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On the Role of Transfer of Function in the Understanding of Preferences

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A Behavior Analytic Account of Consumer Behavior

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Abstract

The current article uses the frame of consumer behavior to provide a behavior analytic account for complex behavior. Behavior analysis has been accused of not being able to account for behavior that seems to emerge without being directly reinforced, and that complex behavior can best accounted for by cognitive oriented explanations. Concepts such as conditioned motivational operations, stimulus equivalence and the transfer and transformation of functions are presented as behavior analytic approaches to understand the multi-facetted contingencies controlling behavior in real world settings. First, recent theoretical and empirical investigations on conditional motivating operations and consumer behavior are presented and discussed. Second, stimulus equivalence research is presented as a conceptual and empirical approach to understand how arbitrary related stimulus-stimulus and stimulus-response relations generate novel controlling stimulus-response relations. Stimulus equivalence relations are recognized by testing for the emergent properties of reflexivity, symmetry and transitivity. Findings from equivalence research have shown that psychological functions trained to one member of an equivalence class can emerge to the other members of the class. This observation has been termed the transfer of function, and has been observed with a variety of stimulus functions. Further, the transformation of function is a more generic description that presented to account for stimulus functions that not only transfer but transforms. Finally, research on what has been termed generalized equivalence classes is presented and used as examples of how arbitrary and perceptual equivalence classes can merge and account for behavior in the world outside the laboratory.

Keywords: Stimulus equivalence, functional stimulus class, transfer of function, generalized equivalence class, consumer behavior

Complex behavior and emergent relations: A translational approach

In the 1980's, scholars from the branches of marketing and organizational psychology started to recognize that the pragmatic and contextualistic approach of behavior analysis could contribute to the understanding of variables that influences consumer behavior. They were positive to behavior analysis as a supplement to cognitive models but the idea was that the data derived from stringent laboratory settings could not be generalized to the complex world of the marketplace (Nord, 1980; Rothschild & Gaidis, 1981).

Rothschild and Gaidis (1981) divides consumer behavior into high and low involvement cases. High involvement cases involves intricate decision processes, demands complex cognitive and mental activity and requires cognitive oriented explanations. Further, they argue that the level of cognitive activity increases as a function of involvement. In comparison, low involvement cases involves low involvement products and choices, which have little significance to the consumer. They argue that these low involvement cases are more suitable for behavior analytic theory and interventions because they do not require complex cognitive or mental activity. Moreover, Nord (1980) challenges researchers from the field of behavior analysis as he states that "In terms of consumer behavior research, it will undoubtedly be some time before researchers actively catalog and sample elements of the external environment given the predilection toward the study of internal processes" (p. 46).

Complex mental activity and higher order cognitive skills are commonly explained within cognitive psychology with the use of coding algorithms (Lewicki, Hill, & Czyzewska, 1992). An recent example of research on concept formation based on coding algorithms is based on function learning theory (McDaniel & Busemeyer, 2005). Some examples of behavior explained by function learning theory can be to estimate the landing spot of a kicked football based on its trajectory, predicting the sound of a piano key based on its location amongst the tangents, or predict sailing time based on wind speed. In a typical function learning experiments, participants are presented with cue criterion values for one continuous variable (x) and the task is to predict the values of another continuous variable (y). The training trials are presented with following corrective consequences. The stimulus dimensions are usually displayed graphically using either figures or arrows of varying lengths. Response magnitudes can be provided with either written or verbal responses using graphical means, numeric values or, other topographies (Kalish, Lewandowsky, & Kruschke, 2004). The training phase is followed by a transfer test. In this phase, novel values are presented without corrective feedback. The purpose of this phase is to test if the participants have formed concepts regarding the functional relationships between the stimulus dimensions. The two dominant views regarding function learning behavior are the rule learning approach and the associative learning model (McDaniel & Busemeyer, 2005). The rule learning approach postulates that rules are abstracted based on the stored values of the training cues and response dimensions provided during training. Later on during testing, the emitted responses are chosen based on how well they fit the generated rule. The associative learning model postulates that participant's store the presented stimuli and responses in stimulus and response pairs. Next, during testing, the responses are emitted based on the closest resemblance to the stored stimulus-response pairs (DeLosh, Busemeyer, & McDaniel, 1997). Recently, models that integrate both rule learning and associative learning approaches have been suggested (McDaniel & Busemeyer, 2005). Moreover, two types of function learning behavior can be tested for, extrapolation and interpolation. During extrapolation tests, novel stimulus values that lie outside the range of the trained stimulus dimensions are presented. Interpolation tests involve the presentation of stimulus values within the trained range (DeLosh et al., 1997; McDaniel & Busemeyer, 2005).

Based on observations from environment behavior relations, mental models are constructed that fits the observed relations. The models are later on tested through experimentation, and given causal status for behavior if they fit the observed relations. This way of conducting science is referred to as a constructionist view, and states that there are mental events compensating and constructing representations of what is lacking in the environment (Donahoe & Palmer, 1994; Sidman, 1994). The models themselves become the primary focus of inquiry and behavior becomes the secondary focus.

Behavior Analysis

An alternative way of understanding complex behavior can be provided using a behavior analytic framework. From this point of view, groups of objects or events are classed together based on their ability to evoke or elicit the same responses (Keller & Schoenfeld, 1950). Behavior analytic theory does not view concepts as something that can be found inside the mind, brain or a processing system, “one does not *have* a concept, just as one does not *have* extinction–rather, one demonstrates conceptual behavior, by acting in a certain way" (Keller & Schoenfeld, 1950, p. 154). It is when we generalize within stimulus classes and discriminate between them that we show conceptual behavior.

Radical behaviorism is the philosophy of behavior analysis as a science. Its main goal is the description, prediction and influence of behavior as the dependent variable with the manipulation of independent variables that are part of the organism’s environment. Thus, it avoids giving a causal status to hypothetical constructs in the form of unobservable events taking place somewhere else than in the manipulable environment of the organism (Moore, 2008; Skinner, 1953).

The scientific data accumulated from cognitive psychology is of great importance in the description and prediction of human behavior, but fulfilling the goals of behavior analysis—the description, prediction and influence of behavior— requires answers to different types of why questions (Holth, 2013). The empirical data stemming from research from both cognitive psychology and behavior analysis is worthy in its own right, but the two fields are interested in different research questions based on different worldviews (Dougher, 1995; Hayes & Brownstein, 1986; Holth, 2013). A collaboration between the fields has been suggested to assure continued progress in the area of concept formation (Zentall, 1996).

Pavlovian conditioning is an important part of behavior analytic theory and application, and have played a big part in the advertisement business (DiClemente & Hantula, 2000). Furthermore, the matching law (Herrnstein, 1961) describes how the general rate of responding matches the general rate of reinforcement is another behavior analytic concept that has been applied to the understanding of choice behavior. The applications and theory of both classical conditioning and the matching law are both beyond the scope of the present article, and have been reviewed elsewhere (DiClemente & Hantula, 2000, 2003; Poling, Edwards, & Weeden, 2011). The purpose of the present paper is twofold. First to answer the challenge given by Nord (1980) by providing examples from recent behavior analytic theory and research that contribute to an understanding of variables influencing consumer behavior in complex settings. Second, examples from behavior analytic research will be provided that can account for what Rothschild and Gaidis (1981) calls high involvement cases and demands complex cognitive processing. The transfer of stimulus function will be presented and discussed as presented in the stimulus equivalence literature, and the term will be compared to the more generic term transformation of function as described in Relational Frame Theory (RFT).

Motivational Operations and Consumer Behavior

Motivations and drives are terms used to describe goal-oriented behavior. From a behavior analytic point of view, these behaviors are governed by manipulable environmental events such as deprivation and satiation. The stimulus that we have been deprived from will also acquire a reinforcing effect on our behavior (Keller & Schoenfeld, 1950; Skinner, 1974).

Recently the concept of motivating operation (MO) have been introduced as a concept to help uncover which antecedent variables that influence online consumer behavior (Fagerstrøm & Arntzen, 2013; Fagerstrøm, Foxall, & Arntzen, 2010). Michael (1982) first introduced the terms establishing and abolishing operations (EO, AO) to differentiate the discriminative and motivational functions of stimuli. EOs are antecedent procedures that results in the increased value of reinforcers and at the same time evokes responses that is followed by the reinforcers. The AO abolishes the reinforcing effects of stimuli, and abates behavior followed by them. In contrast, the discriminative functions signals the availability of a reinforcing consequence, while the EO and AO alters the reinforcing effects as well as the response rates (Michael, 1982, 1993). MOs are later introduced as a collective term for both EO and AO and with a further elaboration on the value altering effects that follows MOs (Laraway, Snycerski, Michael, & Poling, 2003). As a part of the conceptualization of the value altering effect of the MOs Laraway et al. (2003) defines the MOs as unconditioned MOs (UMOs) and conditioned MOs (CMOs). The UMOs can be described as a result of our phylogenetic endowment—our dependency on primary reinforcement such as food, water, sex and social reinforcers.

The CMOs are again divided into the *surrogate* CMO (CMO-S), the *reflexive* CMO (CMO-R) and the *transitive* CMO (CMO-T). The CMO-S can be described as the altered value of consequences under control of an MO because of the pairing with the MO. To put it in a context of consumer situation Fagerstrøm and Arntzen (2013) exemplifies this with the altered value of a café situation as a result of the café being repeatedly paired with the UMO of coffee deprivation. Eventually the café itself might evoke buying a coffee even though the original UMO of caffeine deprivation is not present. The CMO-R is described as a CMO that alters the value of its own removal or presence. It signals a worsening or an improvement of a condition (Michael, 2007). Here, Fagerstrøm and Arntzen (2013) puts this in the context of a consumer situation using the example of a customer's review of a product. The review can function as the signaling of either a worsening or an improvement of the situation of a later customer. Last, the CMO-T is a CMO that alters the value of other stimuli or situations as punishers or reinforcers. Fagerstrøm and Arntzen (2013) provides an example of online shopping, where the acquirement of one item, alters the reinforcing effect of other previously neutral items. If you purchase a cell phone, accessories compatible with that particular cell phone acquires reinforcing effects. What is common to the CMOs is that some previously neutral stimuli or events acquire their functions as a result of a pairing with UMOs, other CMOs or punishment or reinforcement (Langthorne & McGill, 2009). Research on stimulus equivalence and Relational Frame Theory have shown interest in the derived transfer of stimulus function, and how stimuli can acquire meaning or functions of other stimuli as the result of the manipulation of different procedural variables.

DiClemente and Hantula (2003) suggests that in the context of marketing research these procedures might contribute to a greater understanding of processes that results in the acquisition of stimulus functions that goes beyond the scope of classical conditioning procedures. Further, they suggest that this research is especially promising when accounting for the transfer of emotional stimulation.

In another context, Foxall (2001) adds that the research on stimulus equivalence has been one of the most significant conceptual fields in behavior analysis in the recent years. He concludes that this type of research—stimulus equivalence and the transfer and transformation of function—could be important to understand how we evaluate brands. He states that this line of research is in need for further investigations, and that the answers provided could be of both practical as well as theoretical significance.

Stimulus Equivalence

The equivalence research paradigm came as a result of a series of experiments performed by Murray Sidman and colleagues in the sixties (Rosenberger, Mohr, Stoddard, & Sidman, 1968; Sidman, 1969; Sidman & Stoddard, 1967; Sidman, Stoddard, & Mohr, 1968; Stoddard & Sidman, 1967), which led up to the canonical paper that started off the equivalence research as we know it today (Sidman, 1971). In this experiment, a 17-year or boy with learning disabilities was taught reading comprehension. The boy knew how to match pictures, colors and numbers to their auditory names, but he could not match the stimuli to their written names. With the use of conditional discrimination training in a matching-to-sample (MTS) format, the boy was trained in matching auditory words to their written words and pictures. At that time, MTS procedures were usually conducted by identity matching, which is matching stimuli that bore some physical resemblance to each other. Sidman and colleagues used MTS procedures where there were no physical resemblance between the stimuli, thus calling it conditional discriminating with arbitrary matching criteria (Sidman, 2009). This conditional discrimination training resulted in the emergence of new relations among the stimuli used in training. The boy could now match the pictures to the written words and the words to the pictures. He could even read the words aloud, without any direct reinforcement for doing so. The boy had learned to read with comprehension as an emergent result of the MTS training. The written words, spoken words and the pictures had now become equivalent to each other (Sidman, 1971, 2009).

Conditional discriminations consists of if-then relations among stimuli. MTS is a format used to present the conditional discriminations. During conditional discrimination training, a sample stimulus is presented, and choosing only one of two or more comparison stimuli occasion's reinforcement. For explanatory purposes, one often labels the stimuli used in the conditional discriminations with letters and numbers. Common to stimulus equivalence studies, the letters indicate the stimulus classes, and the numbers indicates the class membership. A conditional discrimination in a MTS format can be expressed like this: If stimulus **A1** serves as sample stimulus, choosing B1 and not B2 or B3 occasions reinforcement. The present paper will continue to abbreviate stimulus relations in this manner, by presenting the sample stimulus first in bold, then the experimentator defined correct choice in underlined together with the comparison stimuli (e.g., **A1**/B1B2B3).

During conditional discrimination procedures the three term contingency comes under contextual control of a another stimulus (Sidman, 1994). As described in the above example, the sample stimulus **A1** determines which three term contingency will occasion reinforcement. The sample stimulus is also referred to as the contextual stimulus (S^c) and the conditional discrimination can be notated as [S^c] S^D: R-S^R. This leads to an expansion of the three term contingency to a four term and possibly *n* terms (Sidman, 1994). The conditional discriminations can be presented using simultaneous matching, where the sample stimulus is present at the onset of the comparison stimuli. Delayed MTS is another variant, where responding to the sample stimulus leads to its removal, and after *n*-seconds delay the comparison stimuli are presented (Arntzen, 2006; Blough, 1959). For a review of other procedures used in generating stimulus equivalence classes see Barnes, Smeets, and Leader (1996); Dougher and Markham (1996).

Stimulus equivalence relations are described by responding in accordance to the emergent properties of reflexivity, symmetry and transitivity. These properties stems from mathematical set theory, and they are ascribed to facilitate methodological conceptualization of the behavioral definitions (Clayton & Hayes, 1999; Sidman, 1994; Sidman & Tailby, 1982). A reflexive relations is shown when the stimuli are matched to themselves, e.g., **A** to A, **B** to B and **C** to C. Reflexivity will be what is commonly referred to as identity matching (Sidman, 1990). Reflexivity is normally not tested for due to the extensive experience that humans have with identity matching, and one cannot be sure that reflexivity tests are positive due to the experimental variables, or the historical variables (Sidman, 1990, 1994). Symmetry is shown when the relation amongst stimuli are bidirectional. That is if the trained relations **A1** B1B2B3 results in the emergent **B1** A1A2A3 during testing. Transitivity is a property that requires three classes of stimuli, and can be annotated as training **A1** to B1B2B3, **B1** C1C2C3 and results in the emergence of **A1** C1C2C3. A **C** A test tests for both symmetry and transitivity, and is often referred to as an equivalence test or a combined test (Sidman, 1990). The conditional discriminations can be presented with the use of three different training structures. The above example is provided with the use of the linear series (LS) training structure (**A**B, **B**C). The one-to-many (AB/AC) training structure trains a single sample stimulus to many comparison stimuli (**A**B**A**C**),** and the many-to-one (AC/BC) structure trains several sample stimuli to one comparison stimulus (**A**C**B**C). For a recent review of how training structures and different variables influence equivalence class formation see Arntzen (2012).

The Real World and Equivalence Classes

Stimuli that constitute members of equivalence classes can—and will in most cases be—concurrently members of other stimulus classes (Sidman, 1994). In the world outside the laboratory, stimuli participate in several classes at the same time, and they need not be bound by a single modality (Fields & Reeve, 2001; Lane, Clow, Innis, & Critchfield, 1998). This is probably the fact in many complex environmental situations, where smells, sounds, tastes, tactile, visual or haptic stimuli all can participate in equivalence classes. An example here could be the voice of a relative, the relative's perfume, the picture of the relative or the actual relative, they might all constitute, or be part of one or several equivalence classes.

Fields and Reeve (2001) describes three different types of stimulus classes based on properties of the members constituting the class. First, close-ended stimulus classes are classes, which contains a given number of members that cannot be arranged alongside a specific stimulus dimension. Equivalence classes is one type of close-ended class—the stimuli in the class bear no common physical properties. Second, open-ended classes—or perceptual classes—can consist of an infinite number of members and the members are arranged alongside some stimulus dimension, either physical, psychometrically or mathematical. In addition, when a response is trained to one or some members of the class, the rest of the members will also occasion the response, and at the same time, members of no overlapping classes will not evoke the response. Finally, most of the members of the open-ended class must be discriminable from each other (Fields, Matneja, Varelas, & Belanich, 2003). Third, the authors describe generalized equivalence classes, which constitute one or several members of an open-ended class alongside members of open-ended classes. An example could be the written word “vegetable” the picture of a cartoon figure and different pictures of a carrot, where the different pictures constitute an open-ended class. Generalized equivalence classes are important in the present context because they can function as response transfer networks, causing emergent responding to a wide array of stimuli after the merging of classes. See Fields and Reeve (2001) for a more in depth discussion regarding training and testing parameters and inclusion criterions for the different types of generalized equivalence classes.

Belanich and Fields (2003) found that generalized equivalence classes could serve as response transfer networks. They conducted a study where 15 participants in three experimental groups first formed two perceptual classes where one member of each class was a member of an equivalence class, resulting in two 3-node 5-member equivalence classes. Groups 1 and 2 were exposed to a linear training structure (ABCDE) where the nodes (BCD) served as both samples and comparisons. Group 2 was exposed to a different training structure, where the nodes served only one function (**A**B/B**C**/**C**D/**D**E). The conditional discriminations resulted in the emergence of two generalized equivalence classes, where the E stimuli were members of perceptual classes. Next, responses in forms of key presses were reinforced in the presence of one member of each generalized equivalence class. The findings were that the discriminated responses trained in the presence of the members, transferred to all of the other members for all the participants in Group 1 and 2, and for 3 out of 6 participants in Group 3. Further, the authors conclude that the numbers of functions serving the nodes in the generalized equivalence classes affected the likelihood of response transfer (Belanich & Fields, 2003).

Fields and Moss (2008) conducted a study where participants formed generalized equivalence class where either one or two members of the equivalence class were also members of perceptual classes. In Experiment 3 of the study, 4 out of 5 participants formed what they term fully elaborated generalized equivalence classes. This class consists of three members (ABC) where all members also participate in open-ended or perceptual classes. These classes portray environmental relations as they occur in natural settings. They can be constructed in laboratory settings, and variables responsible for their intersection and mergence together with their ability to function as response transfer networks are manipulable (Fields & Garruto, 2009; Fields & Moss, 2008). An example could be the commercial jingle of a coffee brand, the visual logo of the brand and the scent or the taste of the coffee from the particular brand. All are perceptual classes, and could merge into a fully elaborated generalized equivalence classes (Fields & Moss, 2008).

Functional Stimulus Classes and Stimulus Equivalence Classes

A widely cited definition of a functional stimulus class is provided by Goldiamond (1962) (as cited in Sidman, 1994; Dougher & Markham, 1994) and states that stimuli in a class must share a specific behavioral function, and that contingencies applied to one or more stimuli in the class also affects the remaining stimuli in the class. Further, if discriminative stimuli outside the class would guide the same responses as the stimuli within the class, the definition would not hold much conceptual power. Again it is useful to bring up the definition of concepts by Keller and Schoenfeld (1950), conceptual behavior demands generalization within classes and discrimination between classes. Sidman (1994) sums up the definitions of a functional stimulus class as (a) stimuli within the class guide a common response, (b) stimuli outside the class does not guide the class defined response, and (c) contingencies applied to one or some members of the lass will also come to guide the rest of the members of the class. This leaves some blurred lines between functional stimulus classes and stimulus equivalence classes.

An Important Discovery

Vaughan (1988) published a study often cited in context of concept formation, and the first to demonstrate the formation of functional stimulus classes using pigeons as subjects. The subjects were six pigeons—one escaped after session 433—and the stimulus material consisted of 40 slides containing perceptually different trees that were randomly assigned into two subsets (A and B). The slides were presented successively to the pigeons in a go/no-go discrimination procedure. Within a timeframe of two seconds, pecking in the presence of slides from set A (S^D) occasioned reinforcement with access to grain. Pecking in the presence of slides from set B (S^Δ) were not reinforced. Each trial was followed by an inter trial interval (ITI) of four seconds before the next trial was presented. When the pigeon's discriminations had stabilized, the contingencies were shifted so that the slides from set A now functioned as S^Δ and the slides from set B functioned as S^R. The set contingencies were shifted back and forth several times, resulting in the transfer of discriminative functions from the early slides to the rest of the slides in the respective sets.

Based on the data at hand, Vaughan (1988) inferred that the pigeons had formed equivalence classes. The stimuli had been partitioned into two functional classes, where changes in contingencies to some of the stimuli in a set occasioned the same contingencies to emerge for the rest of the stimuli within the set. The argument was that the partitioning could infer equivalence sets. The definition of stimulus equivalence provided by Sidman and Tailby (1982) stated that the stimuli within an equivalence class, must bear the properties of reflexivity, symmetry and transitivity. Vaughan (1988) did not test for these emergent properties so the question remained unanswered.

One Step Further

Sidman, Wynne, Maguire, and Barnes (1989) wanted to investigate further on the findings from Vaughan (1988), and at the same time test for stimulus equivalence in functional classes. Three adult participants were taught simple to-choice simultaneous discriminations. The stimuli were divided into pairs, where one of the stimuli occasioned reinforcement, and the other stimulus did not occasion reinforcement. The contingencies were shifted several times, creating functional equivalence classes where the discriminative functions shifting for some members occasioned the shifts for reminding members. Sidman and colleagues went one-step further and wanted to see if the formed functional classes also consisted of the properties of reflexivity, symmetry, and transitivity. Two of the participants responded in accordance with the stimulus equivalence criteria, whereas the last participant did not. The findings from Sidman and colleagues (1989) systematically replicated the findings from Vaughan (1988), and in addition showed that the procedures that generate functional stimulus classes can also generate stimulus equivalence classes.

Even though two of the participants responded in accordance with stimulus equivalence after forming functional classes, one participant did not show the emergent properties of reflexivity, symmetry and transitivity. This caused Sidman et al. (1989) to argue that two different behavioral processes constitute the two classes. As a closing comment the authors argues that "It may turn out, for example, that the most important function of equivalence relations is to transfer new stimuli—for example, words—into already existing functional classes."(Sidman et al., 1989, p. 273). Based on later empirical findings, Sidman (1994) admitted that the third participant's failure to form stimulus classes that met criteria of the mathematical defined properties was due to methodological errors. Sidman argues that "the partition and the equivalence relation are two sides of the same coin behaviorally as well as mathematically" (Sidman, 1994, p. 447). The relationship between functional and stimulus equivalence classes is still a matter of empirical investigation, but it is suggested that the answer can be found in the selection processes governing the discriminations (Wirth & Chase, 2001). As mentioned earlier, equivalence class formation have been successful with the use of different procedural arrangements (Barnes et al., 1996). This shows that equivalence class formation holds a procedural independence (Fields, 2001), and according to Sidman (1994) the fact that equivalence can establish functional classes and vice-versa strengthens the theoretical coherence of the behavioral definition derived from set theory.

The observation that stimulus functions transferred because of class merging lead to a new focus in equivalence research, and the concept transfer of function gained a lot of attention. Sidman (1994, 2000) objects to the use of the term transfer of function, and especially when it introduced as a third variable derived from observation to explain observed processes. He states that the terms class merging and class intersection reliably accounts for the observed transfer of function effect, and that the mathematical description of equivalence relations is sufficient in its explanation. Despite Sidmans objections, the observed effects had spiked the scientific interest for equivalence research, and a link from the laboratory to the real world had been established.

The Transfer of Function

Even if the term class merging, class intersection or transfer of function is used as a description, the observed effect is shown with a variety of stimulus functions. There are several ways to conduct transfer of function experiments, but the most common way is as follows. First, a series of conditional discriminations are trained and the emergent equivalence classes are tested. When the equivalence class have been established, one member is given a specific behavioral function. The transfer of function test is conducted by presenting the other members of the class to test if they have acquired the function. It should be mentioned that there is a difference between symmetrical transfer and transfer through equivalence. For example following equivalence training and testing using the linear training structure (ABC), and a behavioral function is trained to A and then transfer is tested for by presenting stimulus B. This would be termed a transfer through symmetry. A transfer through transitivity is observed if the function is emitted in the presence of stimulus C. Transfer through symmetry is often described as a transfer through equivalence. For further discussion regarding the different transfer procedures see (Dymond & Rehfeldt, 2000). Some of the stimulus functions that has been shown to transfer or transform are respondent elicitation and extinction (Dougher, Augustson, Markham, Greenway, & Wulfert, 1994), discriminative functions (Catania, Horne, & Lowe, 1989; Dougher, Hamilton, Fink, & Harrington, 2007; Hayes, Devany, Kohlenberg, Brownstein, & Shelby, 1987), sexual arousal (Roche, D. Barnes-Holmes, Smeets, Y. Barnes-Holmes, & McGeady, 2000; Roche & Barnes, 1997), rule following (McGuigan & Keenan, 2002c), eliciting emotional functions (Amd, Barnes-Holmes, & Ivanoff, 2013), preference (Arntzen, Fagerstrøm, & Foxall, in press; D. Barnes-Holmes, Keane, Y. Barnes-Holmes, & Smeets, 2000), and ordinal functions (Green, Sigurdardottir, & Saunders, 1991).

Transfer through equivalence was observed in an study by (Hayes et al., 1987). Adult participants conducted conditional discriminations in a MTS procedures (**A1** <u>B1</u>B2, **A2** B1<u>B2</u>**,** **A1** <u>C1</u>C2 and **A2** C1<u>C2</u>) forming two equivalence classes (A1B1C1, A2B2C2). Following positive test for emergent relations, one stimulus from each equivalence class was given a discriminative function. Clapping was reinforced in the presence of B1 and waving was reinforced in the presence of B2. During transfer testing, the presentation of stimulus C1 occasioned clapping and the presentation of C2 occasioned waving. Thus, the discriminative functions trained to B1 and B2 transferred to C1 and C2 without directly training the discriminative functions in the presence of C1 and C2.

In another study by Barnes and Keenan (1993) using the same training structure (**A**B/**A**C), low rate of key pressing was reinforced in the presence of stimulus B1 and a high rate of key pressing was reinforced in the presence of B2. The rate of key pressing then transferred to the C stimuli. Low rate transferred to C1 and high rate to C2. In experiment 2 of the same study, it was also shown that the high and low rates of key pressing transferred to novel stimuli that was physically similar to the C stimuli (Barnes & Keenan, 1993). This can be an important finding when trying to account for how stimuli in perceptual classes can acquire novel functions.

The two above experiments show how discriminative functions can transfer as the result of equivalence class formations and function training to a member of the class. In the light of consumer behavior, one could imagine the discriminative functions of picking a specific product of a category based on some acquired discriminative functions could transfer to other members of the category. If a category of products is mutually interchangeable in a context, then contingencies applied to one of the members can come to transfer to the other members as well.

Dougher et al. (1994) conducted a study showing the transfer of respondent elicitation, extinction and reconditioning. A MTS procedure was used to introduce conditional discriminations in a one-to-many training structure (AB, AC, AD). The conditional discriminations resulted in potential two 4-member equivalence classes (A1B1C1D1, A2B2C2D2). A third stimulus set (A3, B3, C3, D3) was used as a dummy set. The stimulus set used as a dummy set was solely used as incorrect comparison stimuli during training, and was never used during testing or conditioning. After the eight subjects had responded in accordance with stimulus equivalence on a test, a Pavlovian conditioning procedure was implemented, pairing B1 with a mild electric shock. Skin conductance was used as measurements of the dependent variable. In a transfer test, six out of eight participants showed greater skin conductance when presented with stimuli from the same class as the conditioned stimulus B1 (C1, D1). The A stimuli were not presented during the transfer tests, because skin conductance in the presence of the A stimuli could be interpreted as higher-order respondent conditioning. The same procedure was followed in Experiment 2, but after the conditioning procedure and transfer test, a respondent extinction procedure was implemented. When the shock was reconditioned to B1, the reconditioning effect was seen for all the participants. The transfer tests showed that not only respondent elicitation but also respondent extinction could transfer following the implementation of the extinction procedure to only one member of the stimulus class. Finally, reconditioning following the extinction would lead to a new transfer of function to all members (Dougher et al., 1994).

This procedure points to important clinical aspects of the derived transfer of stimulus function. It also contributes to help understand how previously neutral stimuli and situations can come to elicit and evoke fear and avoidance behavior without any direct conditioning. To understand these behavioral processes can contribute widely to help treatments and learning in clinical settings (Dougher, 1998). To put this in the context of consumer behavior, one would have to presume that respondent elicitation with positive behavioral functions also could transfer to words, pictures and context of stimuli that participates in equivalence relations. Words enter into the equivalence relations, and comes to acquire the behavioral functions of the stimuli in the class (Sidman, 1994).

In extension of the study by Dougher et al. (1994) Amd et al. (2013) incorporated the use of electroencephalograms (EEG) as an supplementary measure of the derived transfer of emotive functions. EEG is a measurement tool that is used to measure the change in electrical activity in the brain. Event-related potentials (ERPs) represents EEG measurements that signals specific electrical activity correlated with behavioral, cognitive and emotional events. Twelve participants formed three 3-member equivalence classes. Next, images containing presumed positive emotional effects were paired with A1, neutral emotional images were paired with A2 and negative emotional images were paired with stimulus A3. Participants were then presented with forced choice situations where stimulus A1, B1, C1, A2, B2, C2, A3, B3, C3 were presented together with non-related A4, B4, C4 stimuli. The EEG measurements functioned as an additional measurement, supporting the observation that the emotive effects of valenced stimuli could transfer to other members of equivalence classes (Amd et al., 2013).

Rule following or instructional control governs a big part of our everyday behavior (Poppen, 1989; Skinner, 1974). McGuigan and Keenan (2002a) found that when stimulus A1 and A2 consisted of written instructions in two 3-member equivalence classes, the responding in accordance to the written instructions transferred to the B and C stimuli. (Barnes-Holmes, Hayes, Dymond, & O’Hora, 2001). The inclusion of rule-governed behavior as a function that can emerge to stimuli in equivalence classes, contributes to the environmental explanatory aspect of behavior controlled by stimuli that participates in equivalence classes.

The Transformation of Function

In a study by Dougher et al. (2007) participants were trained to respond to symbols that arbitrarily represented relations among stimuli in the frame of comparison. Participants were trained to choose the smallest of three shapes in the presence of one abstract symbol (A), then to pick the middle sized shape in the presence of a second abstract symbol (B) and to pick the largest shape in the presence of a third abstract symbol (C). This procedure established the previously abstract symbols as contextual cues for initiating relational responding in the frame of comparison amongst stimuli. After the relational responding training, the participants were trained to emit a medium rate of key pressing in the presence of the B stimulus. Following the bar press task, a respondent conditioning phase was conducted. The B stimulus served as a conditional stimulus for shock as the unconditional stimulus. Skin conductance was used as a measurement of the dependent variable. Next the A stimulus was presented to the participants, and the voltage of the shock presented was half the amount of the voltage used for conditioning with the B stimulus. This was done to prevent the stimuli from being partitioned into two classes. One class signaling shock (B) and two classes without (A, B). Following a 90-s ITI a C stimulus was presented. Due to the possibility of respondent extinction, the C stimulus was presented only once. Six out of 8 participants produced ha higher level of skin conductance in presence of the C stimuli, which was also connected to the relational training. Thus the skin conductance level was not only transferred, but the stimulus function had transformed into eliciting a greater amount of skin conductance as a result of the relational training.

The transformation of stimulus function is a defining feature of arbitrarily applicable relational responding as described in the Relational Frame Theory literature. Stimulus equivalence is just one of several relational frames, and is often referred to as sameness or coordination. Other relational frames described by RFT are hierarchical relations, temporal relations, spatial, conditionally and causal, deictic, opposition and comparison. To illustrate, the frame of Comparison governs relational responding such as bigger - smaller, faster - slower, better - worse. An illustration of this can be training A larger than B and B larger than C which results in the derived relations A smaller than B, A smaller than C, C larger than A etc. (Hayes et al., 2001).

The relational frames in RFT are defined by the three properties of mutual and combinatorial entailment and the transformation of function. Mutual entailment is synonymous to symmetry in equivalence research, and refers to the derived bidirectionality of stimulus relations. In a given context, if A is better than B then B is worse than A in that context. Combinatorial entailment refers to the instances where two or more stimulus relations either trained or derived; it can be seen as a generic term for transitivity as used in equivalence research. If in a given context A is related to B and B is related to C, then the same context governs the mutually entailment of A and C (Hayes et al., 2001). Thus, mutual and combinatorial entailment are particular kinds of transformation of function (Dymond & Rehfeldt, 2000).

When reading a review of products, one might obtain information stating that product A is better that product B and product B is better than product C. The combinatorial entailment of A > B and B > C might one to derive that product C is worse than product A and the combinatorial entailment might cause one to derive that product B is worse than product C. Thus the stimulus functions of the stimuli are transformed in accordance with their participation in the relational frame (Barnes-Holmes et al., 2001). The transformation of stimulus function is a more generic term than the transfer of function in the notion that functions can transform in accordance with the relational frames (Dougher et al., 2007) . Dymond (2001) states that when all the functions of one stimuli transfers to another, the two different psychological stimuli would not exist anymore. RFT have been met with some critique regarding conceptual issues and explanatory features of the theory (Palmer, 2004), but the experimental data are important in their own right.

Future Directions and Concluding Comments

The reason this paper is pointing towards to consumer behavior is not due to the notion that the world suffers from a lack of consumerism and profit seeking. Consuming is behavior and it has a great impact on both our personal life and on our global community. Our consumer choices are determined by short termed individual consequences, but changes towards how we respond towards categories of objects for example buying green, or buying healthy indirectly relates to accumulated long term positive consequences—not just on the individual level (Layng, 2010). However, it has been questioned whether we can consume our way out of a climate change (Grant, 2011). It can be agreed upon that the way we consume is not always in the best interest, but to ignore the problem is not the solution.

The present paper sought to present recent behavior analytic contributions to understand apparently novel and unreinforced behavior in complex natural settings. First, the concepts of MOs generally and CMOs especially were UMOs as a result of repeated pairings with natural situations can result the transfer of motivating effects from UMOs to previously neutral setting. The response altering and reinforcing altering effects of the CMOs can help us uncover antecedent environmental variables exerting control over behavior in complex situations without giving causal status to unobservable events. The CMO account for behavior in consumer situations can be sees as a conceptual contribution to understand motivation. (Fagerstrøm & Arntzen, 2013; Fagerstrøm et al., 2010). So far the empirical contributions are few (Fagerstrøm et al., 2010; Fagerstrøm & Ghinea, 2011) but findings indicate that price holds a high motivating effect towards frequent shopped items (Fagerstrøm & Ghinea, 2011). This knowledge could guide governing agencies to provide tax incentives and lower prices on frequently purchased goods that holds either a higher environmental friendly standard, or healthier alternatives. Future research could investigate and compare other variables such as price and carbon footprints and price and nutrition information.

Generalized equivalence classes has shown to provide a solid representation of how stimulus networks consisting of cross modal, open-ended and close-ended stimulus classes can provide a window from the laboratory and into the real world. Adding the empirical observations that these classes can function as response transfer networks, provides great a solid conceptual advantage. This allows us to account for behavior that seems to emerge without any prior history of reinforcement. In addition, it is useful to extend the knowledge about how stimuli can acquire functions because of their history of reinforcement with other stimuli (Belanich & Fields, 2003; Fields & Garruto, 2009; Fields & Moss, 2008; Fields & Reeve, 2001).

Combining the knowledge about generalized equivalence classes and the transfer and transformation of stimulus functions could open up for future research towards environmental variables affecting consumer behavior and preferences. It is shown that respondent functions can transfer to members of an equivalence class including positive emotional functions (Amd et al., 2013; Barnes-Holmes et al., 2000; Dougher et al., 1994). Possible future experiments could establish equivalence classes with the use of abstract symbols and expand the existing classes with different types of valenced stimuli. Then transfer tests could be conducted by labeling the previously neutral stimuli on different products to see if any discriminative effects would transfer and influence preference towards the previously neutral symbols. Another variant of this procedure could be done following the procedure from (Amd et al., 2013) by using Pavlovian conditioning. A member of an equivalence class could be repeatedly paired with a positive valenced stimulus, and the abstract class members could be evaluated through different procedures such as preference tests. Further, research could be done in large-scale situations such as schools or kindergartens. For example, children could be introduced to conditional discriminations establishing classes that consists of pictures of different types of garbage, and the respective trashcan it belongs to and smiley figures. This might also occasion the generalization to other types of trash in the same category, and appropriate recycling could emerge to the objects without direct reinforcement. Even if this is not an example of consumer behavior, it just depicts how these procedures could be implemented to generate novel and untrained relations after the direct reinforcement some. The reasons to engage in translational research are many, and it is important for the wellbeing of the science (Critchfield, 2011; Poling & Edwards, 2011)

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Stimulus Equivalence, Preference and the Transfer of Function in a Choice Setting

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Abstract

The present study investigates the role of training different valenced stimuli to the nodes in equivalence classes on the influence of preference towards abstract class members in a choice situation. In Experiment 1, conditional discriminations was used with a one-to-many (AB/AC) training structure to establish three 3-member equivalence classes for two groups. The 20 participants in first group, novel D1, D2 and D3 stimuli consisting of the weather chart symbols sun, cloudy, and rain respectively were trained to the A1, A2 and A3 stimuli. For the 20 participants in the second group, the three D stimuli consisted of neutral pictures. All participants established three 4-member equivalence classes. The B stimuli (B1, B2, and B3) were attached to three water bottles, and the participants were told to pick a bottle. In the Weather Group, 55 % picked the bottle equivalent to the sun symbol, whereas 25 % picked B2 (cloudy) and 20 % picked B3 (rain). In the Neutral Group 35 % picked B1, 30 % B2, and 35 % picked B3. With the same procedure, Experiment 2 investigated the effects of using monetary symbols of different values as D1, D2, and D3 stimuli of highest, middle and lowest value respectively. 45 % picked B1, 40 % picked B2 and 15 % picked B3. The same procedure was followed in Experiment 3, but with another stimulus set, and different monetary symbols with the same value range In addition, the participants picked a bottle before and after the conditional discriminations to establish a baseline. Five participants picked B1, one participant picked B2 and two participants picked B3. Four participants changed their baseline choice to bottle B1. Experiment 4 assessed the valenced and neutral stimuli used in Experiment 1, 2, and 3 by exposing 20 participants to similar choice situations, but with the D stimuli attached to the bottles. Results indicate that preference can be influenced to a certain degree, but the use of supposedly valenced stimuli is unpredictable.

Key words: Stimulus equivalence, one-to-many, preference, transfer of function, choice

Stimulus-Equivalence, Preference and the Transfer of Function in a Choice Setting

Preference can be described as the distribution of responding towards one object or situation more frequently than towards other objects or situations. Behavior analytic approaches towards studying preferences and choice have usually been conducted with the use of concurrent schedules of reinforcement (Pierce & Cheney, 2008). A concurrent schedule procedure is conducted by having two reinforcement schedules operating concurrently under two response keys. Varying the intervals or the ratio requirements leads to proportional change in rate of responding. Choice or preference can be measured as the rate of responding towards any of the signaled schedules (Catania, 1963). Herrnstein (1961) found that the relative rate of responding matched the relative rate of reinforcement when the pigeon's key pecks were reinforced on a two key concurrent schedule operating on variable interval (VI) schedules. The relative rate of key pecking changed in accordance with the relative rate of reinforcement provided by the schedule at work. If Schedule A provided 70 % of total reinforcement and schedule B provided 30 % of total reinforcement then 70 % of the total amount of key pecking would be distributed to schedule A and 30 % of total amount of key pecking would be distributed towards key B. Herrnstein's findings were replicated and developed and later became a principle of behavior known as the matching law (Herrnstein, 1970; Poling, Edwards, & Weeden, 2011).

Even if theories differ regarding the nature of preference and how it is established, it is agreed upon that preference and choices are directly linked (Rachlin, 1989). For example, It has been argued that our preferences influencing seemingly trivial everyday choices might play an indirect or direct part in both our health and global environment (Dannenberg et al., 2003). We choose to have one more drink or a class of water, we choose to recycle or not to recycle, we choose foods high in calories fats and sugars over more healthy alternatives. Related to unhealthy eating, Lowe and Horne (2009) used the term *obesogenic* to describe the state of the environment many lives in. The term refers to an environment that by exposure to commercials and availability encourages people to unhealthy eating and living (Moodie, Swinburn, Richardson, & Somaini, 2006).

How words and objects come to represent each other, and meanings can be transferred from objects to words or words to objects is the focus of stimulus equivalence research (Sidman, 1994; Sidman, Wynne, Maguire, & Barnes, 1989). Stimulus equivalence classes consists of stimuli where the relations amongst stimuli holds the emergent properties of reflexivity, symmetry and transitivity (Sidman & Tailby, 1982). If **A** is related to <u>B</u> then the symmetric relations of **B** related to <u>A</u> can be derived. If training **A** relates to <u>B</u> and **B** relates to <u>C</u>, then the transitive relation of **A** related to <u>C</u> can be derived. Reflexive properties are shown when stimuli can be related to themselves as in generalized identity matching. When stimuli enter into equivalence classes, we act towards one stimulus in an equivalence class in the same manner as we do to the other stimuli in an equivalence class (Sidman, 1994).

When stimuli enter into equivalence classes, they can acquire the specific behavioral functions that represent the class. Moreover variables applied to one member of the category can transfer to the other members of the same equivalence class (Dougher & Markham, 1996). This observed effect has been termed the *transfer of function*. See Sidman (1994, 2000) for an objection against the use of the term transfer of function. Sidmans objections roots mainly in the fallacy of observing a behavioral process and later naming the process and use the label to account for the observed phenomenon. Sidman argues that the term intersection and merging of stimulus classes sufficiently accounts for the observed function transfer (Sidman, 1994). The term transfer of function will be used in the present paper not as an explanation of behavioral processes, but as a description of the observed transfer of a stimulus function independent of the stimulus function representing the class. Further, the effects observed are results of the implementation of environmental procedures.

There are several studies that have investigated the establishment, influence, alternation or reversing of preference with the use of transfer of function designs. Some of the preferences that have been investigated includes racial attitudes (De Varvalho & De Rose, 2014; Dixon, Rehfeldt, & Robinson, 2006), the influence and alteration of preference for soft drinks (D. Barnes-Holmes, Keane, Y. Barnes-Holmes, & Smeets, 2000; Smeets & Barnes-Holmes, 2003) , the influence of preference towards previously meaningless stimuli (Bortoloti & De Rose, 2009, 2011, 2012; Bortoloti, Rodrigues, Cortez, Pimentel, & De Rose, 2013), influence of preference towards food names (Straatman, Almeida, & De Rose, 2014), and the influence of preference towards meaningless stimuli in an choice situation (Arntzen, Fagerstrøm, & Foxall, in press). The results from the above mentioned could be socially important, but the findings are variable, and the critical variables should be investigated further.

Stimuli with positive or negative valence for the participants have been observed to infer and hinder responding in accordance with stimulus equivalence. These findings indicate that the discriminative functions of one member of an equivalence class, can come to affect other stimuli in the class. The discriminative functions of valenced D-stimuli, depends on the learning history of the subject with the specific stimulus. Watt, Keenan, Barnes-Holmes, and Cairns (1991) found that equivalence formation for Protestant participants were hindered when the stimuli consisted of Catholic names (A), nonsense syllables (B) and Protestant symbols (C). The participants learning history with the valenced D-stimuli affected responding in accordance with stimulus equivalence. This indicates that stimuli that holds many discriminative functions and later enters into equivalence classes, might affect responding towards other members of the class.

This was found in a study by D. Barnes-Holmes et al. (2000), where individuals preference for cola-based drinks were influenced as a result of a conditional discrimination procedure with a valenced stimulus. Potentially two 3-member equivalence classes were established with conditional discriminations. The first equivalence class consisted of the nonsense syllable VEK the word CANCER and BRAND X and the second class consisted of the nonsense syllable ZID the word HOLIDAY and BRAND Y. When the classes had been confirmed through a test for derived relations, two similar cola based drinks marked BRAND X and BRAND Y were presented to the participants. The participants rated the cola based drinks labeled with BRAND Y (HOLIDAY) significantly better than the cola based drinks labeled with BRAND X (CANCER). In Experiment two of the same study, they found similar results, but without conducting a test for derived relations. Finally in Experiment three, they found that they could reverse the preferences by reversing the conditional discrimination procedures.

In a similar study, but replacing the emotive words with valenced pictures, Smeets and Barnes-Holmes (2003) influenced children’s preference towards the same soft drink in two experiments. The procedure was conducted by first establishing potential two 3-member equivalence classes (A1B1C1, A2B2C2) where the A1 stimulus was a picture of a smiling, cartoon character, and the A2 stimulus was the picture of a crying child. Next the C1 and C2 stimuli were used as labels on two samples of the same soft drink. The children were asked which soft drink they wanted to taste first, and later on asked which drink they preferred. The children were also asked which picture they liked the most (A1 or A2). Across both experiments 29/32 of the children first wanted to taste the soft drink in the class with the preferred picture. 26 children responded that they preferred the drink with the label from the preferred picture class. The results are consistent with findings from D. Barnes-Holmes et al. (2000) where the emotive words CANCER and HOLIDAY differently influenced the preference of the same soft drink.

Straatman et al. (2014) found that the preference towards food names could be influenced through conditional discriminations using first one smiling male face and two neutral faces—one female and one male—as A1, A2, and A3 stimuli for the first experiment. The second experiment implemented schematic faces (smiling, neutral, and sad) as A1, A2, and A3 respectively. The faces for both experiments were trained to abstract symbols (B1, B2, B3, C1, C2, and C3) and food names (D1, D2, and D3). The pleasantness towards the foods was tested prior to, and after the beginning and at the end of both experiments. In Experiment 1, the participants evaluated the foods that were in an equivalence class with the happy male face and the neutral female face more positive than the food names equivalent to the angry face, but the authors reported high variability in the results. In Experiment two, a delayed matching-to-sample (DMTS) procedure was introduced together with schematic faces. Findings show that the food in the equivalence class with the happy faces scored higher on the pleasantness rating than foods equivalent to the sad face.

In the above-mentioned studies, the valenced meaningful stimuli were trained into the equivalence classes from the beginning of the conditional discriminations. Arntzen et al. (in press) influenced the preference towards previously neutral objects in a consumer choice setting by expanding equivalence classes with three valenced D-stimuli. 16 participants first established three 3-member equivalence classes. With a positive outcome on the test for stimulus equivalence, the three classes were expanded with different D-stimuli (D1, D2 and D3). A smiley face (D1) a neutral face (D2) and a sad face (D3) was trained to the node (**D1**/<u>A1</u>, **D2**/<u>A2</u> and **D3**/<u>A3</u>). Following the class expansion, the participants were presented with a choice setting. The B stimuli (B1, B2, and B3) were attached to three water bottles. The participants were told to pick a water bottle. 13 out of 16 participant picked the bottle labeled B1, which was equivalent to

D1 (smiley). This study is the first reported to influence preference in a consumer-based situation.

It has been argued that positive facial expressions are recognized faster than negative facial expressions (Leppanen & Hietanen, 2004). Others have claimed that emoticons activate the same neural networks as real face expressions (Churches, Nicholls, Thiessen, Kohler, & Keage, 2014). Straatman et al. (2014) found that the schematic smiley faces caused a more consistent transfer than the non-schematic faces. The findings have been replicated in the Arntzen et al. (in press) study showing a transfer of function using schematic faces (smile, neutral, and sad). Faces, either schematic or human, have been evaluated in several studies assessing the preference towards meaningless members of equivalence classes (Arntzen et al., in press; Bortoloti & De Rose, 2009, 2011, 2012; Bortoloti et al., 2013; Straatman et al., 2014), studies that have evaluated other types of valenced D-stimuli (Ferro & Valero, 2008) and words (Ferro & Valero, 2006) have provided variable results.

The present study consist of 4 experiments conducted as systematic replications (Sidman, 1960) of the study by Arntzen et al. (in press). Experiment 1 will investigate the effects of using valenced D-stimuli for an Experimental Group, and supposed neutral stimuli for a Neutral Group. Based on the findings from Arntzen et al. (In press), the predictions would be that a higher degree of transfer effects would be obtained for the Experimental Group over the Neutral Group. Further, it could be predicted that for the Neutral Group, the choices would be equally divided amongst the three water bottles. The purpose of Experiment 2 is to further investigate the effects with different types of D-stimuli. This experiment will use D-stimuli consisting of monetary symbols with different values. To avoid that any possible transfer effects could be a procedural artifact attributed to the topographical features of the abstract stimuli, the stimulus set in Experiment 3 will be changed. Further Experiment 3 will implement a transfer baseline procedure, exposing the participants to the transfer test before and after the experimental procedure (Credited Lanny Fields in a footnote on page 247 in Dymond and Rehfeldt, 2000). Bortoloti and De Rose (2011) used a Control Group to assess rating of the facial expressions on the human facial stimuli used for the Experimental Group. Experiment 4 in the present study will expose an Control Group to 4 choice situations where the D-stimuli used in Experiments 1, 2, and 3 will be assessed.

Experiment 1

Method

Participants. Forty participants, 28 females and 12 males with a mean age of 25 years completed all experimental phases. Five additional participants did not pass the test for derived relations, and their data were not included in the dataset. The participants were recruited through personal contacts and at lectures at Oslo and Akershus University College. The participants were randomly assigned to one of two groups, with 20 participants assigned to each group. Upon completion, all participants were fully debriefed, and any questions they had regarding the study was answered.

Apparatus and setting.

Setting. The length of the experimental sessions varied from 25 to 85 minutes and the mean session length was 48 minutes. The experiments took place in the Experimental Studies of Complex Human Behavior lab at Oslo and Akershus University College. Participants were seated in cubicles that varied in size from 1.3m x 3.2 m to 5.2 m x 4.3 m. The cubicles were furnished with a table and a chair, and all the walls surrounding the participants were blank.

Apparatus. The experiments were conducted on HP Elitebook laptop computers with Intel Core i5 processors and a Windows 7 operating system. The computers had 17-inch screens and external Dell computer mice were used to control the mouse cursor. Cognitive Science

Partners in collaboration with Professor Erik Arntzen wrote the matching-to-sample software used to conduct the conditional discrimination training. The software contained the parameters responsible for the conditional discrimination training and testing, including the presentation of stimuli and class expansion. The software program conducted automatic data recording, including number of trials, trial types, correct or incorrect trials and reaction times. Reaction times were recorded for both responding to the sample stimulus and responding to the comparison stimuli. Recording of the participants verbal reports were done manually on report sheets designed for the experiments. The report sheets contained information about participant number, which choice the participants had made, which experimental group they belonged to, and what they reported on their choice.

Stimuli. Figure 1 shows the stimulus set used by the Weather Group and Figure 2 shows the stimulus set used by the Neutral Group. The D1, D2 and D3, stimuli varied between the groups. For the Weather Group the D-stimuli consisted of weather chart symbols where D1, D2, and D2 were colored symbols of the sun, cloudy, and rain/lighting respectively. For the Neutral Group, the D-stimuli consisted of three different pictures of the dikes in Holland. The D-stimuli varied on colors in accordance with the symbols they pictured, and were presented on a white background. The A, B, and C-stimuli were abstract symbols consisting of Arabic, Cyrillic and Hebraic letters and were presented in black printing on a white background. Each stimulus varied in size from 2.6 cm to 5.7 cm in with and from 0.8 cm to 3.7 cm in height. Each stimulus had a pressure sensitive rectangular area around it which was 10.5 cm in with and 3.7 cm in height. The area was not visible to the participants.

The bottles used for the choice situation was three neutral plastic see through bottles with water inside (see Figure 3). The bottles had black screw caps. The label of the bottles had been removed, and replaced with a white label with a picture of stimuli B1, B2, and B3 on them. The labels were 9 x 5 cm in size and the stimuli varied from 4, 3 to 6, 4 cm in height and 4, 3 to 3, 2 cm in width. The bottles were 21, 3 cm in height and 20 cm in circumference and they contained half a liter of water. The bottles were placed on a table in front of the participants, with approximately 3–4 cm between the bottles. The bottles were placed in a random order for each participant, by shuffling the bottles after each participant.

Design. The current experiment was performed in a quasi-random posttest-only design with an nonequivalent control group (Shadish, Cook, & Campbell, 2001). The Participants were randomly allocated to the two groups based on their availability for participation. For the Weather Group the three 3-member equivalence classes were expanded with D-stimuli consisting of weather chart symbols. For the Neutral Group the three 3-member equivalence classes were expanded with supposedly neutral valenced D-stimuli, consisting of three pictures of the dikes in Holland.

Procedure. After their arrival the participants were handed a consent form which contained general information about who was conducting the experiment, approximate length of the experimental sessions, and that it was an experiment within the field of learning psychology. Further the document stated that the participants could withdraw from the experiment at any time, and that they would remain anonymous. The document also stated that if the participants had any questions regarding the experiment, they could make contact. The participants were asked to sign the consent form before they could proceed with the conditional discrimination training.

The participants were seated facing the laptop computer-screen featuring the instructions for the experiment. The instructions were as following:

> Thank you for participating in this experiment. This is an experiment in the field of learning-psychology, and it requires no prior knowledge regarding the use of a computer. In brief, you are supposed to click on the stimuli that appears on the screen. The goal is to

> make as many correct choices as possible. When moving the cursor on top of the stimulus appearing in the middle of the screen and clicking it, three other stimuli will appear on the screen. Mouse-clicking on the correct one will result in the written words "Correct", or "Good" on the screen. If you click on the wrong one, the words "Wrong", or similar will follow. It is the way you find out what is right and wrong. After a while the words will no longer appear, but you should always click on the stimulus in the middle before you click on the ones in the corners. Good Luck!

The participants were asked if they had any questions regarding the instructions or the experiment in general. The participants were told that they could ask the experimentator at any time if they had any questions. Further the participants were informed that questions regarding the experiment beyond the information that had already been provided by the consent form and the instructions could not be answered, but the information from the instructions could be repeated as they were. The participants were informed that when the experiment was over, it would say so in the screen, and the program would tell the participants to go and get the experimentator.

Conditional discrimination training. When the participants had pressed the begin experiment box at the bottom of the screen, a sample stimulus appeared in the middle of the screen. When the participants used the mouse to move the mouse cursor on top of the sample stimulus and clicked it, three comparison stimuli appeared in three of the four corners of the screen. The positioning of the stimuli was randomized so that the empty corner of the screen varied from trial to trial. The positions of the comparison stimuli were also randomized by the computer program. When the participants clicked one of the comparison stimuli, all four stimuli disappeared followed by the programmed consequences, which consisted of the Norwegian words "Supert", "korrekt", "Bra" (which followed the defined correct choice) or the word "feil" (which followed the defined incorrect choice). The presentation of the programmed consequences lasted for 1000ms. After the presentation of the programmed consequences followed an inter-trial interval (ITI) lasting for 1000ms. After each trial, the mouse cursor was repositioned to the middle of the screen, slightly above the sample stimulus. The conditional discrimination training was employed using a one-to-many (OTM) training structure (AB/AC) in a simultaneous protocol with a concurrent training order. The OTM training structure provides stimulus relations A to B and A to C, and can be exemplified as **A1**/B1-B2-B3 and **A1/**C1-C2-C3 where the underline represent the defined the correct comparison choice in relation to A1 as sample stimulus. When using a concurrent training order, a mix of AB and AC baseline trials are presented in blocks of 30 trials per block. Each relation was presented three times, and the trained relations were **A1/**B1-B2-B3, **A2**/B1-B2-B3, **A3**/B1-B2-B3, **A1**/C1-C2-C3, **A2**/C1-C2-C3, **A3**/C1-C2-C3**.** The simultaneous training and testing protocol trains all the relations before presenting all the baseline relations together with tests for symmetry and equivalence test trials in one test. The programmed consequences were thinned through training blocks contingent on meeting the requirements for correct responding per block. The criterion was set to 90% correct per block, which is a total number of 27 correct trials per block of 30 trials. If the criterion was not met for one block, the block was repeated until mastery. The presented relations were randomized even in repeated blocks. The thinning steps were 75%, 50% and 0% before the test was employed.

Testing. The testing of derived and baseline relations was introduced following the last block of training with 0 % programmed consequences meeting the criterion. The testing was conducted without any programmed consequences. The test consisted of 90 trials, wherein 30 baseline trials, 30 equivalence trials and 30 symmetry trials. The criterion for responding in accordance with stimulus equivalence was 90% correct to the baseline, symmetry and equivalence trials. The trial types were randomly presented in the test block. The testing trials consisted of a mixed presentation of the baseline relations: **A1/**B1-B2-B3, **A2**/B1-B2-B3, **A3**/B1-B2-B3, **A1**/C1-C2-C3, **A2**/C1-C2-C3, **A3**/C1-C2-C3. Symmetry relations **B1**/A1-A2-A3, **B2**/A1-A2-A3, **B3**-A1-A2-A3, **C1**/A1-A2-A3, **C2**/A1-A2-A3, **C3/**A1-A2-A3. Equivalence relations: **C1/**B1-B2-B3, **C2/**B1-B2-B3, **C3/**B1-B2-B3, **B1**/C1-C2-C3, **B2**/C1-C2-C3, **B3/**C1-C2-C3.

Class expansion. The participants who did not respond in accordance with stimulus equivalence on the test, were debriefed and thanked for their participation. The participants who responded in accordance with the set criterion continued to the expansion phase without any halt in the procedure. The expansion stimuli were D1, D2, and D3 and were trained to the A1, A2, and A3 nodes respectively. The D1, D2, and D3 stimuli consisted of the weather chart symbols sun, cloudy and rain respectively for the Weather Group, and for the Neutral Group the D-stimuli consisted of three pictures of the dikes in Holland. The training was performed in a block of 15 trials, where each relation was trained five times. The presented relations were: **D1**/A1-A2-A3, **D2**/A1-A2-A3 and **D3**/A1-A2-A3. The class expansion phase was performed with 100% programmed consequences, and without thinning of programmed consequences. The criterion was of 90% correct, which is 14 out of 15 trials. If the participants did not meet the required criterion, the block was repeated until mastery.

Testing. When participants met the criterion in the expansion phase, a second test for emergent relations was employed. The second test tested for all the trained and emergent relations in both training phases, and consisted of a total of 180 trials divided into 45 baseline relations, 45 symmetry relations and 90 equivalence relations. The tested relations consisted of the same relations as in the previous test described above, but including the baseline relations **D1**/A1-A2-A3, **D2**/A1-A2-A3, **D3**/A1-A2-A3. Symmetry relations: **A1/**D1-D2-D3, **A2/**D1-D2-D3, **A3**/D1-D2-D3. Equivalence relations: **D1/**C1-C2-C3, **D2/**C1-C2-C3, **D3/**C1-C2-C3, **D1/**B1-

B2-B3, **D2**/B1-<u>B2</u>-B3, **D3/**D1-D2-<u>D3</u>, **C1**/<u>D1</u>-D2-D3. **C2/**D1-<u>D2</u>-D3, **C3/**D1-D2-<u>D3</u>, **B1/**<u>D1</u>-D2-D3, **B2/**D1-<u>D2</u>-D3, **B3/**D1-D2-<u>D3</u>. As before, there were no programmed consequences in the testing phase, and all 180 trials were presented in one block. The criterion for responding in accordance with stimulus equivalence was 90% correct to each of the baseline, symmetry and equivalence relations.

Choice setting. When the last test was finished, the text "Congratulations, you can now go and get the experimentator" appeared on the screen. When the participants called the experimentator, they were told to go in to the booth next to where they had been sitting, and to pick a bottle and to give it to the experimentator. The participants were not visible to the experimentator during the choice situation to avoid bias. All the participants were asked "why did you pick that bottle". The participant reports were written down. The written reports were restricted to the first answer the participants gave on the question, to minimize the chance of influencing their answer. The bottles were put back in place and shuffled after each participant had left the session. If the participants did not meet the criterion for emergent relations on the last test, their results were not included in the data set, but they were still exposed to the choice setting and debriefed.

Sequence of experimental phases for experiments 1, 2, and 3.

Phase 1. Initiation of the conditional discriminations in a simultaneous MTS format using the simultaneous protocol in an OTM format (AB, AC).

Phase 2. The test for emergent relations. Participants who did not reach the mastery criterion of 90% correct on the test, were thanked for their participation, and debriefed. The participants who passed the test, automatically proceeded to Phase 3.

Phase 3. Class expansion phase, training the D-stimuli to the A-stimuli. There were no thinning of consequences for this phase, but the phase ended as soon as the mastery criterion was reached.

Phase 4. Second test for emergent relation, testing for the formation of four 3-member equivalence classes.

Phase 5. Choice situation

Phase 6. All participants were debriefed and any questions they had regarding the experimental situation were answered.

Results and Discussion

See Table 1 or an overview of the results for the Weather Group, and see Table 2 for an overview of the results for the Neutral Group. The column to the right of the participant numbers show the total amount of trials (Tot trials). The columns marked with baseline (Bl), symmetry (Sy), and equivalence (Eq) show number of correct test trials of total number of possible correct test trials for each trial type. The first three columns represent the trail types presented in the first test for emergent relations, and the last three columns represent the second test for emergent relations which include the D-stimuli used in the class expansion phase. The column named choice indicate which bottle the participant chose, whereas B1, B2, and B3 represent the B stimulus labeled on the bottle. The Symbols columns indicate which D-stimulus that was trained into the same class as the B-stimulus chosen.

Training and testing. All 20 participants in both groups responded in accordance with the defined criterion of 90 % correct on baseline, symmetry and equivalence relations on both tests for emergent relations. For the Weather Group, the mean number of training trials to establish the equivalence relations was 270 trials, ranging from 180 to 780. The mean total number of trials was 566 ranging from 465 to 1080. For the class expansion in Phase 4 the number of training trials ranged from 15 to 30. For the Neutral Group, the mean number of training trials to establish equivalence relations was 287, ranging from 180 to 510 trials. The mean total number of trials was 579. For the class expansion in Phase 4 the number of training trials ranged from 15 to 30.

Preference. In the Weather Group, 11 of the 20 participants (55 %) chose the bottle labeled with stimulus B1 that was equivalent to the sun symbol. Next, five out of 20 chose bottle B2 (25 %), and four out of 20 chose bottle B3 (20 %). This shows a highest number of choices towards the B1 bottle over B2 and B3. A chi-square test of goodness-of-fit was performed to determine whether the three bottles were equally preferred. Preference for the three sodas was not equally distributed in the group, but the difference was not statistically significant, $\chi 2$ (2, N = 20) = 4.300, $p = .116$. Even though the choice allocation towards bottle B1 over B2 and B3 was not statistically significant, the trends show a tendency towards picking bottle B1 over B2 and B3.

In the Neutral Group, seven out of 20 participants chose the bottle labeled with stimulus B1 (35 %), six participants chose bottle B2 (30 %), and seven participants chose bottle B3 (35 %). This observation supports the hypothesis that choices would be randomly allocated amongst the bottles if the D-stimuli were neutral pictures.

Comparing the present findings where 55 % of the participants chose bottle B1 (sun) to the findings from the Arntzen et al. (in press) stydy where 81 % of the participants chose bottle B1 (smiley), the influence of preference is not as clear in the present experiment. First, Arntzen et al. (in press) had only 16 participants, but based on the high preference towards B1, it could be predicted that at most 1 or 2 participants would picked B2 or B3 if 20 participants were included in the group. Second, it could be argued that weather chart symbols are not as familiar as smiley faces. Stimulus familiarity have been defined as the quantity of established behavioral functions of the specific stimulus (Fields, Arntzen, Nartey, & Eilifsen, 2012). Arntzen, Nartey, and Fields

(2014) defined meaningfulness as the denotative and connotative properties of the stimulus. The denotative properties stand in relation to the defining features of the stimulus. For example a sign featuring the words STOP written in red color with a white background denotes to stopping. The directly translated meaning of the sign is to initiate someone to stop. The connotative meaning of the sign might be danger, and can evoke feelings of alertness or attention to specific features of the environment. A stimulus can have few or no denotive or connotative properties, or it can have several denotive or connotative properties. It could be argued that the stimuli used for the Neutral Group had little or no meaning to the participants in comparison to the stimuli in the experimental group. Participant # 13145 reported that he picked the B3-stimuli because lately the weather had been too warm and sunny, and he would now prefer some rain.

Experiment 2

The general purpose of Experiment 2 was to further investigate the transfer effects of different types of D-stimuli. It was argued in Experiment 1 that the weather chart symbols used as D-stimuli might not bear as many connotative and denotative properties as first assumed. The D1 and D2-stimuli might also hold many of the same discriminative functions opposed to the D3-stimulus. To find D-stimuli that might show functions similar to the smiley faces used in previous studies (Arntzen et al., in press; Straatman et al., 2014) it would be reasonable to use stimuli that has a high possibility of holding many discriminative functions that are consistent across contexts. Further, the stimuli should have been a part of the participants learning history over time. The neutral stimuli used for the Neutral Group in Experiment 1 could be argued to hold a neutral valence and did not influence any participant choices towards any of the bottles (B1, B2, and B3). Money and monetary symbols is a part of everyday life, and they should hold both connotative and denotative functions. Monetary symbols have been used in the Relational Frame Theory (RFT) literature to establish more than, less than relations based on the written value of the stimuli rather than their arbitrary size and it its argued that monetary symbols are members of pre-experimental behavioral repertoires (Y. Barnes-Holmes, D. Barnes-Holmes, & Smeets, 2004). The purpose of the present experiment was to test if monetary symbols of different values as members of equivalence classes would influence preferences towards the B-stimuli.

Method

Participants, setting, and apparatus. Twenty participants, 16 females and four males participated in the experiment. Their mean age was 27 years. Six additional did not pass the first test for emergent relations, and their results were not included. The participants were recruited through personal contacts and at lectures at Oslo and Akershus University College. Upon completion, all participants were fully debriefed, and any questions they had regarding the study was answered. The setting and apparatus used for Experiment 2 was exactly the same as in Experiment 1. The sessions lasted from 29 minutes to 80 minutes and the average session length was 46 minutes.

Design. The current experiment is designed with the use of a quasi-random posttest-only design where the Neutral Group from Experiment 1 functions as a nonequivalent control group.

Stimuli. The A, B, and C-stimuli used in Experiment 2 were the same as in Experiment 1. The D-stimuli in Experiment 2 consisted of colored pictures of Norwegian monetary bills (see Figure 4). The D1 stimulus was the picture of a 500 Norwegian kroner (NOK) bill, D2 pictured a 200 NOK bill and D3 pictured a 50 NOK bill. 1 U. S. dollar = 7.40 NOK.

Procedure. Experiment 2 followed exactly the same flow of experimental phases as described in Experiment 1.

Results and Discussion

The purpose of Experiment 2 was to investigate if monetary symbols as D-stimuli trained to the node in an equivalence class would influence preference in any differing manner than previously used symbols. The results from Experiment 2 are displayed in Table 3. The columns are the same as for Table 1 and Table 2 in Experiment 1, but the symbols in Table 3 represents the monetary values for the bills (D1, D2, and D3) that were equivalent to the B-stimulus labeled on the chosen water bottle. The mean number of training trials to establish the equivalence relations in Phase 1 was 296 trials, ranging from 150 to 870 training trials. The mean number of total trials for all phases were 590, ranging from 450 to 1170 trials. For the class expansion with the monetary symbols (D1, D2, and D3) the number of training trails varied from 15 to 30 trials. 9 out of 20 participants (45 %) chose the water bottle labeled with stimulus B1 that was equivalent to the 500 NOK bill (D1). 8 out of 20 participants (40 %) chose bottle B2 (200 NOK) and 3 participants (15 %) chose bottle B3 (50 NOK).

The class expansion training trails varied from 15 to 30 training trials where the D-stimuli were trained to the A-stimuli (node). For the nine participants who chose bottle B1 (500 NOK) eight of the participants had been exposed to thirty training trials and one participants was exposed to 15 training trials. For the eight participants who chose bottle B2 (200 NOK) three of them were exposed to 30 training trials, whereas five of them were exposed to 15 training trials. For the three participants who chose bottle B3 (50 NOK) two of them was exposed to 15 training trials whereas one participant was exposed to 30 training trials.

Participants who picked bottle B2 reported their choice being based on topographical aspects of some of the stimuli in the equivalence class (A2B2C2D2). Participants also reported similar answers from Experiment 1. For example Participant 13098 in the present experiment reported to pick bottle B2 because of a preference towards stimulus A2. A closer look at the results shows that participant 13098 was exposed to 40 reinforced **A2**B2 and **A2**C2 trials. In Phase 3, the participant was exposed to 15 class expansion trials divided into five trials per **D**A relation where the participant responded in accordance with the defined relations for all trials.

This makes out 5 reinforced **D**A trials per relation. This shows that the **A**B, **A**C trials were reinforced more frequently than the **D**A trials. The choice of B2 over B1 and B3 might indicate a transfer of function, but governed by the A2-stimulus rather than the D1, D2, or D3 stimuli.

In a study by Perkins, Dougher, and Greenway (2007), they found that the stimulus control topography of stimuli in an equivalence class could exert contextual control over the transfer of function. Three 4-member equivalence classes were formed by five college students. The class members varied alongside a common topographical dimension. The A-stimuli consisted of linear figures, the B-stimuli consisted of circular figures, the C-stimuli consisted of triangular figures, and the D-stimuli consisted of four-sided figures. Next, differential reinforcement and punishment was used to train specific discriminative functions for each class topography. Task 1 transfer was reinforced in the presence of B, C, and D-stimuli. Task 2 transfer was punished in the presence of D-stimuli and reinforced in the presence of C-stimuli, and Task 3 transfer was punished in the presence of both the C and D-stimuli. Thereafter, a new stimulus set was used to form three new 4-member classes. Different tasks was trained in the presence of the B-stimuli. Generalized transfer of function was governed by the topographical features of the stimulus classes, and the tasks trained for the B stimuli transferred to the remaining members. Picking a bottle, or clicking one stimulus in the presence of another might be topographically distinct, but functionally similar. This might be what happens during the establishment of the A2, B2, and C2 equivalence classes for participant 13098. Participant 13117, 13103, 13116, 13119, 13105, 13063 and 13121 also reported that their choice was based on some topographically features of the stimuli in the equivalent class—or aspects of the stimulus chosen—rather than any aspect of the D-stimuli. This indicates competing sources of stimulus control. The contingencies of reinforcement that are part of the establishment of equivalence classes in MTS formats establishes numerous forms of stimulus control topographies (SCT) (McIlvane & Dube, 2003;

Moss-Lourenco & Fields, 2011). During post experimental interviews, some participants also reported that the 500NOK bill is rarely obtained, and that it was impractical with the change money resulting in the use of the bill.

Results based on data from the Experimental groups from Experiments 1 and 2 have shown that 50 % of the participants have picked bottle B1 over B2 and B3. Moreover a high number of participants have chosen bottle B2, and some have reported that topographical features of the stimuli in class 2 controlled their choice towards stimulus B2. Verbal self-reports about behavior during conditional discrimination procedures have been used as a supplementary measure that might shed some light on the controlling features of the procedures (Critchfield & Perone, 1993; Lane & Critchfield, 1996), discussions have been raised about the status and usefulness of verbal reports (Baum, 2011; Critchfield & Epting, 1998). Several studies have shown that the inclusion of familiar stimuli in conditional discrimination training enhances the formation of equivalence classes (Arntzen et al., 2014; Fields et al., 2012). The use of different abstract stimuli sets might exclude some of these effects.

Experiment 3

The present Experiment will follow the same procedures as the Experiments 1 and 2, but with the use of a different stimulus set. Based on post experiment reports from Experiments 1 and 2, some of the stimuli from the stimulus sets had similar topographical features of familiar stimuli such as hand-shapes or ice-cone shapes. There are several studies showing class enhancing effects of training with familiar stimuli (Arntzen, 2004; Arntzen & Lian, 2010; Arntzen et al., 2014), further Fields et al. (2012) found that training discriminative effects to one abstract stimulus facilitated equivalence class formation. Participants reported that their choices was based on properties of these stimuli, and not by properties of the D-stimuli. Therefore, the stimuli used in the present experiment were chosen out of a variety of stimuli based on their supposedly non-familiar properties. Further, based on the varying transfer results from Experiments 1 and 2 it would be interesting to establish a transfer baseline that could be used to test for any possible change in preference towards the three bottles, and identify sources of competing stimulus control (Credited Lanny Fields in a footnote on page 247 in Dymond and Rehfeldt, 2000).

Method

Participants, setting, and apparatus. Eight participants, five males and three females participated in Experiment 3, their mean age was 28 years. Only eight participants were included in the present experiment, part due to time limitations, and part because of the high number of participants who did not respond in accordance with stimulus equivalence in the first test in Phase 2. Five participants withdrew during experimental sessions, and 10 participants did not meet the set criteria in the test in Phase 2 and one participant did not pass the test in Phase 4. The participants were recruited through personal contacts and at lectures at Oslo and Akershus University College. The setting and apparatus for Experiment 3 was exactly the same as described in Experiment 1 and 2.

Design. The current experiment implements a quasi-experimental one-group pretest-posttest design with the added design element of the Neutral Group form Experiment 1 as an nonequivalent group.

Stimuli. The stimulus set used for Experiment 3 can be displayed in Figure 5. The stimulus set consisted of a mix of abstract symbols and Chinese letters. The size of the stimuli varied from 0, 7 to 2, 8 cm in height and from 1, 3 to 2, 6 cm in width. The pressure sensitive areas around the stimuli were the same as described in Experiment 1.

Procedure. Experiment 3 followed the same procedural phases as Experiment 1 and 2 except for the inclusion of the transfer baseline. The transfer baseline was conducted by introducing Phase 5 before Phase 1. All participants were asked to pick a bottle before they started the conditional discrimination training and class expansion as well as after they had completed the final test for emergent relations, as described in Experiments 1 and 2.

Results and Discussion

The present experiment was a systematic replication of Experiment 3 with the use of a different stimulus set and different values on the monetary symbols. See Table 3 for a display of the results. Out of the eight participants who completed all the experimental phases, five picked bottle B1 (62, 5 %). Comparing choices made during the transfer baseline to post experiment choices, 50 % of the participants changed their initial choice of bottle towards bottle B1. 1 participant changed the baseline preference from B1 to B3, and one participant changed from B1 to B2. Experiment 3 shows the highest degree of transfer effects, but the results must be interpreted with caution due to the low number of participants.

One interesting finding from the current experiment was the high number of participants who either withdrew from the experiment, or did not meet the criterion for responding in accordance with stimulus equivalence. Ten participants did not pass the first test for emergent relations, and one participant failed the second test. Out of the 60 participants in Experiments 1 and 2, a total number of 13 participants did not pass the test for emergent relations. Thus the high number of participants not responding to experimenter defined relations in the current experiment, might indicate that the participants were responding to a different SCT than the defined stimulus-stimulus relations. Arntzen, Nartey, and Fields (2015) defined a participant defined relation as the same selected comparison stimulus in all presented relations of the test block. The same criterion will be used in the evaluation of the current participants. In the current experiment, all tested relations are presented five times. If relation **B3**/C1C2<u>C3</u> is tested but the participant responds to B3/<u>C1</u>C2C3 in all five presented relations, the responding qualifies as a participant defined relation. Figure 6 displays the trial by trial responding for eight participants who selected the same comparison on three out of five presented test trials. One participant did not pass the second test, and the two other participants responded unsystematically. They are not included in the figure. Participants 13072, 13172, 13180, and 13068 formed participant defined relations. Participants 13072, 13172, and 13068 established the participant defined **B3/**C1C2C3 relation. An interpretation here could be that the Chinese symbols (C1, B2, and B3) were not discriminable from each other (Figure 5). During baseline training **A3/**B1B2B3 relations occasioned reinforcement, where A3 is a Chinese symbol. During **B3**/C1C2C3 equivalence test trials, the participants systematically selects the Chinese symbol C1.

Further, Stimulus specific features could facilitate responding in accordance with stimulus equivalence (Arntzen et al., 2014; Fields et al., 2012). Recent findings have shown that conditional discriminations trained to an abstract member of the to be formed equivalence classes enhanced the following probability of later class formation where the stimulus is a member (Nedelcu, Fields, & Arntzen, 2015).

Experiment 4

Bortoloti and De Rose (2009) used a semantic differential to assess the transfer effect to the D-stimuli after participants established three 3-member classes, where the A-stimuli consisted of 3 faces expression emotions. The semantic differential ratings made by participants in the experimental groups were compared to the ratings made by participants in a Control Group. The participants in the Control Group rated the facial expressions alone. In the present study, participants have chosen water bottles labeled with neutral B stimuli to assess any transfer effects from the D-stimuli. Answers obtained from a semantic differential would not be compatible to the measure of transfer used in the present study. One way to measure the preference towards the D-stimuli could be to expose a Control Group to a similar choice situation as used in the experiments, but with the D-stimuli labeled on the bottles. The allocation of choices towards the neutral B stimuli in the experimental groups could be measured against the allocation of choices towards the bottle labeled with the D-stimuli for the Control Group. This would improve the experimental design in the study, allowing the groups in Experiments 1 and 2 to

Method

Participants, setting, and apparatus. Twenty participants, 11 men and nine women with the mean age of 32 years were recruited to the experiment at Oslo and Akershus University College. The participants had no prior knowledge about the experiment. The experiment was conducted in a classroom at Oslo and Akershus University College. At the immediate entrance of the room, 4 tables were faced towards a blank wall and each table contained one group of three bottles each. Each of the groups of bottles was labeled with the D-stimuli used in Experiments 1, 2, and 3. The front side of the bottles was hidden from the participants with a piece of cardboard that was 32 cm long and 14 cm high.

Stimuli. The stimuli consisted of the D-stimuli described in Experiments 1, 2, and 3 and they were printed in color and labeled on to the bottles. The water bottles used were the same as previously described.

Design. The design elements implemented here could be evaluated as a One-Group posttest-only design. The group in the current experiment will function as an additional Control Group for the other Experiments, adding to the assessment of the construct validity.

Procedure. The participants were brought in to the room, one at a time. When the participant entered the room, the four table’s containing the three water bottles were visible, but the front of the bottles were hidden behind the cardboard. The choice situations were introduced to the participants in a serialized order, always starting with the closest table. Only one group of bottles was visible to the participants at the point of choice, and remaining groups of bottles were hidden behind the cardboard. The experimenter lifted the cardboard from the group of bottles and told the participants to pick a bottle. The experimentator turned away from the participant during the choice situation, and if the participant asked any questions they were asked again to pick a bottle. When they had picked a bottle, they were asked why they picked that bottle. Their choice and answer was noted and the cardboard was placed in from of the bottles again before the next group of three bottles was introduced. This procedure was repeated until the participant had made a choice towards all the four groups of bottles. The participants were not given any feedback on their answer other than “ok”. They were also told to refrain from speaking to any other participants about the experimental procedures until the experiment was completed. Between each participant, both the order of bottle groups and the bottles in each group was shuffled.

Results and Discussion

See Figure 7 for an allocation of choices towards each group of bottles shown in percentage. The Figure also shows the choices allocated towards the D-stimuli for the Control Group in the present experiment compared to the choices allocated towards the different B-stimuli in each of the groups in Experiments 1, 2, and 3 except for the Neutral Group. The allocation of choices is measured in percentage. The evaluative result of the Control Group supports the neutral valence of the stimuli used in the Neutral Group in Experiment 1. The choices in the Control Group fits the trend of the choices in the experimental groups, but choices towards the rain picture in the weather symbols pictures was chosen by 40 % of the participants. Several of the participants reported to have picked the rain symbol because they prefer rain. Possible Implications of this will be discussed in the general discussion. A possible limitation in the present procedure could have been a carry-over effects. The participants were exposed to 4 choice situations in a serialized manner. Some participants reported to have chosen the 50 NOK symbol in the second monetary group because they chose the symbol in the first group. Exposing 20 separate participants to each condition could solve this issue.

General Discussion

Main Findings

The present study investigated the effects of training different types of D-stimuli into established equivalence classes on preference towards three water bottles labeled with the B-stimuli (B1, B2, and B3) in a choice situation. Experiment 1 tested the effects of weather chart symbols (sun, cloud, and rain) as D-stimuli in one group. For the second group, the D-stimuli were neutral pictures. Experiment 2 systematically replicated Experiment 1, but the D-stimuli consisted of monetary symbols with different values. Experiment 3 investigated the effects of a different stimulus set, and with altered values on the monetary symbols. Moreover, Experiment 3 included implemented a transfer baseline to evaluate the change in preference. Experiment 4 evaluated the preference towards the D-stimuli used in Experiments 1, 2, and 3 in a choice based preference test.

The present findings indicate that (1) Valenced D-stimuli trained as members of equivalence classes influences preference towards class members to ha higher degree than neutrally valenced D-stimuli. (2) Summing up the choices towards the B stimuli (See Figure 8), 52 % of the participants in the groups with valenced D-stimuli picked bottle B1, only 19 % of the participants picked the bottle labeled with stimulus B3, and 29% picked bottle B2. (3) In accordance with findings from other studies (Bortoloti et al., 2013), the amount of training trials in during class expansion might be an critical variable in regards to how the properties of valenced D-stimuli effects the remaining equivalence class members. (4) Topographical features of stimuli used in conditional discriminations might facilitate the establishment of participant defined relations. (5) The effectiveness of the OTM training structure (AB/AC) on forming equivalence classes is consistent with other findings (Arntzen, 2012; Arntzen, Grondahl, & Eilifsen, 2010; Arntzen & Hansen, 2011).

Variability of transfer effects. The transfer effects found in experiments that evaluates influence of preference towards soft-drinks have been reported positive, but variable (D. Barnes-Holmes et al., 2000; Smeets & Barnes-Holmes, 2003). Further, some procedural variances might have influenced the obtained results. For example, in the study by D. Barnes-Holmes et al. (2000) the conditional discriminations were presented in a 0.5 s DMTS procedure. The sample stimulus was presented on the screen, and after 2 s the screen cleared for 0.5 s before the 2 comparison stimuli appeared. First, DMTS procedures have been shown to positively correlate with how abstract symbols are rated in accordance with the valenced D-stimuli (Bortoloti & De Rose, 2009, 2011, 2012). In the study by Smeets and Barnes-Holmes (2003), the conditional discrimination training was conducted by manually presenting trials to the children on a table top. The experimenter might indirectly provide cues for correct responding. Further, during testing if they did not respond in accordance with the set criterion for two consecutive test blocks, further training was introduced. Moreover, if the participants did not provide a rating of the sodas, a forced choice was implemented where the experimenter verbally instructed the participants that one soda must have tasted a little better than the other one. Another aspect of the two previously mentioned studies is the use of two-choice comparisons during conditional discriminations. In both studies the participants formed two 3-member equivalence classes, which leaves each conditional discrimination with one sample stimulus and two comparison stimuli. It has been argued that the use of to-choice comparison procedures might establish a stimulus control of rejecting the incorrect comparison rather than choosing the correct one (Carrigan & Sidman, 1992; Sidman, 2000).

In experiments using familiar or supposedly valenced D-stimuli to test for transfer effects, the participants learning history with the stimuli influences observed effects. For example in the study by D. Barnes-Holmes et al. (2000), where the emotive words CANCER and

HOLIDAY were trained into equivalence classes with the nonsense syllables VEK and SID and brand X and brand Y. Two participants showed a preference towards BRAND X, which was equivalent to the word CANCER. Both these participants had reported that they were under the star sign cancer, thus they had interpreted the word as if it was their star sign. They also reported recently having unpleasant vacation experiences. Some similar effects were observed in the present study where 1 participant from the Weather Group in Experiment 1 reported to have picked bottle B3 because the weather lately had been too sunny and warm, and some rain would have been preferred. Similar effects were observed for a participant in Experiment 2 with monetary symbols as D-stimuli reported that picking B1 would be greedy, so B2 was preferred. Experiment 4 revealed similar effects, when four participants reported to pick the bottle with the rain symbol either because they felt sad or liked rain.

These findings points to a weakness in studies that uses supposedly valenced D-stimuli in transfer procedures. Even if the stimuli are extracted from databases where they have been evaluated by populations of participants, the individual preferences in transfer studies cannot be controlled for. Ferro and Valero (2008) used negatively valenced D-stimuli from the International Affective Picture System (IAPS) (Lang, Bradley, & Cuthbert, 1997), but only three out of 10 participants showed a transfer of rating towards the class members in accordance with the valenced D-stimuli. Comparing the present findings to the findings of Arntzen et al. (in press), preliminary results indicate that smiley faces are more efficient than the stimuli used in the current study.

Overtraining. In Experiment 2, eight out of nine participants who picked bottle B1 had been exposed to 30 class expansion training trials, training the three D-stimuli to the A-stimuli. Out of the participants who picked bottle B2 and B3, 4 participants were exposed to 30 training trials. In Experiment 3, three out of the five participants who picked bottle B1 were exposed to 30 class expansion trials, whereas one was exposed to 45 trials. One of the three participants who picked bottle B2 and B3 were exposed to 30 training trials, whereas the other two participants were exposed to 15 trials. This might be compared to the observed effects on overtraining of baseline relations and relational strength. Overtraining is defined as the continuous implementation of training trials even if the criterion of correct trials per training block is met. Bortoloti et al. (2013) found that overtraining of baseline relations influenced the rating of abstract stimuli. Emotional facial expressions (A) were established as equivalent to abstract stimuli (B, C, D, and E). A Control Group rated the emotional faces using a semantic differential rating scale, whereas the two experimental groups rated the D-stimuli after conditional discrimination training and positive tests for emergent relations. The overtraining group was exposed to twice as many training trials past the point of mastery as the participants in the regular training group. The results from the semantic differentials by the Overtraining Group were more in accordance with the rating by the Control Group, than Regular Training Group and Control Group.

Travis, Fields, and Arntzen (2014) recently found that pertaining the first 84 simultaneous discriminations followed by increasing steps of over-training successive discriminations with abstract symbols, matched the class enhancing effects of familiar pictures. This is an important finding that provides a stimulus control account for the class enhancing effects by familiar stimuli. It would be interesting to follow the procedure from their experiment to first train simultaneous discriminations followed by over-training of successive discriminations with an abstract symbol. Then, following the procedure from the present study, the overtraining symbol could be implemented as D1 stimulus and a familiar picture as another D2 in a class expansion phase, to see how it would affect preference towards B1 and B2 in a choice situation.

Limitations

Some limitations in the current study is that only Experiment 3 implemented a baseline to evaluate if the preferences actually change. Moreover, Experiments 1 and 3 would have to include more participants to draw any conclusions. Further, with the use of three bottles to choose from, the choice towards B1 has a 33 % chance of being random. In the present study the participant reports helps to support the transfer effects by the high number of participants who picked B1 reported that their choice was based on D1 stimulus attributes.

Reflections regarding validity of findings

The current study uses a one-to-many training structure forming three 3-member classes before the D-stimuli are trained to the nodal stimuli (A). If an influence of preference is observed, this qualifies as transfer through equivalence because the stimulus functions transfers via the nodal stimulus. Several studies that have reported transfer effects, have observed transfer through symmetry (Barnes & Keenan, 1993; Catania, Horne, & Lowe, 1989). Transfer through symmetry is assumed to be a different process than transfer through equivalence, because the stimuli are directly paired during training. When stimuli are directly paired, the observed effects might be accounted for by Pavlovian conditioning (Dymond & Rehfeldt, 2000). This supports the cases of observed transfer in the current study, and provides to rule out transfer through direct stimulus pairings. On the other hand, it cannot be completely ruled out that the stimuli are related through second order conditioning (Tonneau, 2001; Tonneau & Gonzalez, 2004).

Further support of the observed transfer effects in the current study comes from the fact that the transfer test consisted of only one probe. The observed transfer effect in the first test block termed *immediate transfer (*Dymond & Rehfeldt, 2000*).* Sometimes participants are repeatedly tested for the transfer effects. Test-retest procedures might produce the outcome that is tested for, and thus the observed effect could be attributed to manipulations in the independent variable. This constitutes an internal validity threat (Shadish et al., 2001).

The most obvious threat to the internal validity of the current study is the construct validity. Construct validity refers to the notion that a causal relationship exists between a process or construct inferred by the experimentator and the observed effects (Shadish et al., 2001). As mentioned previously, the prominent variability of results from transfer studies that implements the use of supposedly valenced stimuli might all suffer from construct validity issues (Ferro & Valero, 2008). Findings from the current study actually supports the notion that stimuli does not hold any specific value or emotional effects to the degree that can be reliably produced across contexts and individuals. This supports the behavior analytic view that stimulus functions are established through contingencies of reinforcement. This is supported by several recent findings from research on the properties of stimuli referred to as meaningful, where findings indicate that similar properties can be created by different types of discrimination procedures. This reveals properties of meaningful, valenced or connotative or denotative effects that can be accounted for by referring to stimulus control functions (Arntzen et al., 2014; Travis et al., 2014).

Practical Implications and Generalization

Previous studies have shown that the test for emergent relations are not necessary to obtain the observed transfer of function effects (D. Barnes-Holmes et al., 2000; Smeets & Barnes-Holmes, 2003). This could have implications both for further experiments, and for the generalization of findings to real world settings. In laboratory settings the equivalence testing is an important part of exerting control of the establishment of equivalence classes, but in real world settings different types of equivalence classes are formed and expanded continuously (Fields, 2009; Fields & Reeve, 2001). A counter argument here could be that the relations among the stimuli are not represented with the properties of reflexivity, symmetry and transitivity. If the properties are not tested for, they cannot be inferred to be present (Sidman, 1994). The argument of experimental control has to be weighed against the generalizability of the findings from laboratory research. When the critical variables are discovered in the laboratory and findings are replicated, more effective procedures can be implemented in intervention settings (Sidman, 1960).

According to recent numbers from the Worlds Health Organization obesity has more than doubled worldwide since 1980 (World Health Organization, 2015). In 2014 36 % of the worldwide population were overweight and 13% were obese. Interventions targeted at establishing and changing children's preference towards eating healthy foods, such as fruits and vegetables have been effective. In the *Food Dudes* program, they have found that peer modeling and direct reinforcement of the consumption of fruit and vegetables increases the consumption. Furthermore, some interesting findings from the programs shows that targeting some fruits and vegetables in a category, influences the preference towards the other foods in the same category (Horne et al., 2011; Horne, Lowe, Fleming, & Dowey, 1995; Lowe, Dowey, & Horne, 1998; Lowe & Horne, 2009). This is similar the type of within category arbitrary generalization that is similar observed with findings from the present and similar studies from the stimulus equivalence paradigm.

The results from the present study could have implications for intervention packages such as the ones described by Horne et al. (2011) and Lowe and Horne (2009). When trying to change a preference towards a category, for example food items, it might be facilitative to include preferred members into the category. For example, first one could establish conditional reinforcers or perform a reinforcer assessment procedure. Then the reinforcing objects could be trained to members of a category targeted for an increased preference intervention. Behavioral interventions targeted at overweight and obesity in children has accumulated strong empirical support (Jelalian & Saelens, 1999), and findings from the present experiment might have supplemental value to such interventions.

Furthermore, Interventions have been implemented mostly towards normally developed children. Another group of people who are prone to obesity and eating disorders, are people with learning and developmental disabilities (Mikulovic et al., 2011; Rimmer, Yamaki, Lowry, Wang, & Vogel, 2010). Findings from a survey performed in Norway show that people with severe disabilities are prone to underweight, whereas people with less severe mental disabilities are prone to overweight (Hove, 2004). Present findings could be beneficial as part of an intervention targeting food preferences for people with learning disabilities. For example, conditional discrimination procedures could be conducted to establish sugar-free alternatives of soft-drinks as equivalent to positive valenced-stimuli.

Future Directions

In Experiment 2 of the study by D. Barnes-Holmes et al. (2000), the preferences that had been established towards BRAND X and BRAND Y were reversed by reversing the conditional discriminations. This strengthens the conclusion that the procedure actually can alter preference. Future experiments should further investigate the possibilities of first establishing preference towards meaningless symbols, and later reversing the preferences by reversing the conditional discriminations. Some recent findings that have investigated the generalized alteration of preference have been promising (Valdivia-Salas, Dougher, & Luciano, 2013). Future studies should include the use of three comparison discrimination, to eliminate the possibilities of rejection control by rejecting the wrong comparison.

Further, the use of both DMTS procedures with different delays and overtraining procedures have been shown to be effective in establishing transfer effects. The range of 3s to 6s delay from the offset of the sample stimulus to the onset of the comparison stimuli have shown to result in more accurate responding (Arntzen et al., 2015). Future studies should investigate and compare the effects of both overtraining the D-stimuli to the A-stimuli, and using DMTS procedures. The stimulus functions should be established during experiment condition, and not be inferred to pre-exist. In addition, future studies should implement and evaluate the use of transfer baselines to evaluate possible changes or trends in preferences as a result of the experimental procedure. Transfer baselines can identify stimulus control inferring with transfer effects (Dymond & Rehfeldt, 2000). The use of more than three choice alternatives will also help to support any observed transfer effect.

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Table 1. *The table displays the results from Experiment2. The Trials column shows the number of training trials required to reach the first test. Bl (baseline), Sy (symmetry), and Eq (equivalence) columns displays the number of correct trials out of total number of possible correct. The Exp column displays the number of expansion trials, the TTrials column displays the total number of trails. Choice column indicates the bottle chosen and Symbol column shows which D-stimuli that was equivalent to the chosen bottle.*

Weather Chart Group												
ID #	**Age**	**Trials**	**Bl**	**Sy**	**Eq**	**Exp**	**Bl**	**Sy**	**Eq**	**TTrials**	**Choice**	**symbol**
13097	24	180	1	1	1	15	1	1	1	465	B1	sun
13136	23	210	1	0,97	1	15	1	1	1	495	B1	sun
13141	21	180	1	1	1	30	1	1	0,95	480	B1	sun
13143	21	180	1	1	0,97	30	1	1	0,99	480	B1	sun
13144	22	270	1	1	1	30	0,98	1	0,98	570	B1	sun
13146	21	270	1	1	1	30	1	1	0,99	570	B1	sun
13124	24	330	0,97	1	0,97	30	1	1	0,98	630	B1	sun
13122	37	360	1	0,97	1	30	1	1	0,98	690	B1	sun
13126	21	300	1	1	0,97	30	1	1	1	600	B1	sun
13109	21	210	0,97	1	1	15	1	1	0,98	495	B1	sun
13050	22	780	1	0,93	0,9	30	1	1	1	1080	B1	sun
13090	16	270	1	0,97	1	15	1	1	1	555	B2	cloudy
13138	23	240	1	1	0,97	30	1	1	1	540	B2	cloudy
13139	22	360	1	0,97	0,93	30	0,98	1	1	660	B2	cloudy
13142	21	180	1	1	1	30	1	1	1	480	B2	cloudy
13067	22	240	1	1	1	30	1	0,98	1	540	B2	cloudy
13145	23	180	1	0,97	0,93	30	0,98	0,96	0,98	480	B3	rain
13147	20	180	0,97	1	1	30	1	1	1	480	B3	rain
13148	25	240	0,93	1	0,97	30	1	0,96	0,95	540	B3	rain
13065	29	240	1	1	1	30	1	0,98	1	540	B3	rain
Neutral Pic Group												
ID #	**Age**	**Trials**	**Bl**	**Sy**	**Eq**	**Exp**	**Bl**	**Sy**	**Eq**	**TTrials**	**Choice**	
13194	22	585	1	1	0,93	15	1	1	1	300	B1	
13196	30	465	1	1	1	15	1	0,96	1	180	B1	
13198	22	570	1	0,97	1	30	1	1	0,99	270	B1	
13202	32	495	1	1	0,97	15	0,98	1	0,98	210	B1	
13205	42	630	1	1	0,93	30	1	1	1	330	B1	
13209	29	750	1	0,97	1	30	1	0,96	1	450	B1	
13211	25	555	1	1	0,97	15	1	1	1	270	B1	
13192	22	810	0,97	1	1	30	1	1	1	510	B2	
13197	23	615	0,97	0,97	1	15	0,98	1	1	330	B2	
13201	37	660	1	1	0,97	30	0,98	1	0,99	360	B2	
13206	24	465	1	1	0,93	15	1	1	1	180	B2	
13210	24	570	1	1	0,97	30	1	1	1	270	B2	
13212	26	540	1	1	0,97	30	0,98	1	0,97	240	B2	
13191	23	525	1	1	1	15	1	1	1	240	B3	
13193	21	630	1	0,93	1	30	1	1	0,98	330	B3	
13195	22	480	1	1	1	30	1	1	0,98	180	B3	
13199	42	690	1	1	0,9	30	1	0,98	0,98	390	B3	
13203	20	495	1	1	1	15	1	1	0,99	210	B3	
13204	32	495	1	1	0,93	15	0,98	1	1	210	B3	
13208	32	555	0,97	1	1	15	1	1	1	270	B3	

Table 2. *The table displays the results from Experiments 2 and 3. The Trials column shows the number of training trials required to reach the first test. Bl (baseline), Sy (symmetry), and Eq (equivalence) columns displays the number of correct trials out of total number of possible correct. The Exp column displays the number of expansion trials, the TTrials column displays the total number of trails. Choice column indicates the bottle chosen and Symbol column shows which D-stimuli that was equivalent to the chosen bottle. In the Bills 2 Group, the BLC (baseline choice) column shows the bottle chosen during the baseline choice.*

Bills 1 Group

ID #	Age	Trials	Bl	Sy	Eq	Exp	Bl	Sy	Eq	Choice	Symbol	TTrials
13091	30	420	1	1	1	30	1	1	1	B1	500	720
13092	35	180	1	1	1	30	1	1	0,99	B1	500	480
13095	22	240	1	1	1	30	1	1	1	B1	500	540
13099	28	150	1	1	1	30	1	1	1	B1	500	450
13117	21	210	1	1	0,97	30	1	1	1	B1	500	510
13102	21	870	1	1	1	30	1	1	0,99	B1	500	1170
13103	27	390	1	0,97	0,97	30	1	1	0,99	B1	500	690
13123	24	300	1	0,97	0,9	30	1	1	0,97	B1	500	600
13069	30	210	1	1	0,97	15	1	1	0,99	B1	500	495
13096	22	150	1	1	1	15	0,98	1	0,98	B2	200	435
13098	22	210	1	1	1	15	1	1	1	B2	200	495
13116	26	300	1	1	1	30	1	1	1	B2	200	600
13119	20	270	1	1	0,97	30	1	1	1	B2	200	570
13106	37	240	1	1	1	15	1	1	0,99	B2	200	525
13105	35	300	1	1	0,97	15	1	1	0,99	B2	200	585
13108	20	210	0,97	1	1	30	1	1	1	B2	200	510
13063	25	300	1	1	1	15	1	1	1	B2	200	585
13121	23	210	1	1	1	30	1	1	0,99	B3	50	510
13149	48	450	1	1	0,93	15	1	1	0,99	B3	50	735
13064	24	300	1	1	1	15	1	1	0,98	B3	50	585

Bills 2 Group

ID #	Age	Trials	Bl	Sy	Eq	Exp	Bl	Sy	Eq	BLC	Choice	Symbol	TTrials
13061	27	300	1	1	0,97	30	1	1	0,99	B2	B1	200	510
13066	28	390	1	1	1	30	1	0,98	0,99	B3	B1	200	690
13068	29	270	1	1	1	15	1	0,96	1	B2	B1	200	555
13173	27	330	1	1	1	30	1	1	1	B3	B1	200	630
13175	32	570	0,9	1	1	45	0,98	1	1	B1	B1	200	885
13171	32	285	1	1	1	15	1	0,98	0,99	B1	B2	100	465
13177	26	180	1	1	1	15	1	1	0,99	B1	B3	50	465
13181	20	330	1	1	1	30	1	1	0,99	B3	B3	50	630

Figure 1. The figure displays the stimulus set used for the Weather group. The weather chart symbols are trained to the A-stimuli in the class expansion phase. The D-stimuli were presented in color during the conditional discriminations. The numbers indicate the class and the letters indicate class members.

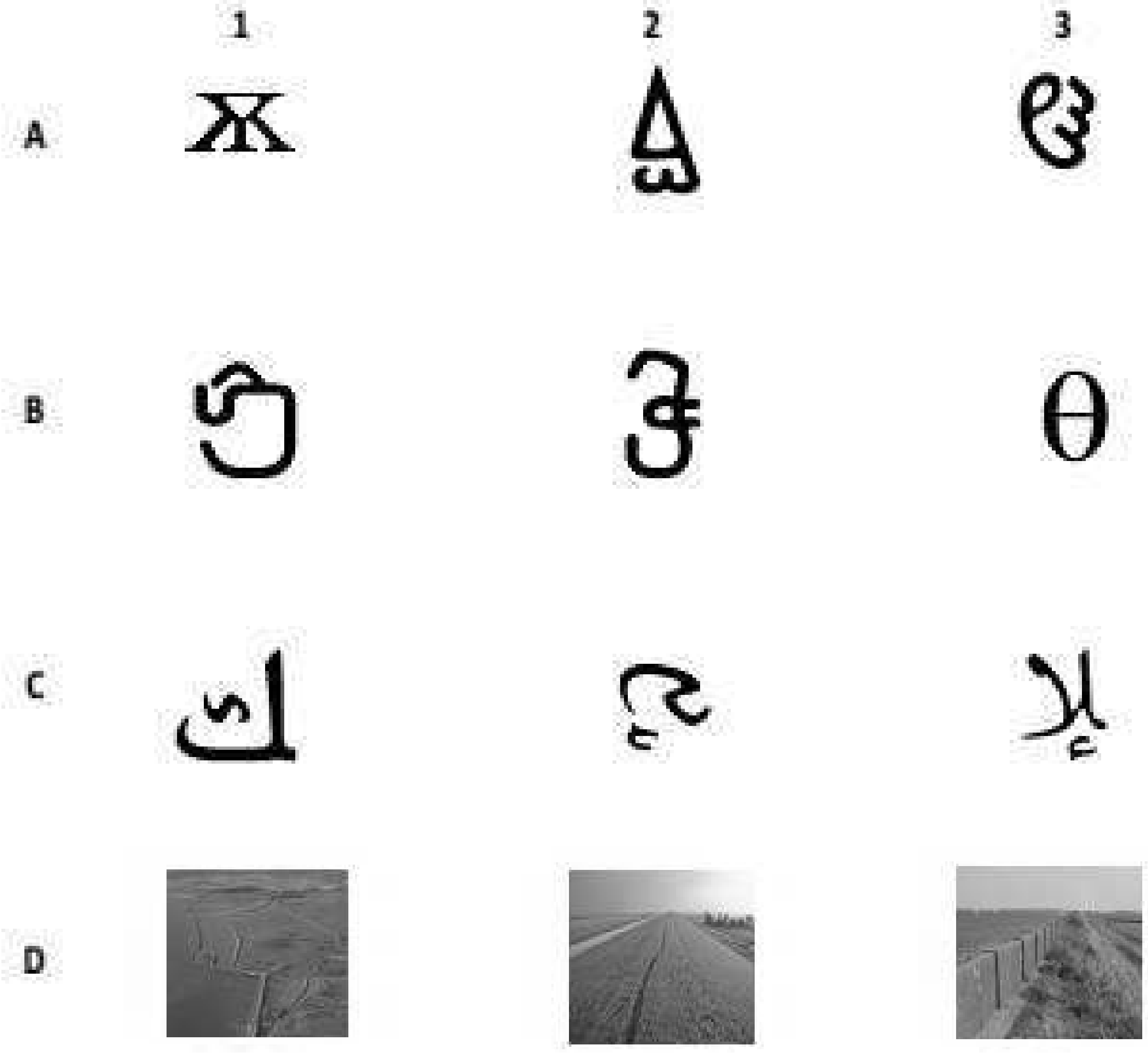

Figure 2. The stimuli used for the Neutral group. The D-stimuli were trained to the A-stimuli during the class expansion phase. The D-stimuli picture the dikes in Holland. They were presented in color during the conditional discriminations.

Figure 3. The figure shows the bottles used in the choice situations as they were presented to the participants. The stimuli labeled on the bottles pictured the B1, B2, and B3 stimuli used during conditional discrimination training and testing. The participants in Experiment 3 had the-B stimuli from the stimulus set used in Experiment 3 labeled on identical bottles.

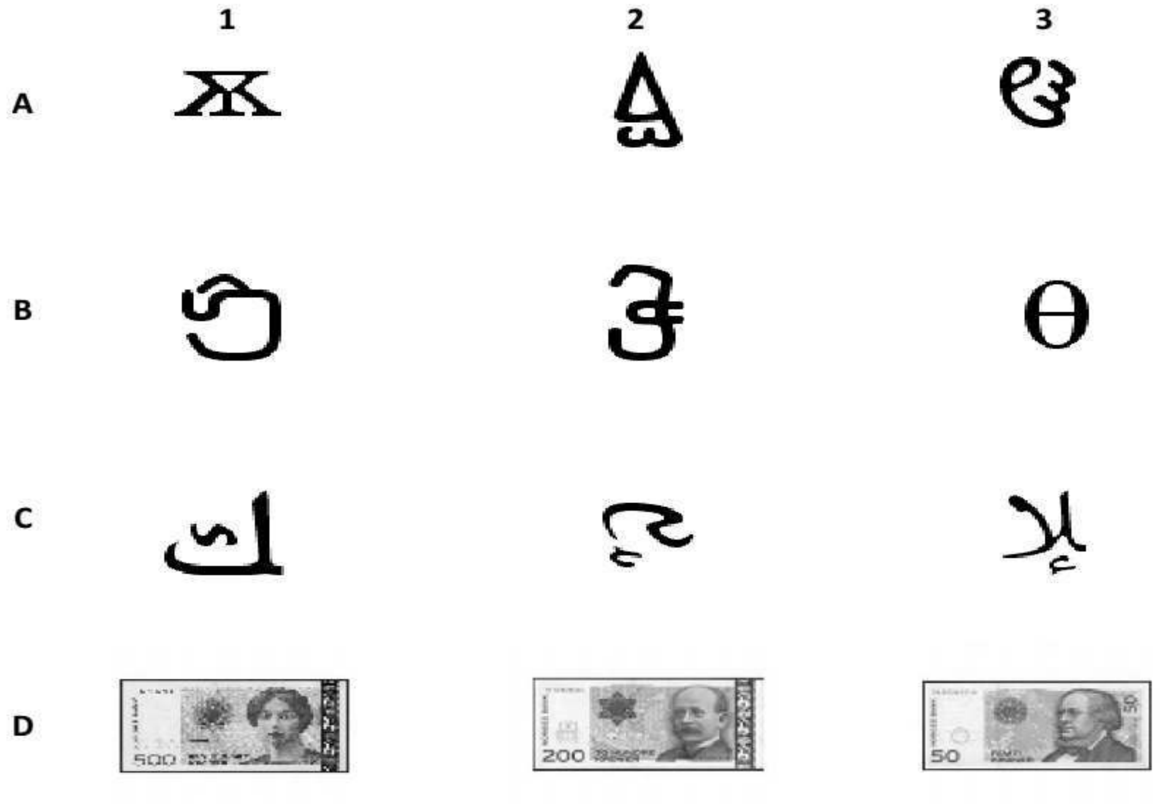

Figure 4. The figure shows the stimulus set used in Experiment 3. The D1, D2, and D3 stimuli pictures 500, 200, and 50 NOK respectively. The numbers indicate classes, and letters indicate class members. The D-stimuli were presented in color during the conditional discrimination training and testing.

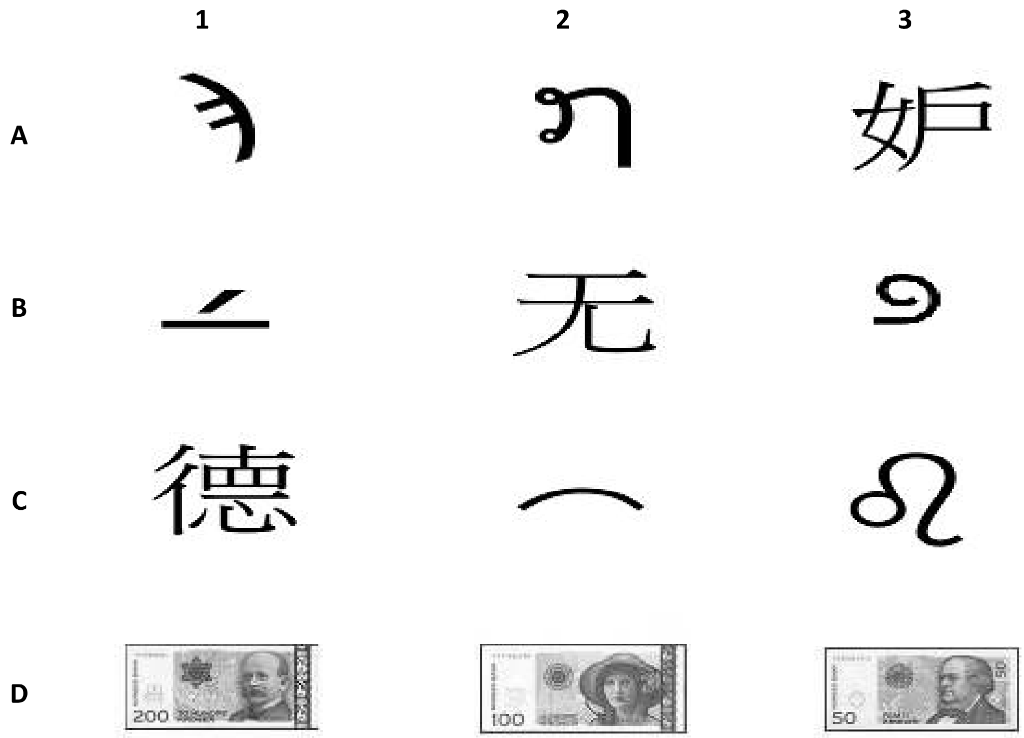

Figure 5. The figure shows the stimulus set used in Experiment 3. The D-stimuli were trained to the A-stimuli. The D1, D2, and D3 pictures 200, 100, and 50 NOK bills. The stimuli were presented in color during the conditional discrimination training and testing. The numbers identifies the classes and the letters identifies the class members.

13072

SY	A1	A2	A3	A1	A2	A3
C1	0	5	0			
C2	0	5	0			
C3	0	0	5			
B1				5	0	0
B2				0	5	0
B3				0	0	5

EQ	C1	C2	C3	B1	B2	B3
B1	5	0	0			
B2	0	0	5			
B3	5	0	0			
C1				0	0	5
C2				0	4	1
C3				0	5	0

13172

SY	A1	A2	A3	A1	A2	A3
C1	5	0	0			
C2	0	5	0			
C3	0	0	5			
B1				5	0	0
B2				0	5	0
B3				0	0	5

EQ	C1	C2	C3	B1	B2	B3
B1	5	0	0			
B2	2	3	0			
B3	5	0	0			
C1				1	0	4
C2				0	5	0
C3				0	2	3

13179

SY	A1	A2	A3	A1	A2	A3
C1	1	4	0			
C2	0	4	1			
C3	3	1	1			
B1				2	2	1
B2				1	2	2
B3				4	1	0

EQ	C1	C2	C3	B1	B2	B3
B1	0	4	1			
B2	0	1	4			
B3	2	1	2			
C1				2	1	2
C2				2	0	3
C3				1	2	2

13068

SY	A1	A2	A3	A1	A2	A3
C1	5	0	0			
C2	0	5	0			
C3	0	0	5			
B1				5	0	0
B2				0	5	0
B3				0	0	5

EQ	C1	C2	C3	B1	B2	B3
B1	5	0	0			
B2	2	3	0			
B3	5	0	0			
C1				1	0	4
C2				0	5	0
C3				0	2	3

13174

SY	A1	A2	A3	A1	A2	A3
C1	1	4	0			
C2	0	4	1			
C3	3	1	1			
B1				2	2	1
B2				1	2	2
B3				4	1	0

EQ	C1	C2	C3	B1	B2	B3
B1	0	4	1			
B2	0	1	4			
B3	2	1	2			
C1				2	1	2
C2				2	0	3
C3				1	2	2

13180

SY	A1	A2	A3	A1	A2	A3
C1	5	0	0			
C2	0	5	0			
C3	0	0	5			
B1				5	0	0
B2				0	5	0
B3				0	0	5

EQ	C1	C2	C3	B1	B2	B3
B1	5	0	0			
B2	0	0	5			
B3	1	0	4			
C1				5	0	0
C2				0	5	0
C3				0	2	3

13069

SY	A1	A2	A3	A1	A2	A3
C1	1	4	0			
C2	0	4	1			
C3	3	1	1			
B1				2	2	1
B2				1	2	2
B3				4	1	0

EQ	C1	C2	C3	B1	B2	B3
B1	0	4	1			
B2	0	1	4			
B3	2	1	2			
C1				2	1	2
C2				2	0	3
C3				1	2	2

13178

SY	A1	A2	A3	A1	A2	A3
C1	5	0	0			
C2	0	5	0			
C3	0	0	5			
B1				5	0	0
B2				0	5	0
B3				0	1	4

EQ	C1	C2	C3	B1	B2	B3
B1	5	0	0			
B2	0	2	3			
B3	0	0	5			
C1				5	0	0
C2				0	5	0
C3				0	2	3

Figure 6. The figure displays the response matrices for the eight participants who shows indications for participant formed relations. Numbers in the black boxes are defined as experiment defined relations, and numbers outside the boxes shows the participants responses. The left square displays the symmetry relations, and the right box displays the equivalence relations. All non-experimenter relations responded to more that three times are colored in gray.

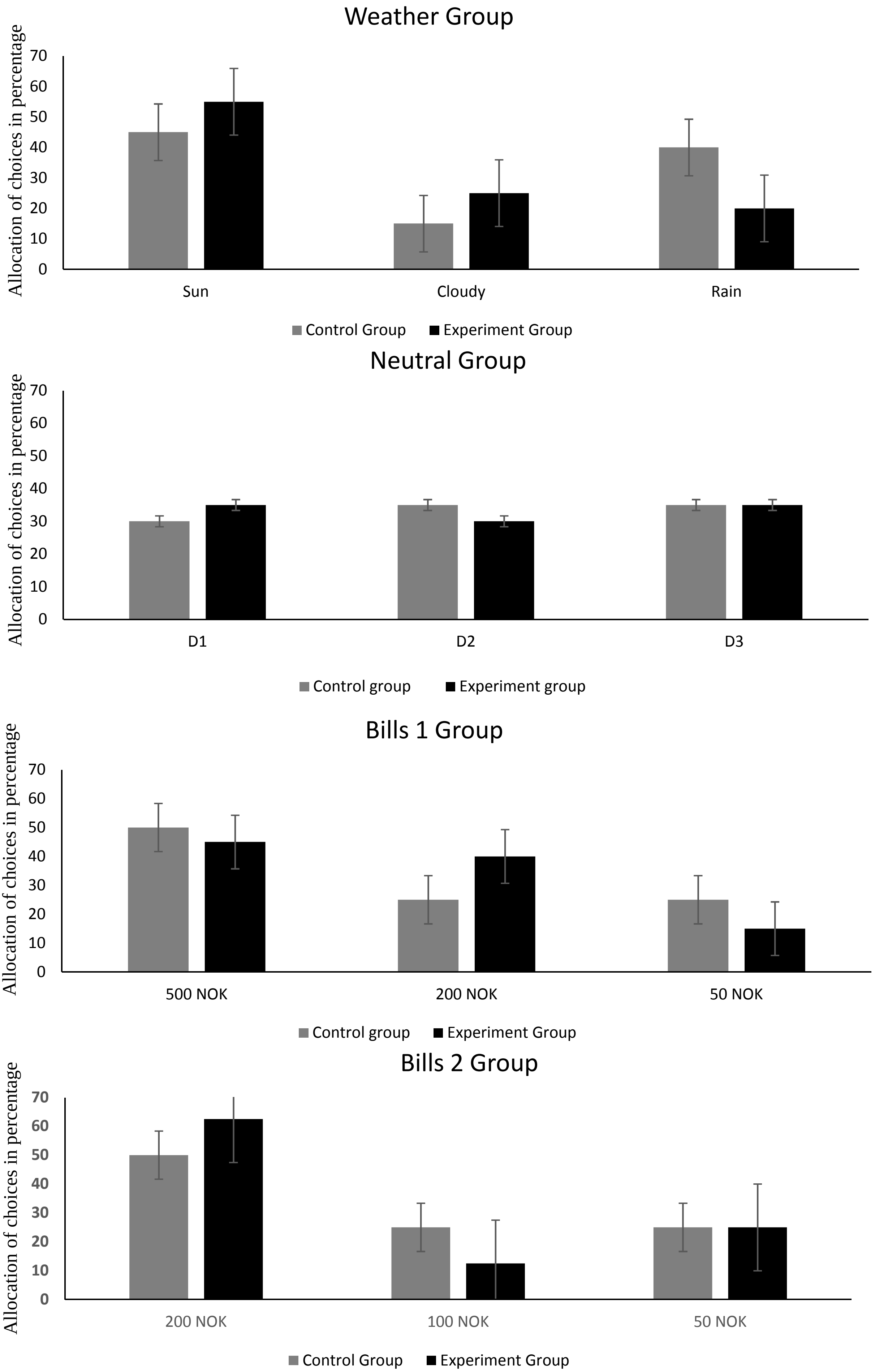

Figure 7. The figure shows choices towards the bottles labeled with the B-stimuli for all experiments (Experiment Group) compared to the choices made by the participants towards the D-stimuli the Control Group in Experiment 4.

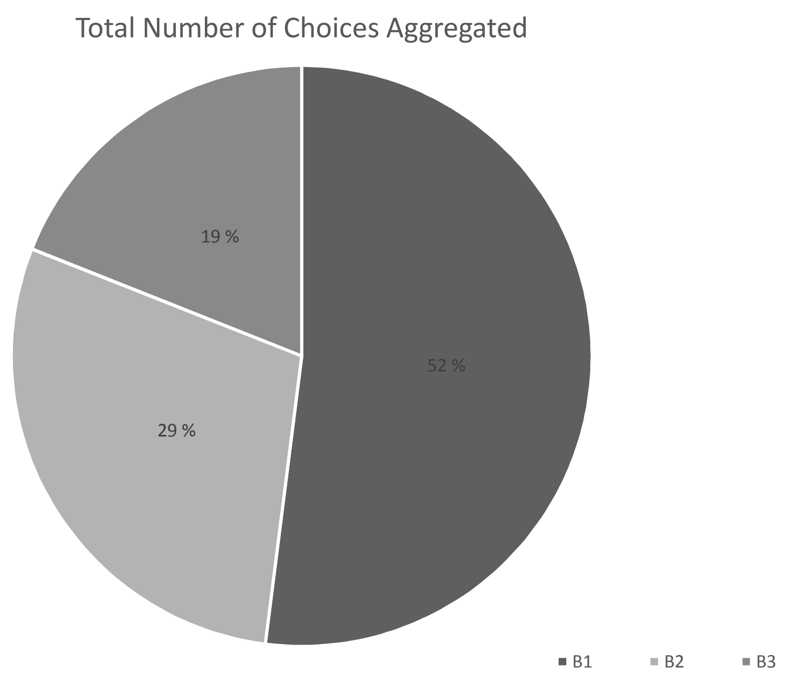

Figure 8. The figure shows the aggregated number of choices towards the B1, B2, and B3 stimuli for Weather Group, Bills 1 Group, and Bills 2 Group.The Neutral Group and Control Groups are not included.