participants to complete the present experiment, baseline conditional discrimination training was doubled. All participants recieved four blocks with baseline training. The programmed consequences in the mixed baseline block was redused from 30% to 25% in this study. Baseline training were redused to one block if the participants failed to reach the criteria and were re-exposed to the training. Instructions were translated from English to Norwegian in the present experiment.

Method

Participants

There were 30 participants in the study, all recruited through personal contacts. None of the participants had previous experience with this type of experiment. The participants varied in age between 21 – 51 years (*M* = 34, *SD* = 9,2). The participants were randomly assigned into two groups (A and B). Twenty-four small patches with a written letter (either A or B), was designed and placed in a small box for the experiment. In front of the experiment, participants drew one patch each, and the letter on the patch decided which group the participant should be in. A new patch was replaced in the box in cases where participants chose to withdraw from the experiment or participants were removed from the study due to the strict training criteria. Participants in Group A received baseline conditional discrimination before the classical conditioning, while participants in Group B, on the other hand, underwent the classical conditioning before they received the baseline conditional discrimination. See Figure 1 for the order of the experimental phases.

Apparatus, Stimuli and Setting

In the present study, an Acer Travelmate P633 laptop computer, with an Intel® Core™ i5-3210M CPU 2.50 GHz processor and a 13.3-inch display, was used to run the MTS program Visual Basic 6. Nineteen abstract shapes were used as visual stimuli (see Figure 2). Each stimulus was 4^2 cm when displayed on the screen. Table 1 shows an overview of the conditional discriminations that were trained. Three supplementary neutral stimuli (N5, N6, N7) were included only for the reflexivity tests. The auditory stimulus consisted of a 91 dB (1200 Hz) high tone, transmitted through Sony® headphones. Decibel level was checked using an iPhone app (iOS) “dB Volume”. Decibel level could be reduced if the participant asked for it. In order to control for discriminative functions over the tone contingency at different phases of the experiment, the participants wore the headphones throughout the whole experiment.

The experiments were conducted in a quiet room at two different locations. The participants were seated in front of a table with the computer. The experimenter was present during the experiment, placed behind the participant to avoid interference. The experimenter’s role was to make sure that the participants wore the headphones throughout the whole experiment, to intervene when task setting was necessary (change the settings in the software between the different phases), and to answer any questions regarding the on-screen instructions. Participants were told in advance that interaction with the experimenter was not endorsed. The experiment took approximately 1.5–2.5 hours from the time of arrival until the participants were finished.

Design

The research design used in this study is a within subject design to compare the results for the participants within each of the groups (Arntzen, 2010a). All participants in Group A were exposed to the same conditions, and all of the participants in Group B were exposed to the same conditions. A between subject-design was applied to compare the conditions between the groups exposed to the same experimental phases, with a different order. Participants in Group A received baseline conditional discrimination before the classical conditioning procedure, while participants in Group B received a classical conditioning procedure prior to the baseline conditional discrimination.

Procedure

On the basis of ethical considerations (the use of an aversive tone), The Norwegian National Research Ethics Committee was contacted via telephone during the planning of the experiment. According to them, an application was not necessary, it was sufficient enough to confirm with them on the phone. Before starting the experiment all participants were asked to read and sign a statement of informed consent highlighting that the experiment involved presentation of an aversive tone, and that participants were free to withdraw from the experiment at any time. Each participant was informed about the anonymous nature of his or her participation in the study. After the experiment they were thanked for their participation and given a debriefing. All participants who participated in the study, without withdrawing, were able to win an iPhone8.

Phase 1: Baseline conditional discrimination. A conditional discrimination with an OTM training structure was used in the present study. Nine baseline conditional discriminations were trained and followed by testing of three four-member classes. The trained relations were A1B1, A1C1, A1D1, A2B2, A2C2, A2D2, A3B3, A3C3, and A3D3. Figure 3 shows the sequence flow of the experimental phase for training of conditional discrimination and testing for equivalence class formation.

A sample stimulus appeared in the middle of the computer screen for each trial. When the participant clicked on it, made an “observing response”, four comparisons appeared in the corners with the sample remaining present in the middle. The participants choose one of the comparisons by clicking at it, and programmed consequences such as a conditioned reinforcer or punisher appeared in the middle of the lower half of the screen for 1,5 seconds. A green tick image indicated correct selections, and a red cross indicated incorrect selections. Differential audible chimes were presented together with each of these images. One point was added to the tally located at the bottom-center of the screen for each correct selection, and one point was subtracted for each incorrect selection. For instance, if A1 was presented as the sample stimulus, and B1, B2, B3, and B4 were presented as comparisons, the selection of **B1** was reinforced while selection among the other comparisons (B2, B3, B4) were punished. A “correctional feedback” feature was used in the baseline trials. If an incorrect comparison was selected, all the incorrect comparisons disappeared, leaving only the sample and the correct comparison present for two seconds. This post-response cueing was programmed to only occur once per each sample, after the first incorrect response. Comparison arrays always comprised stimuli with the same alphabetic designation, both in training and in testing as well. On-screen instruction given to the participant before starting the experiment;

> “In a moment some figures will appear on the screen. Look at the image in the center of the screen, click on it in order to make appear four ‘outer images’ in each of the corners of the screen. Select one of the four outer images by clicking on it. At the beginning the computer will give you feedback on every choice, and at other times it will not, but there is always a correct selection. Besides, you can make a correct selection in all the tasks without feedback by carefully attending to the tasks that come with feedback. Even though the first tasks are easy, it is important to pay close attention as these will increase in difficulty and choosing the correct figures in the latter part of the experiment will depend on the knowledge you gain during the early parts of the experiment. Your objective is to make as many correct selections as

possible. If you have any questions, please ask the experimenter now and when ready: Press the button below to continue."

Baseline training consisted of four trial-blocks (blocks AB, AC, and AD, each consisting of three trial types) with 100% feedback, in terms of either reinforcement or punishment. The learning criterion for baseline conditional training consisted of minimum five consecutive correct selections within each trial block in order to move on to the next block. Participants had to reach the performance criterion four times. On-screen instruction after the baseline training was; "Great! You have completed this part of the experiment correctly. Pay attention, there are more tasks! When you are ready: Press the button below to continue."

As a preparation for the probes to be run in extinction, a mixed-baseline block with 27 trials was presented with 25% programmed consequences. The criterion was 25 correct out of 27 (93%). If a participant had more than two wrong selections this led to a repetition of the same block. If the participant failed to meet the criteria the second time, s/he was re-exposed to the baseline training (the unmixed blocks). Baseline training was reduced to one trial-block at this point. This instruction appeared on the screen after the mixed-baseline block; "Great! You have completed the first part of the experiment. The next task requires more of you, so pay attention! To proceed, press the button below."

Once the baseline blocks were accomplished successfully, a series of unreinforced test probes were given. The participants were presented to a 36-trial block of mixed symmetry, where the criterion was sat to 35 correct out of 36 (97%). If a participant had more than one incorrect selection, this led to a repetition of the same block. If the participant failed to meet the criteria the second time, s/he was re-exposed to the baseline training. The instruction on the screen after mixed symmetry was; "Awesome! There is more to come, so keep up the good work. Press the button below to continue."

A 72-trial block of mixed transitivity trials with a criterion sat to 70 correct out of 72 (97%) followed. If a participant had more than two incorrect selections, this led to a repetition of the mixed transitivity block. If the participant failed to meet the criteria the second time, s/he was re-exposed to the baseline training. On-screen instruction after mixed transitivity was; “Brilliant! The next task is difficult, keep up your attention! To proceed, press the button below.”

After mixed transitivity, the participant was presented to a 27-trial block with mixed symmetry and transitivity. The criterion was sat to 26 correct out of 27 (96%), and more than one incorrect selection led to a repetition of this block. Failing to meet the criterion the second time, the participant was re-exposed to the baseline training. Participants re-exposed to baseline training three times, without meeting the mastery criterion, were withdrawn from the study. Reflexivity probes with a set of neutral stimuli (N5, N6, N7) was introduced at the end to test for reflexivity relations. On screen instructions given to the participants prior to the reflexivity trials; “Some last tasks before you are done with this part of the experiment. When you are ready: Press the button below to continue.” Reflexivity probes consisted of 12 identity-matching trials, one trial for each stimulus relation (A1A1, A2A2, A3A3, B1B1, B2B2, B3B3, C1C1, C2C2, C3C3, D1D1, D2D2, and D3D3). The criterion was 11 correct out of 12 (92%), but failure to achieve did not lead to repetition or rehearsal of baseline training.

Phase 2: Classical conditioning. To establish the relation between a stress-eliciting tone (US) and stimulus B1 (as CS), a delayed classical conditioning procedure was applied. Stimuli B1 (CS+) and B2 (CS-) were presented alone in the center of the screen four times in a random sequence for 10 seconds. An interim black screen varying between 2–8 seconds was used between the stimulus presentations to minimize the temporal conditioning effects. The stimuli appeared in the middle of the screen, and a 5-secound high pitch tone equivalent to 91 dB (1200 Hz) at its peak was used to elicit a probable stress response (UR). On-screen instructions given to the participants were; "In this phase you do not need to select any image. All you need to do is to pay careful attention to the screen until further instructions are given. Some figures will appear on the screen, one at the time. It is important that you watch the figures carefully. At times a sound may be played. If you have any question, please ask the experimenter now and when ready: Press the button below to continue."

Phase 3: Discriminated avoidance. The conditioning parameters in this phase were similar to the previous phase. The visual stimulus on the screen disappeared after 10 seconds. Fewer than eight responses (FR-8) on the spacebar during the first five seconds of B1 presentation, resulted in exposure to the tone for the remaining 5 seconds, and eight responses or more during the first 5 seconds deactivated the aversive tone. The participant was not informed about how many space-bar presses that were necessary to deactivate the tone, but they were informed that they could exit the tone with several responses to the space-bar, in order to prevent rule-governed behavior (Garcia-Guerrero et al., 2014). Avoidance training consisted of a minimum of four presentations of both B1 and B2, and continued until the participant made four sequential avoidance responses successfully. Avoidance responses (FR-8 or more) during B2, which was not contingent upon the presentation of the tone, counted as errors and led to resetting of the avoidance criterion. Number of exposures to the tone during this phase could differ across participants. The participant was prompted to review the instructions carefully and returned to the previous phase if he/she was presented to the tone four times without demonstrating effective avoidance. Instructions given to the participants; "As previously, in a moment some figures will appear and some will be followed by the tone you experienced before. However, this time, you can prevent the tone from playing by pressing the spacebar-key of your keyboard several times as soon as the image appears when you think it is necessary. If no key-presses are made during the first seconds (or an insufficient number of times), the tone will follow. It is important that you pay attention and concentrate on the screen at all times. Your objective is to prevent the tone. If you have any questions, please ask the experimenter now. And when ready: Press the button below to continue."

Phase 4: Transfer of avoidance functions. Transfer of avoidance function was tested, employing the same parameters as in the two previous phases. All of the stimuli from classes 1, 2 and 3, with the exception of A-stimuli, were presented quasi-random in each of two blocks. A-stimuli were left out due to a risk of preconditioning or second-order conditioning effects. This on-screen instruction was given to the participant before transfer of avoidance function was tested; "As before, in a moment some figures will appear, and some will be followed by the tone you experienced earlier. This time, however, more figures will be involved. Continue to press the spacebar several times, as soon as the image appears, to prevent the tone when you think it is necessary. Press the button below to continue with the task."

Phase 5: Estimation of the probability of tone presentation. Each stimulus from class 1, 2 and 3 (except A-stimuli) were presented individually in the middle of the screen. The participant was asked to estimate the probability for the tone being played if s/he had not responded to the spacebar. After each stimulus presentation a box with four different choices appeared on the screen. The participant could choose between (1) definitely happening, (2) probably happening, (3) definitely not happening, and (4) probably not happening. Next trial appeared after a 2-seconds inter-trial interval, once the participant had made a choice. This block consisted of 12 trials, each stimulus was presented one time. The instructions given to the participants were; "During this phase, continue to perform as you have been in accordance to the previous tasks; pressing the space-bar when you think it is necessary in order to avoid the tone. In addition, you will be asked the likelihood of the tone sounding. Please follow the on-screen instructions. Press the button below to continue."

Phase 6: Probability estimation with feedback. The parameters in this phase were the same as in phase 5, except that B1 was no longer followed by the tone. The participants had to rate the probability of the tone, with a two-choice selection (would have happened/would not have happened). A new window with a challenging question appeared on the screen after the participant had given their estimation. The participants were asked "Are you sure of your prediction? Would you like to corroborate it?". S/he could choose whether they wanted to corroborate their estimation or not, although they were encouraged to corroborate. Participants were given three points for a correct estimation, or they lost three points for incorrect estimation. In addition to points, feedback was given immediately below the answer button in the form of a green tick or red cross image, similar to the images used in Phase 1. Participants who chose to not corroborate their estimation, still gained or lost points, but no further feedback was provided. This phase consisted of three blocks, considered to be enough to reveal a gradual change in response pattern. Prior to the probability estimation, this on-screen instruction was given to the participant;

> "Similar to the previous task some images might be followed by the tone unless you press the space-bar several times. Again, we will ask your estimation about the probability of the tone happening, this time you will only have two choices as to whether you think the tone would have happened or not. However, an additional option is at play: you will be challenged and given the opportunity of corroborating your estimation before winning or losing points. You are given two options: 1. To go ahead and corroborate your estimation or 2., opting for not corroborating. If you decide to corroborate your estimation, for each "correct" estimation you will win three points, and for each "incorrect" estimation you will lose three points. The addition or

subtraction of points will be immediate and feedback would be provided. If on the other hand, you decide not to corroborate your estimation, you will win or lose one point for "correct" or "incorrect" estimations respectively. In this case, the total amount of earned or lost points will be displayed at the end of the entire task; after several trials. Your aim is to make as many correct estimations as possible. If you have any questions, please ask the experimenter now. And when ready: Press the button below to continue."

Phase 7: Post-experiment equivalence tests. To support that the equivalence relations had endured throughout the experiment, a final matching-to-sample trial block of mixed symmetry and transitivity was introduced.

Debriefing

After the post-experiment equivalence test, the participants were informed through the program that the experiment was over, and that he or she could contact the experimenter. The experimenter answered any additional questions that the participants had, and explained the purpose of the study. Since the participants were recruited from different places, they were encouraged to not discuss the task to one another.

Results

The general results from the experiment show that (1) a proportion of the participants in both groups demonstrated transfer of conditioned avoidance stimulus functions through equivalence classes, (2) extinction of these avoidance functions with verbal prompts were achievable for the majority of the participants, (3) it was partially consistency between the verbal estimations given by the participants and their avoidance behavior.

All participants finished the experiment in one session. The time varied from 1 hour and 15 minutes to 2 hours and 10 minutes. One participant chose to withdraw from the study in the middle of the experiment. Five participants failed to reach the criterion in the baseline conditional discrimination phase, and did not get the opportunity to continue further in the experiment. All of the participants wore the headphones throughout the experiment, and none of them asked if the decibel level could be reduced. Data from the results contains only those participants who conducted the whole experiment.

Conditional discrimination

The results from the baseline conditional discrimination for participants in Group A are shown in Table 2. All participants in this group reached the performance criterion in the baseline conditional discrimination. All participants met the criterion set to 93% in the mixed-baseline block. Participant 15668 completed 36 trials in the mixed-baseline block, while the rest of the participants in the group completed 27 trials in the same block. All participants met the criterion in the mixed-symmetry block, except from participant 15651 who had to repeat the same block. He succeeded the second time. Except from participant 15668, all participants met the criterion in the mixed transitivity block. The criterion was sat to 70 correct out of 72 trials, in which participant 15668 had 68 correct out of 72, and therefore had to repeat the same block. He met the criterion the second time with 71 correct out of 72 trials.

In the block with mixed symmetry and transitivity, all participants met the criterion sat to 26 correct out of 27 trials. All participants had 27 correct out of 27 trials, except participant 15670 who had 26 correct out of 27, and participant 15667 who had 25 correct out of 27. Participant 15667 did not meet the criterion in this block. She was supposed to repeat the same block, but instead she was sent to the next block (reflexivity probes). All participants had 12 correct out of 12 trials, except from participant 15674 who had 11 correct out of 12, in the reflexivity probes. Ten participants had 27 correct out of 27 trials in the post-experiment equivalence test. Participant 15654 had 26 correct out of 27 trials. Participant 15651 did not receive the post-experiment equivalence test.

Table 3 summarize the results from the baseline conditional discrimination for participants in Group B. Ten of the participants made it through the baseline trials without any need for repetition. Participant 15660 and 15675 did not reach the performance criterion four times, and had to repeat the baseline training. Both of them met the criterion the second time. All participants met the criterion in the mixed-baseline block, with 27 correct out of 27 trials, except from participant 15660 who had 52 correct out of 54 trials. Participant 15653, 15656, 15659, 15662, 15666, 15672, 15675, 15677 and 15680 all made 36 correct out of 36 trials. Participant 15660 did not meet the criterion in the mixed symmetry block with 34 correct out of 36 trials. This led to a repetition of the same block. Also, the second time, he had 34 correct out of 36 trials. Since he failed to meet the criterion the second time, he was re-exposed to the baseline training. Baseline training was reduced to one trial-block at this point. He made 45 correct out of 45 in the baseline training, 27 correct out of 27 trials in the mixed baseline block, and 36 correct out of 36 trials in the mixed symmetry block.

Participant 15671 had 34 correct out of 36 trials in the mixed symmetry block, and failed to meet the criterion. She had to repeat the mixed symmetry block, and had 31 correct out of 36 trials the second time. She was re-exposed to baseline training because she failed to meet the criterion the second time. She made 45 correct out of 45 in the baseline training, 27 correct out of 27 in the mixed-baseline block, and 33 correct out of 36 in the mixed symmetry block. She had to repeat the same block, and the second time she made 32 correct out of 36. She was re-exposed to baseline training for the second time. In the baseline training she made 45 correct out of 45 trials. In the mixed-baseline block, she made 27 correct out of 27 trials. In the mixed symmetry block, she made 36 correct out of 36 trials. Participant 15676 failed to reach the criterion with 34 correct out of 36, and had to repeat the same block. Also, the second time, she made 34 correct out of 36, but she was not re-exposed to baseline training.

Participant 15653, 15659, 15660, 15662, 15666, 15671, 15672 and 15680 met the criterion in the mixed transitivity block. Participant 15656 made 63 correct out of 72 trials and had to repeat the block. The second time, he made 72 correct out of 72 trials. Participant 15675 made 52 correct out of 72 trials, which led to a repetition of the same block. The second time, she successfully met the criterion with 71 correct out of 72 trials. Participant 15676 did not meet the criteria with 68 correct out of 72 trials and had to repeat the block. She made 68 correct out of 72 trials the second time, and was re-exposed to the baseline training. In the baseline training she made 59 correct out of 60 trials, in the mixed baseline she made 27 correct out of 27 trials, in the mixed symmetry she made 36 correct out of 36 trials, and in the mixed transitivity, she made 71 correct out of 72 trials.

Participant 15677 did not meet the criterion in the mixed transitivity when she made 25 correct out of 72 trials. She had to repeat the same block, and made 72 correct out of 72 trials the second time. All participants met the criterion in the mixed symmetry and transitivity block; all made 27 correct out of 27 trials. In the reflexivity trials, all participants made 12 correct out of 12 trials. All participants in Group B received the post-experiment equivalence test. Nine of the participants (15656, 15659, 15660, 15662, 15666, 15671, 15672, 15677 and 15680) made 27 correct out of 27 trials. Participant 15653 and 15675 both made 26 correct out of 27 trials. Participant 15676 made 24 correct out of 27 trials.

Because some of the participants had to repeat one or more of the blocks, and some were re-exposed to the baseline training, the number of trials in the different conditions varied among the participants. There are also differences between the two groups concerning number of trials. Table 4 shows an overview of the number of trials between the two groups. Participants in Group A had a total of 3522 trials, and participants in Group B had 3563 trials in total in the baseline training. In the mixed baseline block participants in Group A had a total of 333 trials, while participants in Group B had 459 trials in total. In the mixed symmetry block participants in Group A had 936 trials in total and participants in Group B had 720 trials in total. In the mixed transitivity participants in Group A had a total of 936 trials, while participants in Group B had 1224 trials in total. In the block with mixed symmetry and transitivity both groups had a total of 324 trials. Both groups had a total of 144 trials in the reflexivity block, and a total of 324 trials in the post-experiment equivalence test.

Transfer test

The individual results from Phase 4, 5 and 6 are listed in Table 5 for participants in Group A, and Table 6 for the participants in Group B. The first and second columns show the number of key presses from the two transfer of avoidance tests. Ten of the participants in Group A (15651, 15652, 15658, 15667, 15668, 15669, 15670, 15673, 15674, and 15679) made avoidance responses by pressing the spacebar when stimulus B1 appeared on the screen in the first transfer test, and 11 participants did so in the second test for transfer. Six of the participants in this group pressed the spacebar when other stimuli than B1 appeared on the screen. Participant 15651, 15658, 15668, 15669, and 15670 made avoiding responses to all stimuli in Class 1 (B1, C1, D1) in both of the transfer tests. Participant 15652 made 29 key presses to stimulus C1 in the second transfer test. Participant 15654 did not make any avoiding responses to any of the stimuli in the first test, but made 20 key presses to stimulus B1 in the second test. Participant 15664 did not press the spacebar in attempt to avoid either in first nor the second test.

Seven participants in Group B (15662, 15688, 15671, 15672, 15675, 15676, and 15677) made avoidance responses to stimulus B1 in the first transfer test, and all of the participants made avoidance responses to stimulus B1 in the second transfer test. Eight of the participants (15653, 15656, 15660, 15688, 15666, 15672, 15675, and 15677) pressed the spacebar when other stimuli, besides B1, appeared on the screen in the two transfer tests. Participant 15653 pressed the spacebar one time to stimulus C1 in the first test. Participant 15656 did not make any avoidance responses to any of the stimuli in the first test, but made nine spacebar presses to stimuli B1, C1 and D1 in the second test. Participant 15660 pressed the spacebar seven times when stimulus B2 appeared on the screen. Both participant 15688 and 15677 made avoidance responses to stimuli B1, C1 and D1 in both tests. Participant 15666 did not make spacebar presses to B1 in the first transfer test, but to C1 and D1. In the second test he made spacebar presses to all stimuli in Class 1. Participant 15672 made spacebar presses to stimuli B1, C1 and D1 in both tests, while participant 15675 pressed the spacebar to stimuli B1 and C1, not D1.

Estimation

In Phase 5, the participants were asked to estimate the probability for the tone being played if s/he had not responded to the spacebar. After each stimulus presentation the participants could choose between; (1) “Definitely happening”, (2) “Probably happening”, (3) “Definitely not happening”, and (4) “Probably not happening”. Figure 4 shows the results for participants in Group A. Eleven of the participants made spacebar presses and estimated (1) “Definitely happening” to stimulus B1. Participant 15652 estimated (3) “Definitely not happening”, despite the fact that she made 65 spacebar presses.

Five participants made spacebar presses to stimulus C1. The estimations given by the participants varied. Seven of the participants estimated (3) “Definitely not happening”, three estimated (1) “Definitely happening” and two estimated (2) “Probably happening”. The participants who estimated either (1) “Definitely happening” or (2) “Probably happening also made spacebar presses to stimulus C1. Five participants made spacebar presses to stimulus D1. Two participants estimated (1) “Definitely happening”, both of them also made spacebar presses sufficient enough for avoidance responses. Three participants estimated (2) “Probably happening”, and all three of them made spacebar presses. Seven participants estimated (3) “Definitely not happening”, none of them made spacebar presses. None of the participants made spacebar presses to the rest of the stimuli in this trial (B2, C2, D2, B3, C3 and D3). All participants estimated (3) “Definitely not happening” to all of the abovementioned stimuli, with exception of stimulus D2 where participant 15651 estimated (4) “Probably not happening”.

Figure 5 shows the results for participants in Group B. Eleven of the participants in Group B made spacebar presses to stimulus B1. Ten participants estimated (1) “Definitely happening”, one estimated (2) “Probably happening” and one estimated (3) “Definitely not happening” to stimulus B1. Participant 15666 did not make any spacebar presses, still he estimated (1) “Definitely happening”. Participant 15662 estimated (3) “Definitely not happening” despite the fact that he made 11 spacebar presses. Participant 15676 made seven spacebar presses and estimated (2) “ Probably happening”.

Six participants made spacebar presses to stimulus C1. Two participants estimated (1) “Definitely happening”, both of them made spacebar presses, but not a sufficient number of spacebar presses to make avoidance responses (participant 15688 made seven spacebar presses and participant 15675 made one spacebar press). Four participants estimated (2) “Probably happening”, three of them also made spacebar presses (participants 15656, 15672, and 15677). Six participants estimated (3) “Definitely not happening”, none of them made spacebar presses except from participant 15666 who made 20 spacebar presses.

Six participants also made spacebar presses to stimulus D1. Two participants (15688 and 15666) estimated (1) “Definitely happening”, both of them also made spacebar presses. Five participants estimated (2) “Probably happening”, four of them made spacebar presses, but only two of them made enough spacebar presses to make avoiding responses. Five participants estimated (3) “Definitely not happening”, in which none of them made spacebar presses. None of the participants made spacebar presses to the stimuli from Class 2 or 3 in this phase. With the exception of participant 15676 who estimated (1) “Definitely happening” to stimuli B2, C2, D2, B3, C3, and (3) “Definitely not happening” to D3, all participants estimated (3) “Definitely not happening” to all stimuli in Class 2 and 3.

Corroboration

In Phase 6, stimulus B1 was no longer followed by the tone. The participant had to rate the probability of the tone, choosing between “Would have happened” (Y) and “Would not have happened” (N). In the next step, they were encouraged to corroborate their estimation. This phase consisted of three blocks. Results from Group A are shown in Figure 6. All of the participants in Group A made spacebar presses to stimulus B1 in the first corroboration block. Ten of the participants estimated (Y) and got negative feedback on their estimation. The two other participants (15654 and 15664) estimated (N) which led to positive feedback. Five participants (15651, 15658, 15668, 15669, and 15670) made spacebar presses to stimulus C1, all of them estimated (Y) and got negative feedback. Seven participants (15652, 15654, 15664, 15667, 15673, 15674, and 15679) estimated (N) and got positive feedback, none of them made spacebar presses.

Five participants (15651, 15658, 15668, 15669, and 15670) made spacebar presses to stimulus D1. All of the participants who made spacebar presses also estimated (Y), which led to negative feedback. Participant 15669 made seven spacebar presses, not sufficiently to make avoidance responses. Seven participants estimated (N) and got positive feedback for their estimation. All of the participants chose to corroborate their estimation in the first trial. None of the participants in Group A made spacebar presses to stimuli from Class 2 and 3 in any of the three blocks, this is consistent with all of the estimations given by the participants. All stimuli from Class 2 and 3 were estimated (N) and the participants got correct feedback.

Eight participants (15651, 15652, 15654,15658, 15664, 15668, 15673, and 15674) made spacebar presses to stimulus B1 in the second block. Five of the participants estimated (Y), four of them (15651, 15658, 15664, and 15674) chose to corroborate and got negative feedback. Participant 15673 also estimated (Y), but chose not to corroborate the estimation. Seven participants estimated (N), and six of them got positive feedback since participant

15664 chose to not corroborate the estimation. Three participants (15652, 15668, and 15670) made spacebar presses to stimulus C1. Participant 15652 only made one spacebar press. One participant, 15670, estimated (Y) and got negative feedback while the rest of the participants in the group estimated (N) and got positive feedback. Participant 15668 was the only one to make spacebar presses to stimulus D1, he also estimated (Y) and got negative feedback. The other participants estimated (N) and were given positive feedback for their estimations.

Three participants (15652, 15654, and 15673) made spacebar presses to stimulus B1 in the third block. Participant 15654 was the only one to estimate (Y), the rest of the participants estimated (N). None of the participants made spacebar presses to stimulus C1, and none of them estimated (Y). Participant 15652 made two spacebar presses to stimulus D1, but she estimated (N) like the rest of the group.

All of the participants in Group B made spacebar presses to stimulus B1 in the first block (see Figure 7). Eleven of them estimated (Y) and got negative feedback and one participant (15671) estimated (N) and got correct feedback. One of the participants (15676) who estimated (Y) chose to not corroborate her estimation. Seven participants made spacebar presses to stimulus C1. Six participants estimated (Y), but only five of them got negative feedback because participant 15676 chose to not corroborate her estimation. Six participants estimated (N) and five of them got positive feedback. Participant 15656 estimated (N), but he chose to not corroborate his estimation. Four participants made spacebar presses to stimulus D1, three of them estimated (Y) and got negative feedback. Participant 15676 also estimated (Y) although she did not make any spacebar presses, she did not choose to corroborate her estimation.

Eight of the participants estimated (N) to stimulus D1. Two of them (15656 and 15677) made spacebar presses, even though they corroborated (N). Both of them chose to corroborate and got positive feedback. Participant 15676 made one spacebar press to stimulus

C3, she also estimated (Y) and chose to not corroborate. She actually gave (Y) as estimation on all stimuli in the first trial, and chose to corroborate only to stimuli D2 and C2. Apart from this, none of the participants made spacebar presses to stimuli from Class 2 or 3 in the first trial, and all of them estimated (N) and got correct feedback when corroborating.

Seven participants (15656, 15659, 15671, 15672, 15675, 15676, and 15677) made spacebar presses to stimulus B1 in the second block. Participant 15659, 15671 and 15675 estimated (Y) and got negative feedback. The rest of the participants estimated (N) and got correct feedback, except from participant 15656 who chose to not corroborate the estimation. Two participants, 15656 and 15688, made spacebar presses to stimulus C1. Participant 15688 only made three spacebar presses. Both of them estimated (N). Participant 15676 was the only one to estimate (Y), which led to negative feedback. Participant 15656 chose to not corroborate on the estimation (N), but the rest of the participants corroborated and got positive feedback.

One participant (15656) made spacebar presses to D1, yet he estimated (N) and chose to not corroborate the estimation. All participants estimated (N), and all except from participant 15656, got positive feedback. No spacebar presses were made to stimuli B2, C2, D2, B3, or D3 in the second block. Participant 15676 made one spacebar press to stimulus C3, while she estimated (N). She also estimated (Y) to stimuli B2 and C2, while all the other participants estimated (N) to the stimuli from Class 2 and 3.

Four participants (15656, 15659, 15671, and 15676) made spacebar presses to stimulus B1 in the third block. Participant 15671 was the only one who estimated (Y). All the other participants estimated (N) and got correct feedback for their estimation. One participant, 15656, made spacebar presses to stimulus C1 and D1. All participants estimated (N) to stimuli C1, D1 and stimuli from Class 2 and 3, and got correct feedback, except from participant 15656 who chose to not corroborate his estimation (N) to stimulus C1.

Discussion

The purpose of the current experiment was tripartite: (1) to study the transfer of conditioned avoidance stimulus functions through equivalence classes, (2) extinction of these functions using verbal prompts, and (3) if there was consistency between participants` verbal estimations and avoidance responses. The main results from the training showed that participants in Group A used fewer trials to complete the baseline discrimination training than participants in Group B. The general results from the experiment show that (1) a proportion of the participants in both groups demonstrated transfer of conditioned avoidance stimulus functions through equivalence classes, (2) extinction of these avoidance functions with verbal prompts were achievable for the majority of the participants, (3) it was partially consistency between the verbal estimations given by the participants and their avoidance behavior.

The current study was a systematic replication of Garcia-Guerrero et al. (2014). All spacebar presses are included in the present study, even though there had to be eight or more spacebar presses to qualify as avoidance responses, and terminate the aversive tone. Visual inspection of graphed data are used to evaluate the effect of the experimental manipulations completed in the study (Fisch, 2001).

Transfer of conditioned avoidance stimulus functions

There were differences between the two groups in relation to how much training the participants needed to complete the MTS-tasks. Participants in Group A, who received MTS in front of the classically conditioning, used fewer trials to complete the baseline conditional discrimination than participants in Group B. This is connected to the factum that the majority of the participants in Group A succeeded the MTS-tasks without the need of repeating some of the blocks, while many of the participants in Group B had to repeat one or more blocks, in addition to repeat the baseline training.

The results from the current study do not show any correlation between transfer of functions and whether the classical conditioning was done in front of, or after the MTS procedure. Five of the participants from both groups (A and B) demonstrated transfer of avoidance stimulus functions and made spacebar presses to all Class 1-stimuli (B1, C1, and D1). One participant from Group A (15652) and four participants (15653, 15660, 15675, and 15676) from Group B made spacebar presses to some, but not all three of the Class 1-stimuli in the transfer tests. Overall, two participants in Group A, and four participants in Group B did not make any spacebar presses to stimulus B1 in the first test for transfer. Participant 15664 in Group A did not make spacebar presses in the second test for transfer either. These differences may be due to the differences in time from the classical conditioning to the transfer tests. The participants in Group A got a longer period of time from the conditioning took place, than participants in Group B which received the conditioning right in front of the transfer test.

The results from this study differ from those reported by Garcia-Guerrero et al. (2014). The authors found that all of the participants except from one in arrangement B failed to demonstrate the transfer of avoidance stimulus functions, and all of the four participants from arrangement A demonstrated transfer of avoidance stimulus functions (Garcia-Guerrero et al., 2014). Those participants who made spacebar presses in their study, made spacebar press to either all Class 1-stimuli (B1, C1, and D1) or B1 only. This also differs from the present study, wherein the plurality of the participants made spacebar presses to some of the Class 1-stimuli, but not all, or to other stimuli besides Class 1-stimuli.

The results from this current study support the results from a study done by Barnes and Roche (1997). Instead of distinctive overt behavioral responses as implemented in the present study, they used phasic changes in skin resistance as the dependent variable to assess the transfer of functions. They did four experiments in order to examine the derived transformation of eliciting functions using sexual film clips as unconditioned stimuli. They found no effect of the temporal order in which conditioning and equivalence training took place upon the transfer of stimulus functions (Barnes & Roche, 1997).

A delayed classical conditioning procedure was applied in order to establish the relation between a stress-eliciting tone (US) and stimulus B1 (as CS) in Phase 2 (Classical conditioning)**.** The B1 (CS+) and B2 (CS-) stimuli were presented alone in the center of the screen four times each in a random sequence for 10 seconds. The mixed results of transfer of avoidance functions in the present study may be due to weak aversive conditioning. It may be that four presentations of the B1 and B2 stimuli were not sufficient to establish a valid relation between the stimuli. The US (stress-eliciting tone) could have been louder in order to strengthen the conditioning.

Extinction of stimulus avoidance functions

Some of the participants in the present study showed higher resistant to extinction to stimulus B1, which was directly paired with the aversive tone, than C1 and D1, which only was indirectly related to stimulus B1. A prerequisite for seeing this is that the participants demonstrate transfer of avoidance stimulus functions. Two of the participants (15651 and 15658) from Group A and three participants from Group B (15672, 15675, and 15677) showed more resistant to extinction to stimulus B1 than stimuli C1 and D1.

Results from their study show that all participants in both arrangement A and B, except from participant 11 and 12 who served as comparisons and received other conditions. None of the participants made spacebar presses in the last corroboration Block. This differs from the results from the present study. Three participants in Group A (15652, 15654, and 15679) made spacebar presses to B1 in the last corroboration block. Participant 15652 also made two spacebar presses to stimulus D1 in the third corroboration block. Four of the participants in Group B (15656, 15659, 15671, and 15676) made spacebar presses to stimulus B1 in the last corroboration block as well. Participant 15656 stands out from the rest of the participants in the way that he made spacebar presses to all Class 1-stimuli in the last block. This may be related to the fact that he chose to not corroborate some of his estimations, and by this did not receive positive feedback that he could learn from.

Because two of the participants in Garcia-Guerrero et al. (2014) study worked as comparisons and had other conditions than the rest of the group, there are only six participants (three in each group) who will be taken into consideration for this discussion. Four of the participants from their study, who demonstrated transfer of avoidance stimulus functions, showed higher resistance to extinction to stimulus B1 than stimulus C1 and D1. One of their participants made spacebar presses to all Class 1-stimuli in the first corroboration block, and none spacebar presses to any of the stimuli in the second or third corroboration block. The last participant did not demonstrate transfer of avoidance stimulus functions.

Verbal estimations

In relation to the consistency between participants` verbal estimations and avoidance responses the results were diverse. Since all participants wore the headphones throughout the whole experiment, and none of them asked for the decibel level to be reduced, all participants received the same conditions concerning the aversive tone. Participants were given on-screen instructions ahead of each task, the instructions were translated from English to Norwegian. The instructions were available on the screen until the participants pressed the button at the bottom in order to continue.

Some of the participants explained in the debriefing that there was a long time between the presentation of the stimuli in Phase 4 ("Transfer of avoidance functions"), and the stimuli and the box with the related questions in Phase 5 ("Estimation of the probability of tone presentation") and 6 ("Probability estimation with feedback")**.** This could lead them to uncertainty. One participant reported that he "forgot what symbol it was he had seen when the box with questions came on the screen," and another reported that "I should have made spacebar presses, but I did not realize that it was the symbol with the sound on the screen”.

It would perhaps have been more fortunate, and provide a more valid result if the participants had the chance to make a click (make a observing response) once they had seen the stimulus on the screen, instead of waiting for the next stimulus. Most likely, this would also help them keep their attention up.

The role of instructions

Human operant behavior is considerably influenced by verbal instructions (e.g., Baron & Galizio, 1983), and a number of studies suggest that sensitivity to natural contingencies tends to be overridden by instructional control. Sidman (2000) writes: “Until we have answered the question of whether rules give rise to equivalence, or equivalence makes rules possible, we are going to have to be careful about our experimental procedures in investigations of equivalence. If we tell our subjects that stimuli “goes with” each other (or that they “match each other,” “belong together,” “are the same,” “go first” or “go second,” etc.), the data may then tell more about the subject`s verbal history than about the effects of current experimental operations” (pp. 21-22).

According to Dymond and Rehfeldt (2000), there are three main types of instructional variables that can be identified in studies with transfer of functions. The first type of instructional variable involves instructions that include relational terms such as for example “belong together” or “goes with” in the equivalence training and testing phases of transfer studies. The second type of instructional variable involves instructions that relate the equivalence and transfer phases of the study to each other. Dougher et al. (1994) used instructions like; “things that you learn in this part of the study may be important later on,” (p. 334) while Wulfert and Hayes (1988) instructed participants that; “all the tasks are interrelated” (p. 128). The third type of instructional variable involves instructions that describe the contingencies of the operant behavior under study. To give an example, Dymond and Barnes (1994) combined two complex schedules in order to generate two distinct patterns of responding during training and testing of transfer of functions. To initiate contact with the particular schedules, one of which was randomly generated on each trial, they instructed participants to “either keep pressing the space-bar, or not press at all. …There is no way you can get all the space-bar presses correct, but the best strategy is to keep pressing on some tasks, and on other tasks not to press at all.” (p. 256).

All participants received the same instructions in the present study. Garcia-Guerrero et al. (2014), on the other hand, gave minimal instructions to one of the participants. Results from their study shows that this participant demonstrated transfer of avoidance stimulus functions, but the extinction of these functions was not succeeded.

Experimental control and design

Prediction and control are the primary goals of science, and different research designs are applied to illustrate the experimental control (Arntzen, 2010a). According to Cooper, Heron, and Heward (2007) there are two meanings of experimental control. First, experimental control is achieved when a change in the dependent variable (the behavior) are a reliably result of manipulations in the independent variable (the environment). Second, experimental control also refers to the extent to which an experimenter maintains precise control of the independent variable. Baer, Wolf, and Risley (1968) refer to experimental control as an analysis of a behavior, whereas the experimenter must be able to control the occurrence and non-occurrence of the behavior under study.

Garcia-Guerrero et al. (2014) recruited 15 participants to their study, but due to the strict training criteria, six participants were removed from the study. Eight of the participants who completed the study were assigned to either arrangement A or B, while the ninth participant received the conditions from arrangement A, with minimal instructions. The conditions for the participants also varied within each group, which makes it difficult to compare the results for the participants. At the same time, it can be discussed whether at all, if the number of participants in their study is enough to say that they have a valid result. To increase the experimental control, the present study was conducted with 12 participants in each group of the two groups (A and B). All of the participants in each group were exposed to the same experimental conditions.

The present experiment was arranged as both a within subject design and a between subject design. Within subject design to compare the results for the participants within each of the groups (Arntzen, 2010a). A between subject-design was applied to compare the two groups in which received the order of the experimental phases in a different order.

Validity and inter-observer agreement

There are numerous forms of validity, but internal and external validity are two conditions that must be considered when evaluating the relationship between cause and effect (Arntzen, 2010a). When changes in the dependent variable are a result of the independent variable and not the result of unknown or uncontrolled variables it is a matter internal validity. External validity are mostly concerned with the degree to with the findings from the study have generality to other settings, subjects or behaviors (Cooper et al., 2007).

Results from the present study deals with both internal and external validity. The divergent results essentially deal with internal validity. External validity is appropriate when it comes to generality and transfer of functions. Findings from this study are highly relevant to other settings besides laboratory research. For example, for people who struggle with anxiety, these findings could contribute to forms of treatment outside the laboratory.

Inter-observer agreement was not implemented in this present study. All data from the experiments were stored on the computer, which was used to carry out experiments on.

Limitations and future research

The settings in the MTS-program were initially preset, yet some deviations seemed to occur. Participant 15651 did not receive the post-experiment equivalence test. Participant 15667 did not meet the criterion in the block with mixed symmetry and transitivity. She was supposed to repeat the same block, instead she was sent to the next block with reflexivity. Also, participant 15676 was supposed to be re-exposed to baseline training since she failed to reach the criterion for the second time in the block with mixed symmetry. She was not re-exposed to baseline training, instead she was exposed to the block with mixed transitivity. When she also failed to reach the criterion in the block with mixed transitivity twice, she was re-exposed to baseline training.

The present study has potential limitations that should be addressed in future research. Some of the issues that might be addressed in future research are the role of the instructions, methods for measuring conditioning, and research on anxiety in natural settings. As mentioned earlier, the role of instructions in human operant research can be challenging. It would be interesting to do the present study again, with minimal instructions for all participants, and compare the results. Other studies done with transfer of function, for example Augustson and Dougher (1997) and Barnes and Roche (1997), used other measurements such as extra-dermal activity measure to measure conditioning. It may be that other measurements besides spacebar presses is a more valid way to measure conditioning, or that the combination of both skin-conductance and spacebar presses would lead to interesting research. With the latter, the challenges with unawareness as reported by some of the participants in the debriefing, would be reduced. If the participants were inattentive and forgot to make spacebar presses, the skin-conductance measure would compensate and possibly captured measurements regardless of spacebar presses.

Replications are important within the field of behavior analysis, the more times the result is replicated, the better it is. This is related to the experimental control, when you get the same results repeatedly, one can be more certain that it is the independent variable (treatment) that has had effect on the dependent variable (behavior) (Arntzen, 2010a). Considering the differences in the results from the present study and the study done by Garcia-Guerrero et al. (2014), it would be important with further research and more replications. The prevalence of anxiety disorders of the largest and most renowned population surveys in Norway, the rest of Europe and the United States diverge somewhat. An overall picture may nevertheless indicate that every fourth to fifth individual in the population experience an anxiety disorder throughout life, and more than every tenth individual have an anxiety disorder at any times (Folkehelseinstituttet, 2015).

Research on avoidance and anxiety are preferred to do in laboratory settings, Garcia-Guerrero et al. (2014) claims that; "Under laboratory conditions, one controls for pre-existing equivalence classes by using unfamiliar stimuli and training the intended relations among them through arranged contingencies of differential reinforcement. Extra-laboratory situations entail a vast array of "historical" and ongoing equivalence classes in matured individuals, with language serving as an "equivalencing" vehicle. For example, if replications of the present study were made with clinical populations, would "anxious people" require more extinction trials despite the constant negative feedback; hence, showing more insensitivity to contingencies, and would they need more "invalidating consequences" before a change in the contingency occurred?" (p. 596).

Conclusion

In summary, based on the previous discussion, and due to the divergent results, more replications and further research on the combination of transfer of functions, extinction and verbal prompts would be necessary. Research engaging clinical populations in this area is limited, and more research could contribute to understanding alternative ways in which transfer of functions may be sensitive to being by means other than operant conditioning and classical conditioning (Dymond & Roche, 2009; Hayes, Strosalhl, & Wilson, 1999).

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Table 1.

Relations Among Stimuli and Trial-Type Presentations

	Task/block	**Sample**	**Correct**	**Incorrect**		
TRAINED/BASELINE	AB	A1	B1	B2	B3	B4
		A2	B2	B1	B3	B4
		A3	B3	B1	B2	B4
	AC	A1	C1	C2	C3	C4
		A2	C2	C1	C3	C4
		A3	C3	C1	C2	C4
	AD	A1	D1	D2	D3	D4
		A2	D2	D1	D3	D4
		A3	D3	D1	D2	D4
SYMMETRY	BA	B1	A1	A2	A3	A4
		B2	A2	A1	A3	A4
		B3	A3	A1	A2	A4
	CA	C1	A1	A2	A3	A4
		C2	A2	A1	A3	A4
		C3	A3	A1	A2	A4
	DA	D1	A1	A2	A3	A4
		D2	A2	A1	A3	A4
		D3	A3	A1	A2	A4
TRANSITIVITY	BC	B1	C1	C2	C3	C4
		B2	C2	C1	C3	C4
		B3	C3	C1	C2	C4
	CB	C1	B1	B2	B3	B4
		C2	B2	B1	B3	B4
		C3	B3	B1	B2	B4
	CD	C1	D1	D2	D3	D4
		C2	D2	D1	D3	D4
		C3	D3	D1	D2	D4
	DC	D1	C1	C2	C3	C4
		D2	C2	C1	C3	C4
		D3	C3	C1	C2	C4

	BD	B1	D1	D2	D3	D4
		B2	D2	D1	D3	D4
		B3	D3	D1	D2	D4
	DB	D1	B1	B2	B3	B4
		D2	B2	B1	B3	B4
		D3	B3	B1	B2	B4
REFLEXIVITY	AA	A1	A1	N5	N6	N7
		A2	A2	N stimuli randomized		
		A3	A3			
	BB	B1	B1	N5	N6	N7
		B2	B2	N stimuli randomized		
		B3	B3			
	CC	C1	C1	N5	N6	N7
		C2	C2	N stimuli randomized		
		C3	C3			
	DD	D1	D1	N5	N6	N7
		D2	D2	N stimuli randomized		
		D3	D3			
		D3	D3			

Note. The table shows the alternatives of relations among stimuli and trial-type presentation.

Table 2.

Baseline Conditional Discrimination for Participants in Group A

Participant	Gender	Age	BL	MBL (27)	SYM (36)	TRAN (72)	SYM+TRANS (27)	REF (12)	POST (27)
15651	M	33	243/273	27	33				
					35	72	27	12	-
15652	F	29	224/261	27	36	71	27	12	27
15654	M	36	244/301	27	35	71	27	12	26
15658	F	32	256/295	27	36	71	27	12	27
15664	F	32	347/446	27	36	72	27	12	27
15667	F	57	196/214	27	36	72	25	12	27
15668	M	35	304/346	35/36	36	68			
						71	27	12	27
15669	F	29	265/334	27	36	72	27	12	27
15670	M	25	258/301	27	36	71	26	12	27
15673	F	30	266/310	27	36	72	27	12	27
15674	M	31	227/240	27	36	72	27	11	27
15679	M	29	192/201	27	36	72	27	12	27

Table 3.

Baseline Conditional Discrimination for Participants in Group B

Participant	Gender	Age	BL	MBL (27)	SYM (36)	TRAN (72)	SYM+TRANS(27)	REF (12)	POST (27)
15653	F	32	215/255	27	36	71	27	12	26
15656	M	42	303/376	27	36	63			
						72	27	12	27
15659	F	29	208/223	27	36	72	27	12	27
15660	M	28	316/365						
			45/45	52/54	34				
					34				
			45/45	27	36	71	27	12	27
15662	M	27	183/190	27	36	72	27	12	27
15666	M	36	219/239	27	36	72	27	12	27
15671	F	23	240/282	27	34				
					31				
			45/45	27	33				
					32				
			45/45	27	36	71	27	12	27
15672	F	29	273/311	27	36	72	27	12	27
15675	F	33	275/342						
			45/45	27	36	52			
						71	27	12	26
15676	F	21	240/267	27	34				
					34	68			
						68			
			59/60	27	36	71	27	12	24
15677	F	29	204/226	27	36	25			
						72	27	12	27
15680	F	40	189/204	27	36	72	27	12	27

Table 4.

Number of Trials

	BL	MBL	SYM	TRAN	SYM+TRANS	REF	POST	TOTAL
Group A								
Correct	3022	332	463	927	321	143	323	5531
Total	3522	333	468	936	324	144	324	6051
Group B								
Correct	3149	457	698	1135	324	144	319	6226
Total	3563	459	720	1224	324	144	324	6758

Note. The table shows the number of trials from the different blocks for both groups. The differences between the groups in MBL (mixed baseline), SYM (symmetry) and TRAN (transitivity) are noteworthy. Participants in Group B have a higher number of trials compared with participants in Group A in the blocks listed above.

Table 5.

Transfer Test, Estimation and Corroboration for Participants in Group A

Participant	Test		Estimation	Corroboration		
15651	1	2		1	2	3
B1	8	8	10 (1)	8 (Y) -	8 (Y) -	0 (N) +
C1	8	8	8 (2)	8 (Y) -	0 (N) +	0 (N) +
D1	8	8	8 (2)	8 (Y) -	0 (N) +	0 (N) +
B2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D2	0	0	0 (4)	0 (N) +	0 (N) +	0 (N) +
B3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +

Participant	Test		Estimation	Corroboration		
15652	1	2		1	2	3
B1	32	31	65 (3)	39 (Y) -	43 (N) +	49 (N) +
C1	0	29	0 (3)	0 (N) +	1 (N) +	0 (N) +
D1	0	0	0 (3)	0 (N) +	0 (N) +	2 (N) +
B2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +

Participant	Test		Estimation	Corroboration		
15654	1	2		1	2	3
B1	0	20	43 (1)	35 (N) +	24 (N) *	25 (Y) -
C1	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D1	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +

Participant	Test		Estimation	Corroboration		
15658	1	2		1	2	3
B1	14	14	13 (1)	12 (Y) -	18 (Y) -	0 (N) +
C1	22	21	8 (1)	11 (Y) -	0 (N) +	0 (N) +
D1	23	15	10 (1)	9 (Y) -	0 (N) +	0 (N) +
B2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +

Participant	Test		Estimation	Corroboration		
15664	1	2		1	2	3
B1	0	0	13 (1)	8 (N) +	14 (Y) -	0 (N) +
C1	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D1	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +

Participant	Test		Estimation	Corroboration		
15667	1	2		1	2	3
B1	18	15	0 (1)	24 (Y) -	0 (N) +	0 (N) +
C1	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D1	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +

Participant	Test		Estimation	Corroboration		
15668	1	2		1	2	3
B1	28	17	18 (1)	18 (Y) -	23 (N) +	0 (N) +
C1	20	25	12 (1)	22 (Y) -	17 (N) +	0 (N) +
D1	21	24	21 (2)	24 (Y) -	23 (Y) -	0 (N) +
B2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +

Participant	Test		Estimation	Corroboration		
15669	1	2		1	2	3
B1	9	12	8 (1)	11 (Y) -	0 (N) +	0 (N) +
C1	9	9	4 (1)	10 (Y) -	0 (N) +	0 (N) +
D1	7	7	11 (1)	7 (Y) -	0 (N) +	0 (N) +
B2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +

Participant 15670	Test 1	2	Estimation	Corroboration 1	2	3
B1	**8**	**8**	**10 (1)**	**10 (Y) -**	0 (N) +	0 (N) +
C1	**8**	**8**	**13 (2)**	**10 (Y) -**	**9 (Y) -**	0 (N) +
D1	**10**	**8**	**10 (2)**	**13 (Y) -**	0 (N) +	0 (N) +
B2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +

Participant 15673	Test 1	2	Estimation	Corroboration 1	2	3
B1	**22**	**19**	**10 (1)**	**13 (Y) -**	**13 (Y) ***	**11 (N) +**
C1	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D1	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +

Participant 15674	Test 1	2	Estimation	Corroboration 1	2	3
B1	**23**	**19**	**21 (1)**	**17 (Y) -**	**19 (Y) -**	0 (N) +
C1	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D1	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +

Participant 15679	Test 1	2	Estimation	Corroboration 1	2	3
B1	**17**	**27**	**29 (1)**	**33 (Y) -**	0 (N) +	0 (N) +
C1	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D1	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +

Note. The table shows the individual results from Phase 4, 5 and 6 for each participant in Group A. The number standing alone correspond to the number of spacebar presses for each stimulus. Highlighted numbers and gray-colored column indicate spacebar presses. The numbers within brackets in trial 3 refer to the estimation buttons; 1; "Definitely happening", 2; "Probably happening", 3; "Definitely not happening", 4; "Probably not happening". The letters within brackets in trials 4, 5 and 6 refer to the estimation options, (Y); "Happened", (N); "Not happened". Plus (+) or minus (-) indicate whether the feedback received when corroborating their estimations was positive or negative. The * means that the participant chose to not corroborate.

Table 6.

Transfer Test, Estimation and Corroboration for Participants in Group B

Participant	Test		Estimation	Corroboration		
15653	1	2		1	2	3
B1	0	**22**	**43 (1)**	**42 (Y) -**	0 (N) +	0 (N) +
C1	**1**	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D1	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +

Participant	Test		Estimation	Corroboration		
15656	1	2		1	2	3
B1	0	**9**	**8 (1)**	**8 (Y) -**	**8 (N) ***	**8 (N) +**
C1	0	**9**	**7 (2)**	**8 (N) ***	**8 (N) ***	**7 (N) ***
D1	0	**9**	**8 (2)**	**8 (N) +**	**8 (N) ***	**8 (N) +**
B2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +

Participant	Test		Estimation	Corroboration		
15659	1	2		1	2	3
B1	0	**8**	**8 (1)**	**8 (Y) -**	**10 (Y) -**	**8 (N) +**
C1	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D1	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C3	0	0	0 (4)	0 (N) +	0 (N) +	0 (N) +
D3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +

Participant	Test		Estimation	Corroboration		
15660	1	2		1	2	3
B1	0	**9**	**16 (1)**	**19 (Y) -**	0 (N) +	0 (N) +
C1	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D1	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B2	**7**	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +

Participant	Test		Estimation	Corroboration		
15662	1	2		1	2	3
B1	**17**	**15**	**11 (3)**	**12 (Y) -**	0 (N) +	0 (N) +
C1	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D1	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +

Participant	Test		Estimation	Corroboration		
15666	1	2		1	2	3
B1	0	**20**	0 (1)	**17 (Y) -**	0 (N) +	0 (N) +
C1	**20**	**19**	**20 (3)**	**23 (Y) -**	0 (N) +	0 (N) +
D1	**24**	**20**	**20 (1)**	**17 (Y) -**	0 (N) +	0 (N) +
B2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +

Participant	Test		Estimation	Corroboration		
15671	1	2		1	2	3
B1	**14**	**12**	**13 (1)**	**13 (N) +**	**14 (Y) -**	**13 (Y) -**
C1	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D1	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +

Participant	Test		Estimation	Corroboration		
15672	1	2		1	2	3
B1	**10**	**10**	**18 (1)**	**16 (Y) -**	**14 (N) +**	0 (N) +
C1	**13**	**13**	**13 (2)**	**17 (Y) -**	0 (N) +	0 (N) +
D1	**14**	**14**	**12 (2)**	**13 (Y) -**	0 (N) +	0 (N) +
B2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +

Participant 15675	Test 1	Test 2	Estimation	Corroboration 1	Corroboration 2	Corroboration 3
B1	11	12	14 (1)	28 (Y) -	3 (Y) -	0 (N) +
C1	13	1	1 (1)	6 (Y) -	0 (N) +	0 (N) +
D1	0	0	1 (2)	0 (N) +	0 (N) +	0 (N) +
B2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +

Participant 15676	Test 1	Test 2	Estimation	Corroboration 1	Corroboration 2	Corroboration 3
B1	1	11	7 (2)	15 (Y)*	18 (N) +	17 (N) +
C1	0	0	0 (2)	1 (Y)*	0 (Y) -	0 (N) +
D1	0	0	0 (2)	0 (Y)*	0 (N) +	0 (N) +
B2	0	0	0 (1)	0 (Y)*	0 (Y) -	0 (N) +
C2	0	0	0 (1)	0 (Y) -	0 (Y) -	0 (N) +
D2	0	0	0 (1)	0 (Y) -	0 (N) +	0 (N) +
B3	0	0	0 (1)	0 (Y)*	0 (N) +	0 (N) +
C3	0	0	0 (1)	1 (Y)*	1 (N) +	0 (N) +
D3	0	0	0 (3)	0 (Y)*	0 (N) +	0 (N) +

Participant 15677	Test 1	Test 2	Estimation	Corroboration 1	Corroboration 2	Corroboration 3
B1	22	24	10 (1)	11 (Y) -	19 (N) +	0 (N) +
C1	27	12	9 (2)	26 (Y) -	0 (N) +	0 (N) +
D1	16	17	7 (2)	11 (N) +	0 (N) +	0 (N) +
B2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D3	1	0	0 (3)	0 (N) +	0 (N) +	0 (N) +

Participant 15680	Test 1	Test 2	Estimation	Corroboration 1	Corroboration 2	Corroboration 3
B1	10	11	9 (1)	10 (Y) -	0 (N) +	0 (N) +
C1	7	10	7 (1)	10 (Y) -	3 (N) +	0 (N) +
D1	6	10	10 (1)	11 (Y) -	0 (N) +	0 (N) +
B2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D2	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
B3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
C3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +
D3	0	0	0 (3)	0 (N) +	0 (N) +	0 (N) +

Note. The table shows the individual results from Phase 4, 5 and 6 for each participant in Group B. The numbers standing alone correspond to the number of spacebar presses for each stimulus. Highlighted numbers and gray-colored column indicate spacebar presses The numbers within brackets in trial 3 refer to the estimation buttons; 1; "Definitely happening", 2; "Probably happening", 3; "Definitely not happening", 4; "Probably not happening". The letters within brackets in trials 4, 5 and 6 refer to the estimation options, (Y); "Happened", (N); "Not happened". Plus (+) or minus (-) indicate whether the feedback received when corroborating their estimations was positive or negative. The * means that the participant chose to not corroborate.

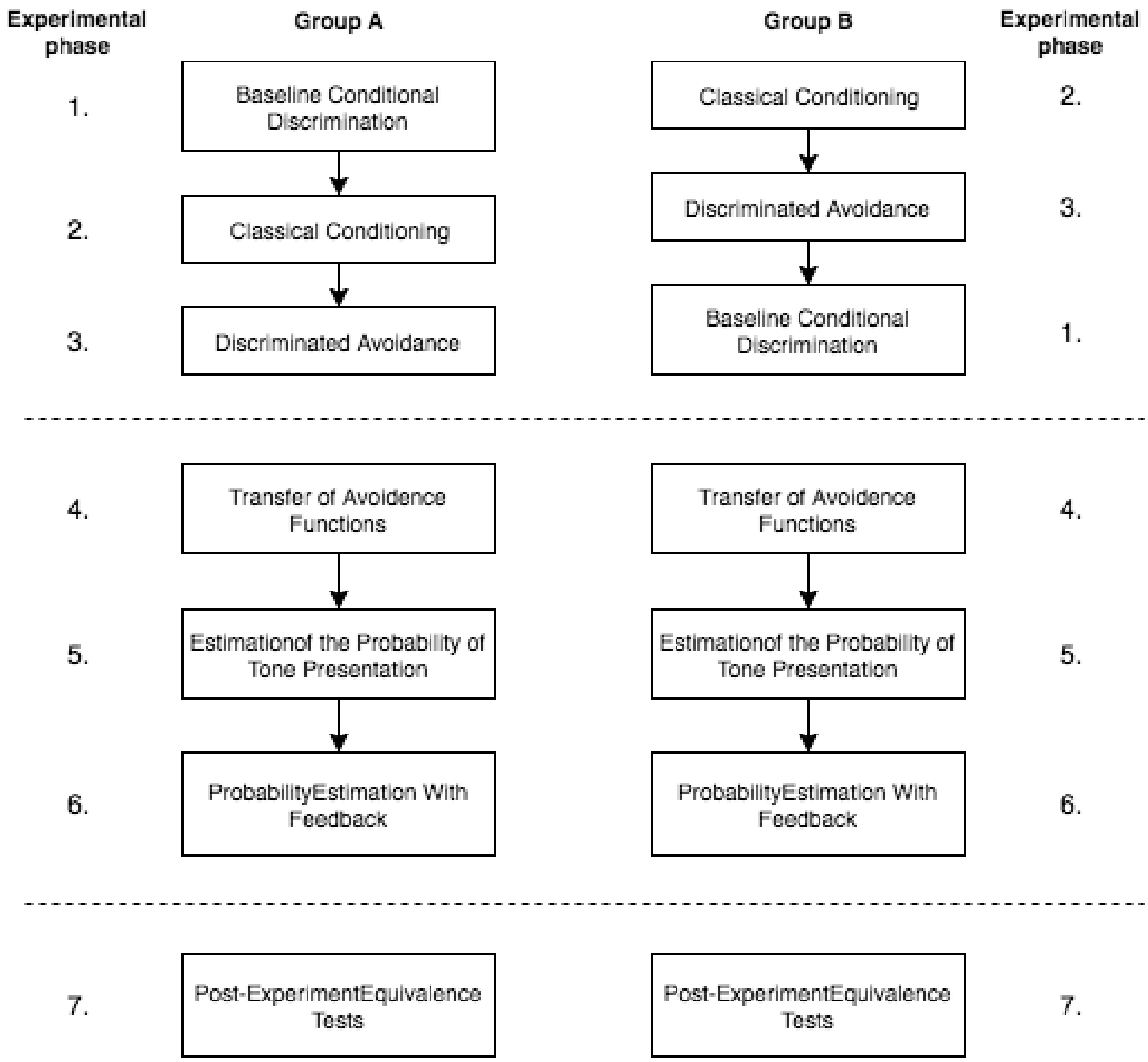

Figure 1. The figure shows the order of the experimental phases. Participants in Group A received Phase 1 with baseline conditional discrimination in front of Phase 2 with classic conditioning, while participants in Group B on the other hand received Phase 2 with classic conditioning prior to Phase 1 with baseline conditional discrimination.

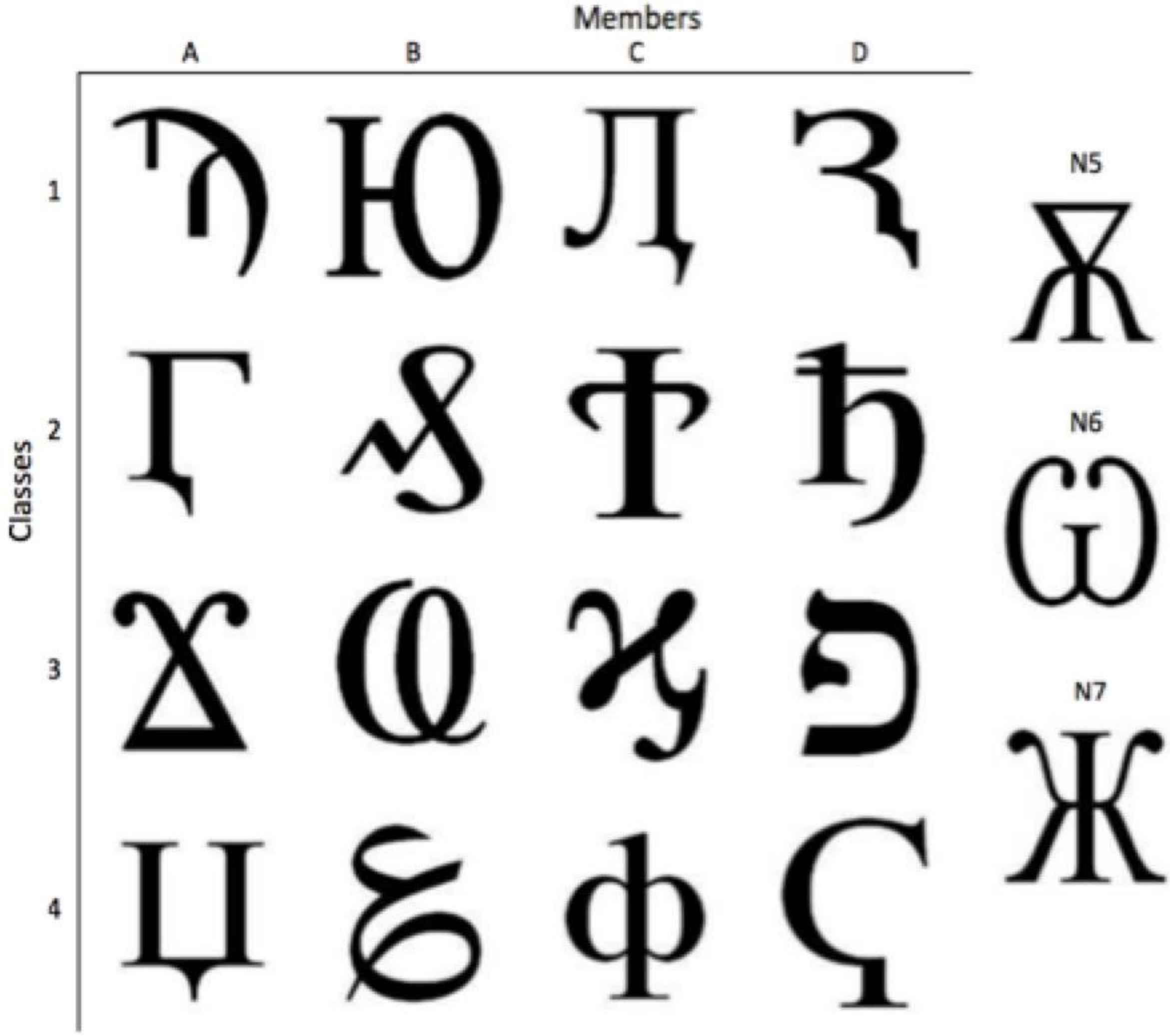

Figure 2. Abstract visual stimuli used in the present study.

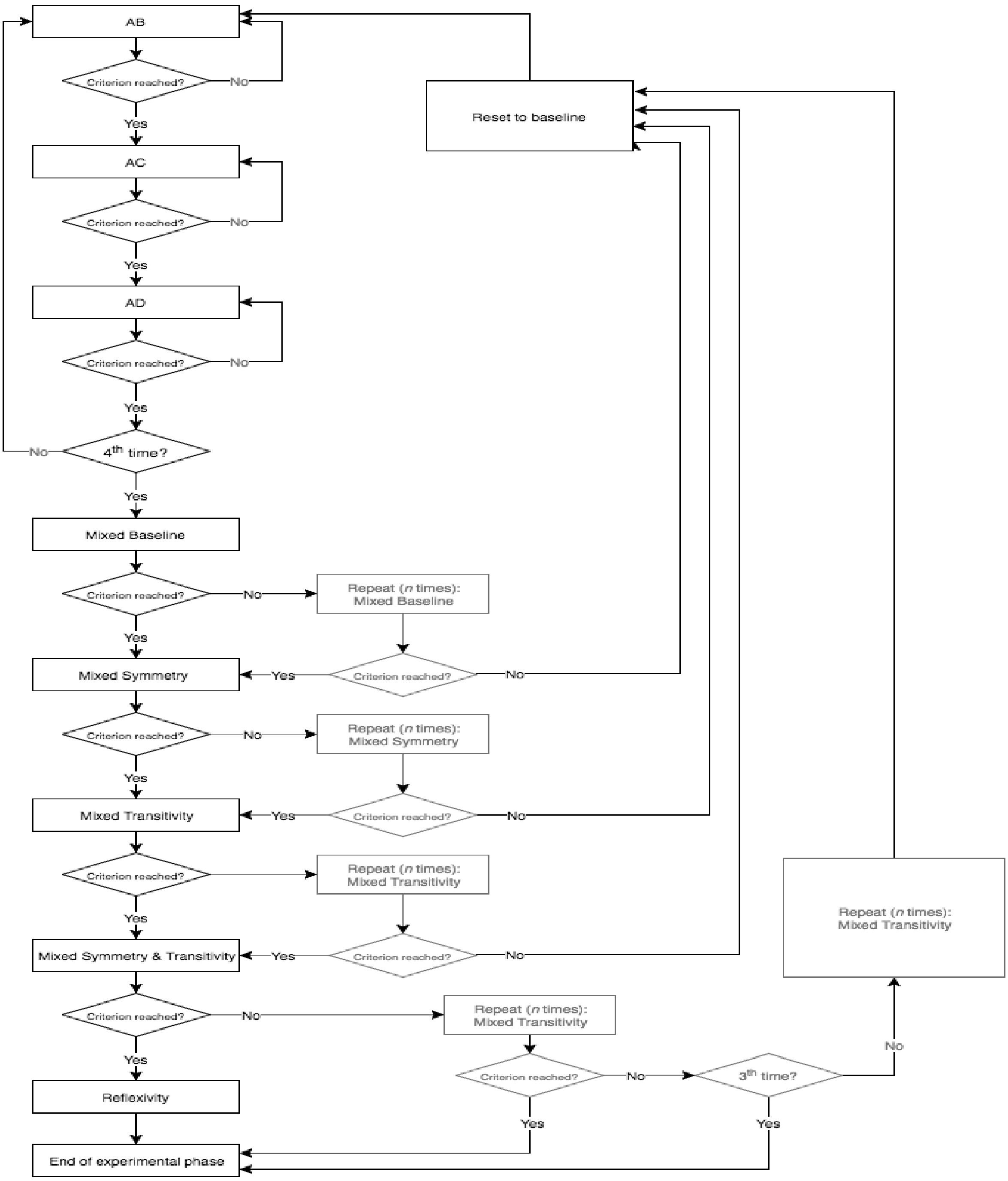

Figure 3. The diagram shows the sequence flow of the experimental phase for conditional discrimination training and testing for equivalence class formation. Failure to reach the criterion in one block led to a repetition of the same block. If the participant failed to reach the criterion the second time, s/he was re-exposed to baseline training. Baseline training was reduced to one trial-block at this point. Participants re-exposed to baseline training three times were withdrawn from the study.

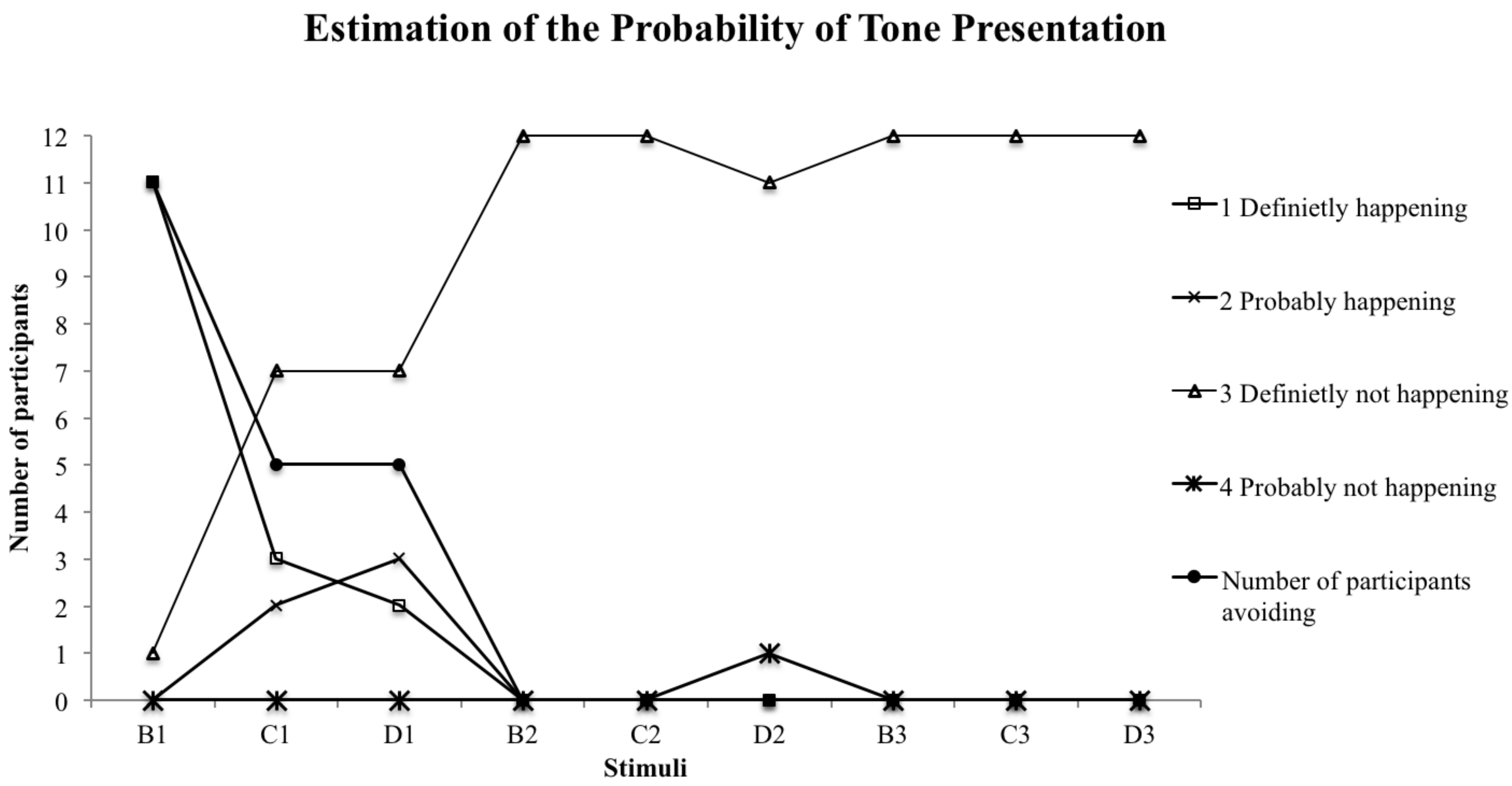

Figure 4. The graph shows the results from Phase 4 for participants in Group A. Eleven of the participants made spacebar presses (avoided) to stimulus B1. The same number of participants estimated 1 "Definitely happening" to stimulus B1.

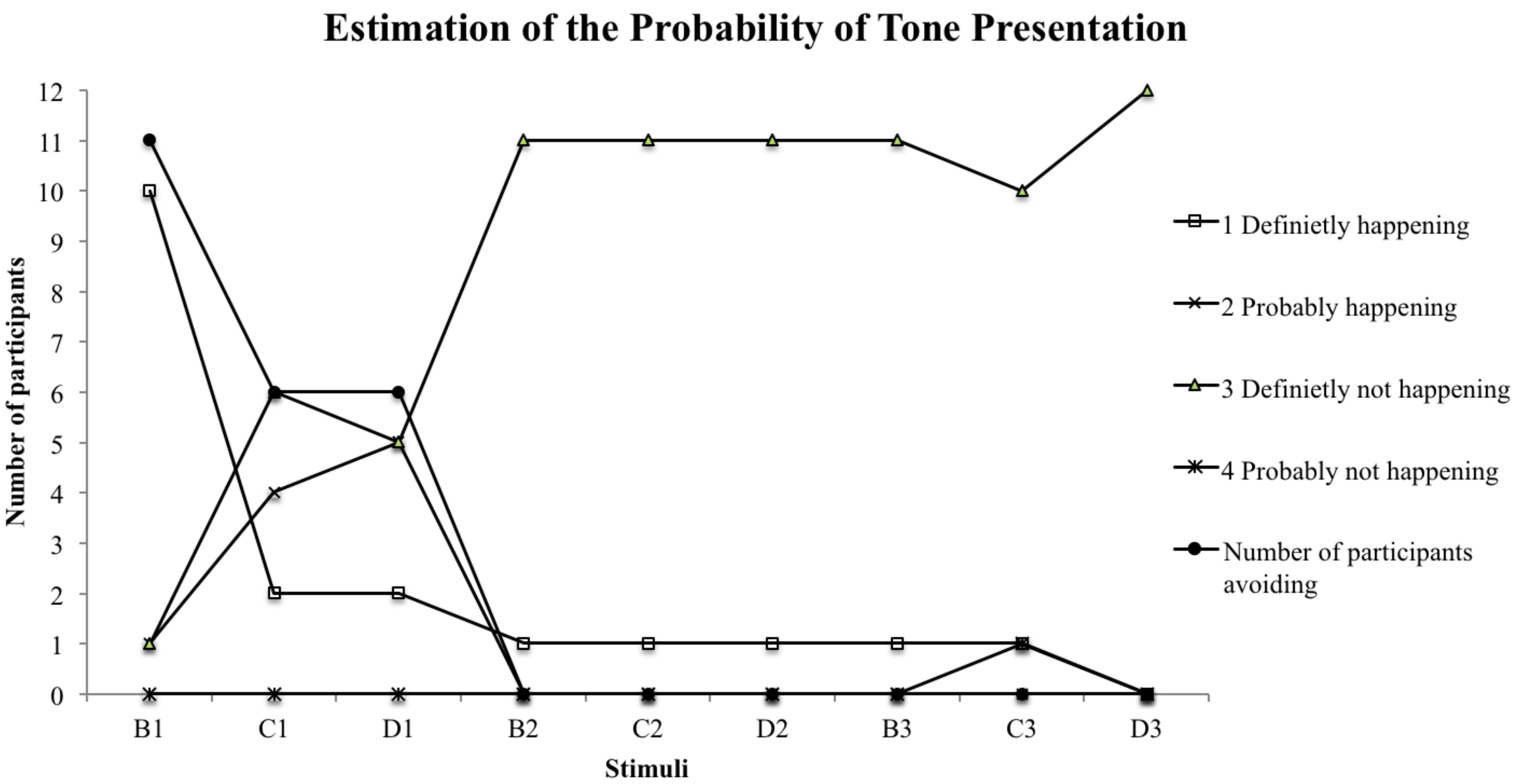

Figure 5. The graph shows the results from Phase 4 for participants in Group B. Eleven of the participants in this group made avoiding responses (spacebar presses) to stimulus B1.

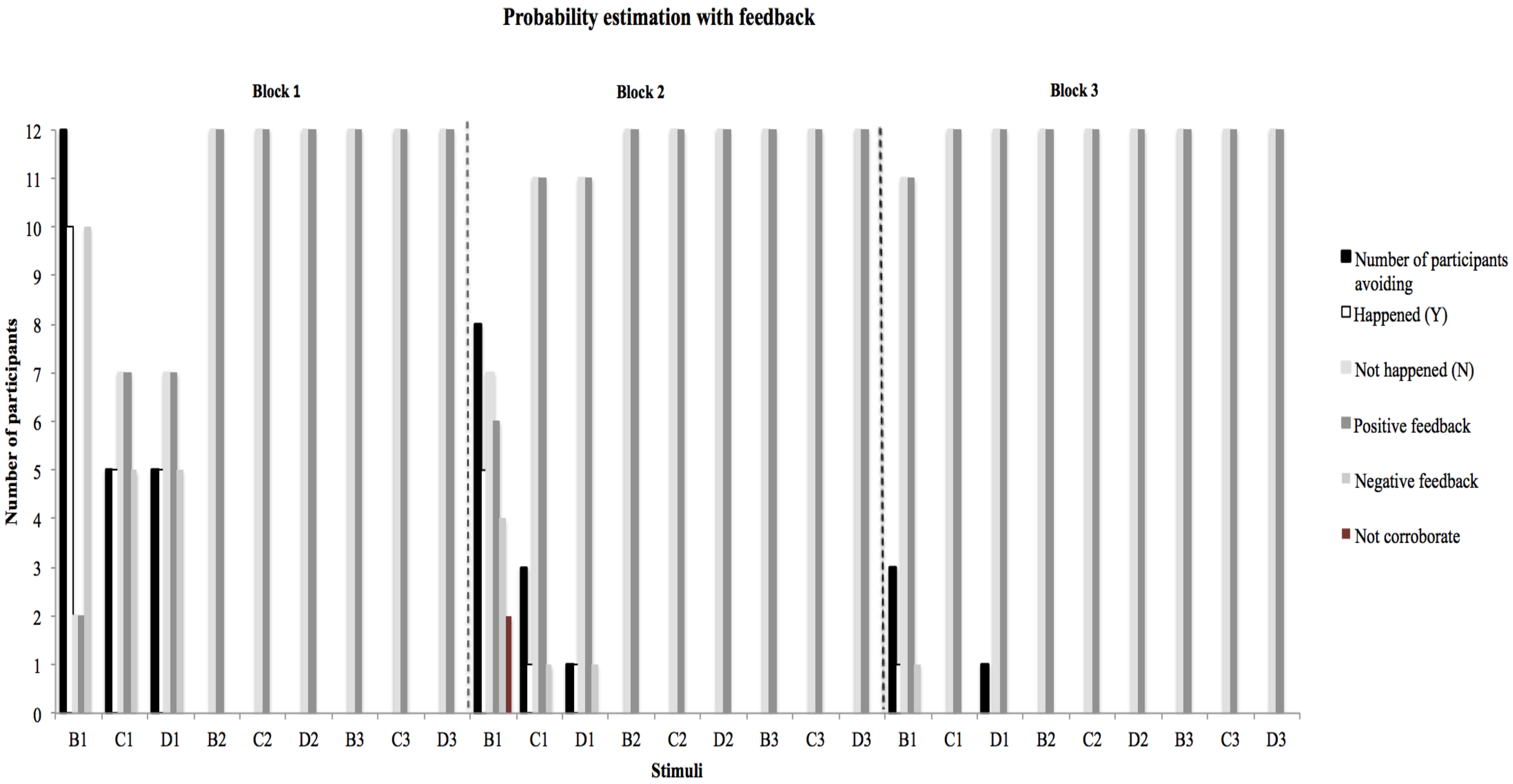

Figure 6. The graph shows the results from Phase 6 for participants in Group A. Number of participants making spacebar presses to stimulus B1, C1 and D2 are declining in Blocks 2 and 3. None of the participants made spacebar presses (avoided) to stimulus C1 in the third Block.

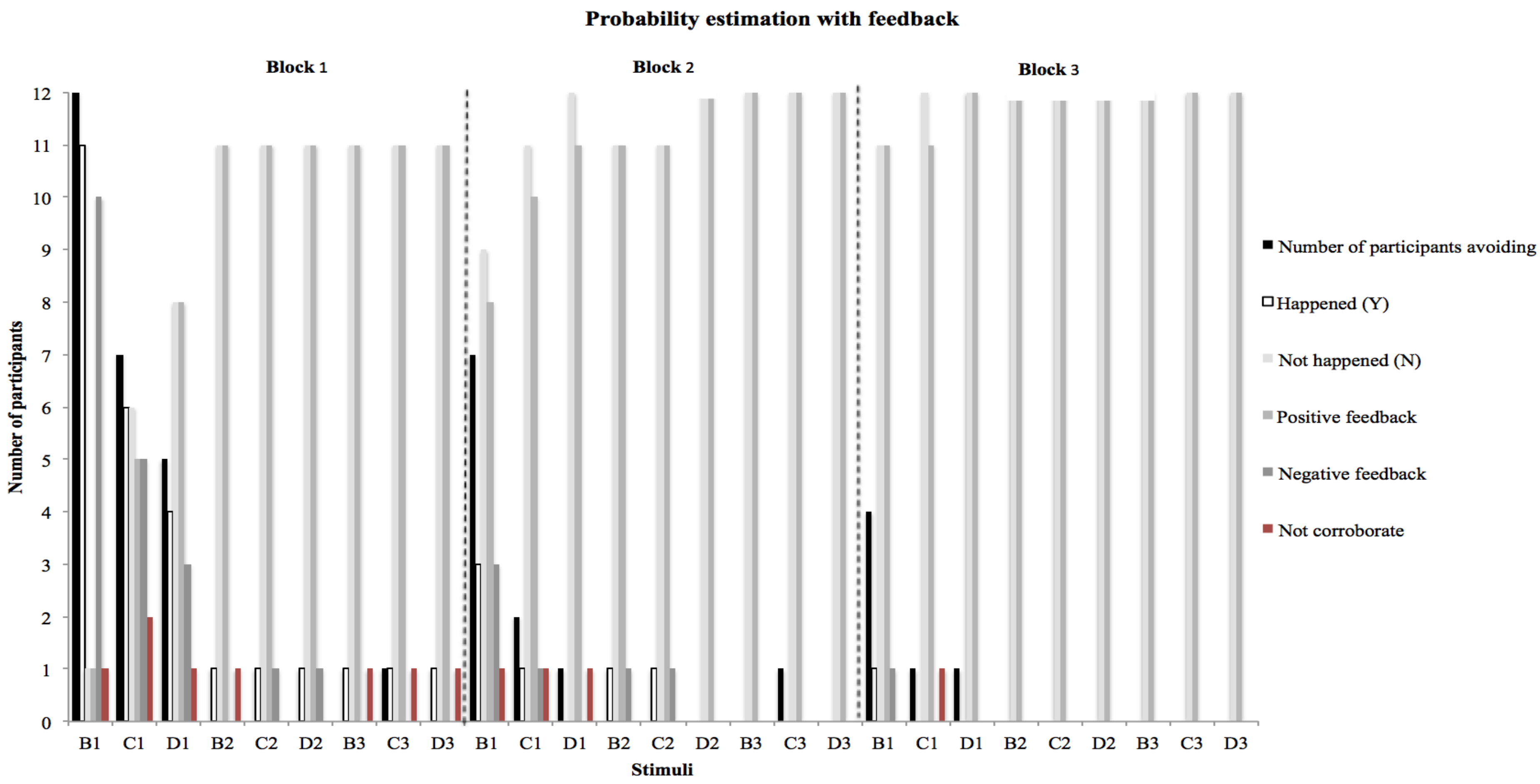

Figure 7. The graph shows an overview of the results from Phase 6 for participants in Group B. Number of participants avoiding are declining in Blocks 2 and 3.

Appendix A

Instructions translated from English to Norwegian

Phase 1: Baseline conditional discrimination.

Det vil snart dukke opp noen figurer på skjermen. Se på figuren som kommer på midten av skjermen, klikk på den slik at kommer frem fire andre figurer på skjermen. Velg en av de fire figurene ved å klikke på den. I starten vil maskinen gi deg tilbakemelding på hvert valg, mens den ikke gir tilbakemelding andre ganger. Det vil alltid være et riktig valg. Ved å følge nøye med på valgene du gjør med tilbakemelding, kan du gjøre det rett på alle valgene som skal gjøres uten tilbakemelding. Selv om de første oppgavene er enkle, er det viktig å følge nøye med fordi oppgavene vil øke I vanskelighetsgrad, og valg av korrekt figur i siste del av eksperimentet vil avhenge av kunnskapen du får tidlig I eksperimentet. Målet ditt er å gjøre så mange korrekte valg som mulig. Hvis du har noen spørsmål, vær snill å spør eksperimentator. Når du er klar: Trykk på knappen nedenfor for å gå videre.

Bra! Du har gjennomført denne delen av eksperimentet riktig. Følg med, det kommer mer! Når du er klar: Trykk på knappen nedenfor for å gå videre

---

Supert! Du har kommet deg gjennom den første delen av eksperimentet. Den neste oppgaven krever mer av deg, følg nøye med! For å gå videre, trykk på knappen nedenfor.

Flott! Hold oppmerksomheten oppe, det kommer mer. Når du er klar: Trykk på knappen nedenfor.

Strålende! Neste oppgave er vanskelig. Konsentrer deg! Trykk på knappen nedenfor for å gå videre.”

Noen siste oppgaver før du er ferdig med denne delen av forsøket. Trykk på knappen nedenfor for å gå videre.

Phase 2: Classical conditioning.

I denne fasen skal du ikke velge noen figur. Alt du trenger å gjøre er å følge nøye med på skjermen til det kommer noen nye instruksjoner. Noen figurer vil duke opp på skjermen, en av gangen. Det er viktig at du studerer figurene nøye. Noen ganger vil det bli spilt en lyd. Hvis du har noen spørsmål, vær snill å spør eksperimentator nå. Når du er klar: Trykk på knappen nedenfor

Phase 3: Discriminated avoidance.

Som tidligere, vil det snart dukke opp figurer på skjermen og noen av figurene vil bli etterfulgt av tonen du hørte tidligere. Denne gangen kan du forhindre at tonen blir spilt ved å trykke flere ganger på “space” på tastaturet så fort figuren du tror blir etterfulgt av tonen dukker opp på skjermen. Dersom det ikke blir trykket noe på “space” I løpet av de første sekundene, vil tonen komme. Det er viktig at du følger med og konsentrerer deg om skjermen. Dersom du har noen spørsmål, spør eksperimentator nå. Når du er klar: Trykk på knappen nedenfor

Phase 4: Transfer of avoidance functions.

Snart vil det dukke opp figurer på skjermen og noen vil bli etterfulgt av tonen du hørte tidligere. Denne gangen vil det være flere figurer involvert. Fortsett å trykke på ”space” gjentatte ganger med en gang figuren dukker opp for å forhindre tonen, dersom du tenker at det er nødvendig. Trykk på knappen nedenfor for å gå videre.”

Phase 5: Estimation of the probability of tone presentation.

I neste fase, forsett å løse oppgaven slik du har gjort tidligere: Trykk på “space” når du tror det er nødvendig. Du vil I tillegg bli spurt om hvor sannsynlig du tror det er at tonen kommer/ikke kommer. Følg instruksjonene som kommer på skjermen. Trykk på knappen nedenfor for å fortsette.”

Phase 6: Probability estimation with feedback.

I likhet med tidligere oppgaver kan figurer bli etterfulgt av en tone, med mindre du trykker på “space” gjentatte ganger. Du vil igjen bli spurt om hvor sannsynlig du tror det er at tonen skal forekomme. Denne gangen vil du bare få to valg: om du trodde at tonen ville bli presentert eller ikke. Et ekstra valg er i spill! Du vil bli utfordret og får muligheten til å underbygge din beregning før du enten vinner eller taper poeng. Du får to muligheter; (1) du kan velge å underbygge beregningen, eller (2) du kan velge å ikke underbygge beregningen. Hvis du bestemmer deg for å underbygge beregningen, kan du få tre poeng for hvert riktige valg, og miste tre poeng for hvert svar som er feil. Poengene vil bli vist underveis, og det vil bli gitt tilbakemeldinger. Dersom du velger å ikke underbygge din beregning, vil du få eller tape poeng for ”rett” eller ”gal” beregning. I dette tilfellet vil den totale summen bli vist på slutten av oppgaven. Målet ditt vil være å gjøre så mange riktige beregninger som mulig. Hvis du har noen spørsmål, vær snill å spør eksperimentator nå. Trykk på knappen nedenfor når du er klar til å gå videre.

Appendix B

Information given to the participants

Forskningsprosjekt om stimulusekvivalens

Informasjon til deltakere

1. **Bakgrunnen for prosjektet**

Som student ved Høgskolen i Akershus arbeider jeg for tiden med et forskningsprosjekt om stimulusekvivalens og transfer of functions. Prosjektet er innenfor fagfeltet læringspsykologi og har som formål å gi mer innsikt hvordan stimulusekvivalens og transfer of functions fremkommer. Å oppnå mer kunnskap om stimulusekvivalens kan være avgjørende for å øke forståelsen av de fenomener man til daglig kaller hukommelse, problemløsning, språk og symbolbruk.

For ikke å påvirke forskningsresultatene kan jeg ikke i detalj forklare hva stimulusekvivalens eller transfer of functions innebærer før forsøket starter. Derimot vil alle deltakere kunne få se egne resultater, få en grundig gjennomgang av stimulusekvivalens som forskningsfelt, samt få en forklart hva det foreliggende forskningsprosjekt spesifikt undersøker etter de har deltatt. Deltakere vil også få en artikkel på norsk om stimulusekvivalens. I denne ”debrifingen” vil det også være muligheter til å stille spørsmål.

2. Selve forsøkssituasjonen

Forsøkene innebærer at deltakerne sitter foran en PC og presenteres for ulike stimuli. Deltakerne vil bli gitt instruksjoner enten av forsøksleder eller på datamaskinen i forhold til hva de skal gjøre til enhver tid.

Hver forsøksperson blir testet på denne måten i ca. 2 timer. Det kan noen ganger ta kortere eller litt lenger tid.

3. Hvem er vi som utfører dette prosjektet?

Erik Arntzen er professor ved Høgskolen i Akershus. Han står ansvarlig for forskningsprosjektet og kommer til å være delaktig i både planlegging og gjennomføring av forsøkene. Om deltakeren på noe punkt har noe spørsmål om forskningsprosjektet, kan Erik Arntzen kontaktes på mailadresse: erik.arntzen@equivalence.net.

Anette Ask Majormoen er Matergradstudent ved Høgskolen i Akershus. Hun vil gjennomføre forsøkene under veiledning av Erik Arntzen.

4. Etiske forhold

Forsøkene som skal gjennomføres kan påføre deltakerne et mildt ubehag, i form av en tone. Dersom tonen oppleves som ubehagelig er det mulig å be forsøksleder om å skru ned lyden.

5. Rettigheter

Prosjektet er et rent forskningsarbeid som ikke involverer klinisk behandling eller opplæring.

Erik Arntzen er ansvarlig for all informasjon om prosjektet i for- og i etterkant.

Det vil ikke bli innhentet personlige data i forbindelse med denne studien og det vil ikke bli oppbevart lister med navn eller former for koding som kan knytte navn opp mot resultater fra forsøket. Det vil ikke under noen omstendighet bli oppgitt personlige opplysninger om deltakere eller opplysninger som kan bidra til at disse kan identifiseres. I all form for publikasjon vil derfor data ikke kunne tilbakeføres til de som har deltatt i disse forsøkene.

Det er når som helst mulig for deltakeren å avbryte forsøket dersom han eller hun ønsker dette. Deltakere som gjennomfører prosjektet vil være med i trekningen av en iPhone av nyeste modell. Trekningen vil bli gjort etter at alle deltakerne er ferdig med prosjektet.

Med vennlig hilsen,

Erik Arntzen

Professor, Dr. psychol, psykologspesialist

Klipp---klipp

6. Samtykke til deltakelse

Jeg har lest denne informasjonen og fått utlevert en egen kopi av denne.

Jeg har fått svar på eventuelle spørsmål jeg måtte ha i tillegg til den skriftlige informasjonen.

Jeg er inneforstått med at dersom jeg på noen som helst tidspunkt har spørsmål vedrørende det beskrevne prosjekt, kan jeg kontakte Dr. Erik Arntzen, erik.arntzen@equivalence.net.

Jeg har lest om prosjektet og gir mitt samtykke til å delta i undersøkelsen om stimulusekvivalens.

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Sted/dato Deltakers underskrift