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Preferences in equivalence classes by low potency benign valenced stimuli

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ABSTRACT

The focus of the present experiment was to study variables influencing preferences in choice situations through equivalence class formation and transfer of function. Three 3-member equivalence classes (ABC) were formed with a one-to-many training structure and were followed by training of the D-stimuli to the A-stimuli. D-stimuli were either valenced or non-valenced. Hence, participants were tested for three 4-member classes (ABCD). Finally, three identical bottles of water with B-stimuli printouts were presented to participants. The results showed that for the valenced stimuli, participants chose B1 in 55% of the cases, while there was no preference among the B-stimuli for the non-valenced stimuli.

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Behavior analytic theory has mainly used the quantitative framework of the matching law to study preference and choice behavior (Fisher & Mazur, 1997). In this context, the term preference has been defined as responding towards one object or situation more frequently than toward other objects or situations. At the theoretical level, most studies have focused on the discovery of environmental factors that are the determinants of preference behavior (e.g., Karsina, Thompson, & Rodriguez, 2011; Tversky & Kahneman, 1981). The study of preference is also of clinical value (Reed & Kaplan, 2011) because choices that we make in everyday life are directly related to both our own health and the global environment. For example, Lowe and Horne (2009) use the term obesogenic to describe the state of environment many people live 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).

An alternative way to study variables influencing preferences in choice situations is through equivalence class formation and transfer of function. Stimulus equivalence refers to relations between stimuli that have been shown in experimental tests to have the properties of reflexivity, symmetry, and transitivity features. The stimuli become interchangeable for each other without direct training (e.g., Sidman & Tailby, 1982). Transfer of function can be characterized as a specific function which is explicitly established for one stimulus that participates in an equivalence relation; the same function may then transfer to the other stimuli participating in the relation without

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further training (Barnes-Holmes, Keane, Barnes-Holmes, & Smeets, 2000; Dougher, Auguston, Markham, Wulfert, & Greenway, 1994; Roche & Barnes, 1997).

For example, Barnes-Holmes et al. (2000) showed that individuals' preferences for cola-based drinks resulted from conditional discrimination training with emotive words in two 3-member equivalence classes. One class consisted of the nonsense syllable VEK, the word CANCER, and BRAND X. The second class consisted of the nonsense syllable ZID, the word HOLIDAY, and BRAND Y. Brands X and Y were different labeled cola-based drinks. After forming the equivalence classes, twenty-seven participants were given samples of Brands X and Y. Sixteen participants rated the cola-based drink labeled with BRAND Y significantly better that the similar cola drinks labeled with BRAND X (the colas were in fact the same). The researchers believed that the emotive functions of the words HOLIDAY and CANCER had transferred to BRAND Y and BRAND X, respectively, and influenced participants' preference for the cola-based drinks. These findings were replicated in a later study with children (Carpentier, Smeets, & Barnes-Holmes, 2003).

Recently, Arntzen, Fagerstrøm, and Foxall (2016) extended these previous experiments by employing an experiment with 16 college students who were trained to form three 3-member equivalence classes with a one-to-many training structure (AB/AC). After the equivalence test, three D-stimuli, a smiley face (D1), neutral face (D2), and a sad face (D3), were associated with the A1, A2, and A3 stimuli, respectively. Another equivalence test showed that the three 4-member classes emerged. Then, participants chose one of three bottles of water with B-stimuli printouts attached to the front of the bottles. The findings showed that thirteen participants (81%) chose the bottle with B1, the stimulus that was in the same class as the smiley face (D1). Thus, the labels on a product influenced the selection of the product based on the membership of the label in a stimulus class that contained a positively valenced class member.

It is important to notice that there are at least three procedural factors that differentiate the Arntzen et al. (2016) and Barnes-Holmes et al. (2000) studies: The potency of the valenced stimuli, the substances used in the preference tests (water vs. cola), and the form of the preference test (choosing on the basis of label alone vs. taste test). The potency of valence can be measured by the eliciting strength and reinforcing potency of stimuli. Thus, Barnes-Holmes et al. (2000) used stimuli which had pronounced positive and negative valences, HOLIDAY and CANCER, In contrast, Arntzen et al. (2016) used stimuli, smiley, and sad faces, which might be considered to be less pronounced than the stimuli used by Barnes-Holmes. Therefore, we wanted to further examine whether preferences could be influenced by even milder or benignly valenced stimuli. The present study investigated how preference for one of three identical objects, water bottles, was influenced as a function of stimuli from the same equivalence class as different valenced stimuli. For one group, the valenced D-stimuli in a three 4-member class (ABCD) consisted of weather chart symbols, including sun (D1), partial sun (D2), and rain (D3). The stimuli were chosen as they were assumed to have distinct positive and negative reinforcing potency, though less than either the emoticons used in Arntzen et al. (2016) or the highly valenced words used in Barnes-Holmes et al. (2000). Furthermore, we compared the valenced stimuli's effects by employing neutral D-stimuli for the other group. The D-stimuli consisted of three pictures of dikes of the Netherlands (a dike is like a massive wall used to hold back water to rescue countryside), which were assumed to be non-valenced stimuli. We predicted that, in contrast with the mildly valenced weather chart symbols, that these non-valenced stimuli would not differentiate choice in the preference test.

Method

Participants

Forty college students, 28 females and 12 males, were assigned to two different groups. The participants' average age was 25 years. Group 1 consisted of three females and 17 males, and, Group 2 consisted of 10 females and 10 males. The average age for Group 1 was 23 years, and for Group 2, 28 years. Five additional participants did not pass the first test for derived relations; their data were not included in the analyses. Participants were recruited through lectures at Oslo and Akershus University College and personal contacts. Participants read and signed informed consent forms prior to the experimental session, and were informed that they could withdraw from the experiment at any time. All participants were debriefed after the experimental sessions.

Apparatus and setting

The experimental sessions were conducted in one of two small cubicles, 1.3 m × 3.2 m and 5.2 m × 4.3 m in the lab that were furnished with a table and chair. The length of the experimental sessions varied between 25 and 85 min with a mean of 48 min. The variation in session length is due to the repetition of training blocks until meeting the 90% mastery criterion. An HP Elitebook laptop computer equipped with an Intel Core i5 processor and a custom-made matching-to-sample (MTS) software presented the stimuli and recorded participants' responses. The laptop computer was equipped with an external mouse that was used to move the cursor and click on the stimuli that were displayed on the screen.

Stimuli

Figure 1 shows the stimuli that were used to form three 3-member classes, while Figure 2 shows the stimuli that were used to expand the class size. The stimuli in Figure 1 consisted of Arabic, Cyrillic, and Hebraic letters and were presented in black print on a white background. Each stimulus was presented on a pressure sensitive area that was 10.5 cm in width and 3.7 cm in height. The stimuli varied in size from 2.6 to 5.7 cm in width and 0.8–3.7 cm in height. Class expansion stimuli (weather chart symbols and dikes of the Netherlands) were displayed in color.

Three identical plastic bottles with water were presented in the preference test. The bottle labels were replaced with white B1, B2, and B3 stimuli printouts. The labels were 9 cm × 5 cm in size, and the stimuli varied between 4.3 and 6.4 cm in height and 4.3 and 3.2 cm in width. The bottles contained half a liter of water. The bottles were placed on a table in a random position across participants and there was approximately a 3–4 cm between each bottle.

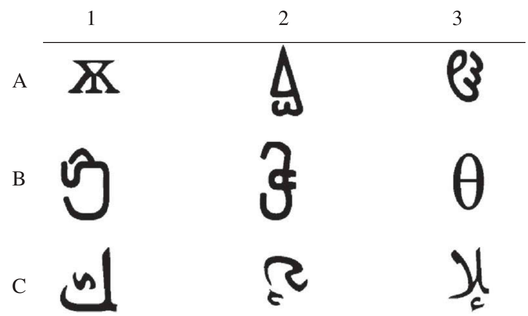

Figure 1. Stimuli used as members of the equivalence classes.

Procedure

The present experiment quasi-randomly assigned 40 college students to two different groups. The computer screen presented the following experimental instructions:

> Thank you for participating in this experiment. This is an experiment in the field of learning psychology, and it requires no prior knowledge of computer use. In brief, you are asked to click on one of the stimuli that appears on the screen. The goal is to make as many correct choices as possible. After moving the cursor over the stimulus that appears in the middle of the screen and clicking it, three other stimuli will appear on the screen. Clicking the correct one will result in the written words "Correct" or "Good" on the screen. If you click on the wrong one, the word "Wrong" or a similar word will follow. This is the way that you will 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!

Participants were asked if they had any questions about the instructions; if so, the instructions that the participants questioned were repeated. Participants were not provided with any information other than what was written in the instructions. Further, participants were informed that the experiment would end when the written text, "Congratulations, you are done, you can now get the experimenter," appeared on the screen. Conditional discrimination training was initiated when participants clicked on a square at the bottom of the screen that stated, "Click here to begin the experiment." The four steps in the procedure are shown in Figure 2. The conditional discrimination training was arranged in a one-to-many (OTM) training structure (AB/AC) (e.g., Arntzen, 2012). Furthermore, we employed a simultaneous protocol with a concurrent presentation of 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. In this denotation, the sample stimuli are in bold, while the correct comparisons are underlined. The sample stimulus was always presented in the middle of the screen; clicking on the sample stimulus with the mouse cursor occasioned the presentation of the comparison stimuli. The sample stimulus remained present during the presentation of the comparison stimuli. The comparison stimuli were presented randomly in three of the four corners of the screen, where one corner was left blank. The computer software randomized both the trial-types and the location of the comparison stimuli, and each baseline relation was presented five times. Responding in accordance with the defined classes was

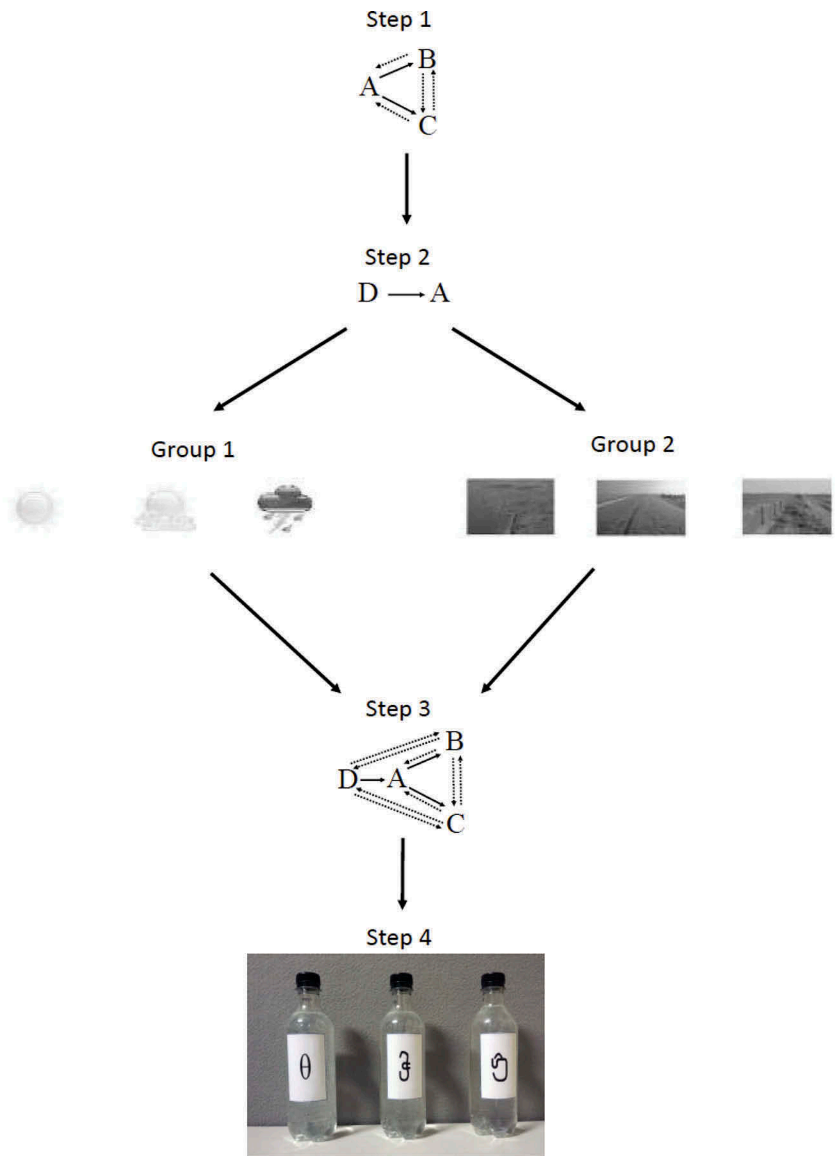

Figure 2. An overview of the different steps in the procedure. In Step 1, potentially three 3-member classes are trained and tested. In Step 2, the D-stimuli are trained to the A-stimuli. In Step 3, all relations are tested. Finally, in Step 4, a preference test for bottles of water with B-stimuli as labels.

followed by the presentation of programmed consequences in the form of written words "correct," "super," and "good" for correct responses and "wrong" for incorrect responses. The presentation lasted for 1000 ms, and were followed by a 1000 ms inter-trial-interval. The baseline relations presentations were randomized into blocks that consisted of 30 trials per block, with a mastery criterion set to 90%. When the criterion was met with 100% probability of the programmed consequences, the probability was reduced by successive steps of 75%, 50%, 25%, and 0%. The mastery criterion for all steps was 90%.

Next, a baseline test and the derived relations, including symmetry and equivalence probes, were presented without programmed consequences (Step 1). Reflexivity was not tested due to the extensive experience humans have with identity matching, and one cannot be sure that reflexivity tests are positive due to the experimental variables, or the historical variables (e.g., Sidman, 1994). For participants who met the criterion of at least 90% correct responses for the baseline, symmetry and equivalence probes, the software initiated the class expansion without interrupting the procedure. When the test criterion was not met, the experimental session ended and participants were thanked and debriefed.

For participants in Group 1, weather pictures indicating "sunny" (D1), "partly cloudy" (D2), and "rain" (D3) were trained to the nodal stimulus (A) (Step 2). For Group 2, a neutral stimulus picture (three different dikes, D1, D2, and D3) was trained to the nodal stimulus (A) (Step 2). For both groups, a test was implemented to determine whether the functions were transferred to all stimuli within the class (Step 3). The tested relations consisted of the same relations as in Step 2, but included the following 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; and equivalence relations: **D1**/C1–C2–C3, **D2**/C1–C2–C3, **D3**/C1–C2–C3, **D1**/B1–B2–B3, **D2**/B1–B2–B3, **D3**/D1–D2–D3, **C1**/D1–D2–D3. **C2**/D1–D2–D3, **C3**/D1–D2–D3, **B1**/D1–D2–D3, **B2**/D1–D2–D3, **B3**/D1–D2–D3.

Finally, participants were exposed to a preference test in which the stimuli from the B set (B1, B2, and B3) were attached to three bottles of water (Step 4). To ensure that the experimenter could not influence participants' choices, the experimenter was situated in another part of the lab. When the Step 3 test ended, participants were told to go to the cubicle next to the one where they had completed the experiment. There, they were asked to choose a bottle and bring it to the experimenter. The scorings of choices B1, B2, and B3 were done in the presence of the individual participant to ensure that scoring was correctly recorded on the experimenter's scoring form. Finally, in a post-experimental interview participants were asked, "Why did you pick that bottle?"

Behavior recorded

The MTS software recorded information about the trial number, number of training trials, correct/incorrect comparison choice, and whether or not programmed consequences were delivered, as well as a summary of a participant's performance in the equivalence test.

Participants' preference test choices (B1, B2, and B3 – labeled water bottles) were manually recorded during the post-experiment interview.

Results

For Group 1, the mean number of training trials to establish the baseline relations was 270 trials, ranging from 180 to 780 trials. The mean total number of trials including test trials was 566 ranging from 465 to 1080. For the class expansion in Step 3 the number

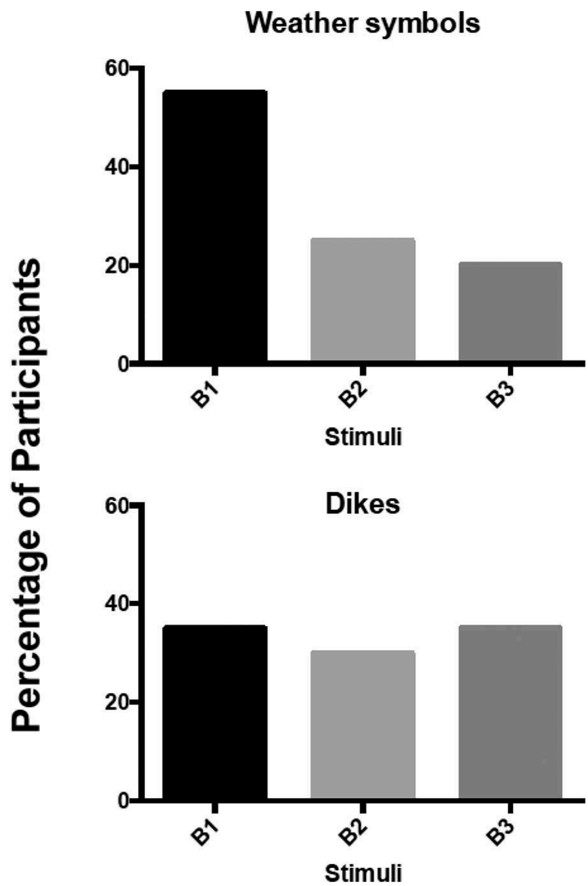

Figure 3. The percent of participants who chose either B1, B2, or B3. The upper panel shows the percentage for Group 1, and the bottom panel shows the percentage for Group 2.

of training trials ranged from 15 to 30. For Group 2, the mean number of training trials to establish baseline relations was 287, ranging from 180 to 510 trials. The mean total number of trials was 579. For the class expansion in Step 3 the number of training trials ranged from 15 to 30. There were no statistical differences between the groups with respect to training trials. In addition, each participant in both groups (totaling 40) formed three 3-member equivalence classes. Furthermore, all participants then formed three 4-member classes after the DA training.

When the preference tests were conducted, for Group 1, 11 of the 20 participants chose the bottle of water labeled with the B1 stimulus in the preference test. In other words, 55% of the participants preferred the stimulus in Class 1, the class that presented the “sunny” weather symbol (D1) (as shown in Figure 3). Five out of 20 (25%) participants chose “partly cloudy” weather symbol (B2), and four out of 20 (20%) chose bottle B3, which bore the label “rainy.” The difference between B1 and B3 was statistically significant, Chi Square X^2 $(1, N = 20) = 6.450$, $p < 0.05$, but not between B1 and B2. In contrast, participants in Group 2 chose the bottles with B1, B2 or B3 in 35%, 30%, and 35% of the cases, respectively. There were no statistical differences among the choices in Group 2.

Discussion

The main findings in the present experiment showed the that it was possible to influence the preference for one of three identical bottles of water by training a specific function to the nodal stimuli in already established equivalence classes.

Implications

There are several implications of the present experiment. First, three 3-member equivalence classes were extended by training of only one new relation D-A. The extension of classes is consistent with previous research by Sidman and colleagues (e.g., Sidman, Kirk, & Willson-Morris, 1985). Hence, the present experiment emphasizes the possibility of training only a few relations and a high number of new relations will emerge, and training one function to a member of a class will transfer to the whole class. Second, it is possible to influence preferences for objects by training valenced stimuli to an existing stimulus class, even with stimuli that are quite benign.

The results obtained in the presence experiment are important for analyzing factors that influence consumer choice in commercial settings. 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) who attempted to change a preference towards a beneficial food category and away from a detrimental food category for a group of typically functioning children. 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 obese children has accumulated strong empirical support (Jelalian & Saelens, 1999), and findings from the present experiment might have supplemental value to such interventions. However, 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 be underweight, whereas people with less severe mental disabilities are prone to be overweight (Hove, 2004). Present findings could be beneficial as part of an intervention targeting food preferences for people with developmental disabilities. For example, conditional discrimination procedures could be conducted to establish sugar-free alternatives to soft drinks as equivalent to positively valenced stimuli.

Meaningfulness and valence

Meaningful stimuli have been defined by their connotative and denotative properties. Denotative properties refer to adjectives used to describe or define the stimulus whereas the connotative properties describe the emotive functions governed by the stimulus (e.g., Fields, Arntzen, Nartey, & Eilifsen, 2012). Stimuli can govern positive and negative connotative valence. For example, the picture of a snake can elicit fear responses such as skin conductance and high pulse, whereas a funny picture can elicit smiling or evoke laughter (Arntzen, Nartey, & Fields, 2014). Meaningfulness points to a variety of stimulus properties, whereas valence refers to the specific emotive or evocative functions associated with the stimulus. Hence, the eliciting and/or conditional reinforcing potency of a stimulus can be directly linked to its connotative and denotative properties, also defined as meaningfulness. Whereas valence relates to the attractiveness or aversiveness.

In the present study, three types of valenced stimuli were used. A strategy which is quite common within cognitive psychology (e.g., Humphreys, Underwood, & Chapman, 2010). Thus, images of dikes of the Netherlands (D-stimuli) were assumed to be neutrally valenced images and the results showed no statistical significant differences among the choices the D-stimuli. These images display similar nature landscapes, none of the pictures are assumed to stand out as more or less valenced that the others. As for the weather chart symbols, it is fair to suggest that people have an extensive learning history with these images. Moreover, it is probable to assume that it is a common understanding that sunny weather holds positive associations and thus are more positively valenced, whereas rain and thunder holds more negative associations–thus are more negatively valenced. In further research, it is important to collect data on how a huge sample of people rate the three weather symbol and the three pictures of dikes as according to "positivity," "neutrality," and "negativity." In addition, experiments should replicate the present experiment with different sets of D-stimuli. In addition, different training structures should be employed to form equivalence classes.

There is no systematic correlation between number of training trials and choice in the preference test. There are experiments indication that the strength of equivalence classes is influenced by over-training (e.g., Bortoloti, Pimentel, & de Rose, 2014; Travis, Fields, & Arntzen, 2014). Over-training is the continuation of training when the mastery criterion is met. This was not tested for in the present study, whereas the participants were automatically forwarded to the equivalence testing when the mastery criterion of 90% was obtained for all the baseline relations. However, the effects of over-training should be further explored in future experiments.

Preferences

The focus of the present study was to study how preferences toward neutral stimuli could be influenced by stimuli assumed to hold pre-experimental behavioral functions. The present experiment replicated the procedure from (Arntzen et al., 2016) in which the participants response was choosing one out of three bottles. This response is seemed to be a more definite response than rating the pleasantness of the same cola drinks on a scale from 1 to 7 as in the study by Barnes-Holmes et al. (2000).

The effects of the weather symbols could have been influenced by variables unrelated to the experimental situation, for example, the weather on the day of the experimental session. Furthermore, it is reasonable to assume that sunshine and rain differ less in typical positive and negative reinforcing potency than the stimuli (holiday and cancer) in the Barnes-Holmes et al. (2000) study. For example, one participant in the present experiment reported that he picked the bottle labeled with the B3 stimulus (associated with D3, rain and thunder) because the weather had been too warm lately, and he would like some rain.

Because we did not conduct preference tests prior to the baseline test, it could be argued that preferences did not change as a result of the experimental procedure but rather because there was an existing preference for the stimuli. For some of the participants in Group 1 who picked the bottle labeled with the B2 printout this could be the case. However, not for the participants who picked the bottle with the B1 printout and the majority of the participants who picked the B3 printout. The five participants who did chose the bottle labeled with the B2 printout, reported that their choice was based on some topographical features of the other members of the class. They reported "I chose that bottle because it was in the same group as the heart shaped symbol (A2)," "it was together with the ice cream symbol (A2), "it reminded me of the carrot (A2), the first relation I learned," "because it looks like an E, the first letter in my name (B2)" and "it was in the group with the symbol I first learned, the ice-cone (A2)." Furthermore, four participants chose the bottle labeled with the B3 printout. For example, one participant reported that "I did not like the other stimuli, I am tired of sunny weather. It would have been nice with a little rain." It is interesting to mention that the experiment was conducted in a sunny and hot period at spring time. In sum, there seem to be some correspondence between self-report and non-verbal performance which might have impeded the experimental manipulation in the present experiment.

Furthermore, the results from Group 2 show that non-valenced stimuli did not affect preferences for the objects. It could also be argued that the participants responded in accordance with what they thought were expected from them rather than to the experimental contingencies. However, verbal reports from the participants were gathered subsequent to the choice situation, and none of the participants reported that their choice was influenced by experiment expectations.

It might be argued that the participant chose the B-stimulus associated with the D-stimulus displaying the participants preferred color. Stimulus D1 and D2 in Group 2 are alike with respect to colors whereas stimulus D3 contain more green. Only participant 13198 and 13212 reported that their choices were based on any topographical features of the pictures, and the participants chose stimulus B1, and B2 that were associated with D1 and D2 respectively.

Summary

The present experiment extended the knowledge on how preferences in equivalence classes cold be influenced by distinct positive and negative reinforcing potency images but not as highly valenced stimuli as in previous reports (e.g., Barnes-Holmes et al., 2000). Henceforth, the present experiment demonstrated that preferences for one of three identical bottles of water could be influenced by training of a specific function to the nodal stimuli in established equivalence classes. Further research should replicate the present experiment with more participants and different valenced D-stimuli.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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Disclosure statement

The authors declare that there is no conflict of interest.

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