BRIEF REPORT

ON THE USE OF MORPHING TECHNIQUES IN CONDITIONAL-DISCRIMINATION PROCEDURES

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A stimulus class is a set of stimuli that can be arrayed along some continuum, all of which occasion the same response after having been trained to occur in the presence of only some of the stimuli in the set (Fields & Reeve, 2001; Keller & Schoenfeld, 1950). Concept formation is inferred when the same response is occasioned by many stimuli in a set or by many of the relations among the stimuli in a set (Dinsmoor, 1995; Keller & Schoenfeld, 1950). These sets of stimuli which differ in terms of their physical attributes have been called perceptual classes (e.g., Fields et al., 1997; Lea & Ryan, 1984), relational classes (e.g., Lea & Ryan, 1984; Smoke, 1932), equivalence classes (e.g., Sidman, 1994; Sidman & Tailby, 1982), functional classes (e.g., Sidman et al., 1989), and semantic categories (e.g., Rosch & Mervis, 1975).

Stimulus equivalence is defined as novel responding after preliminary training of conditional discriminations that is in accord with the properties of reflexivity, symmetry, and transitivity (Sidman & Tailby, 1982). Previously unrelated stimulus relations will arise without direct training, and members of an equivalence class will become mutually substitutable (Green & Saunders, 1998).

Equivalence class formation has been demonstrated with both verbally competent people (Dugdale & Lowe, 2000), including adults and typically developing children (e.g., Arntzen & Vaidya, 2008; Pilgrim et al., 1995; Sidman & Tailby, 1982), and those with developmental disabilities or autism (e.g., Arntzen et al., 2010; LeBlanc et al., 2003). Responding according with stimulus equivalence has also been demonstrated after training with different stimulus modalities such as olfactory (Annett & Leslie, 1995), haptic (Belanich & Fields, 1999), tactile (O'Leary & Bush, 1996), and gustatory (Hayes et al., 1988). Stimulus equivalence has also been demonstrated with a variety of visual stimulus materials, such as different abstract stimuli (e.g., Sidman & Tailby, 1982), consonant-vowel-consonant syllables (e.g., Fields et al., 1997), three-dimensional objects (e.g., Devany et al., 1986), and meaningful pictures (e.g., Arntzen, 2004; Arntzen & Lian, 2010; Arntzen & Nikolaisen, 2011; Bentall et al., 1993; Holth & Arntzen, 1998; Smeets & Barnes-Holmes, 2005).

Research has also shown that responding in accordance with equivalence classes could be influenced by the type of stimuli used. For example, different types of pictorial stimuli (e.g., Bentall et al., 1993) or pronounceable stimuli (e.g., Mandell & Sheen, 1994) have enhanced the formation of equivalence classes. In a series of experiments adult participants trained to form larger equivalence classes with a linear series (LS) training structure have shown that only abstract shapes as stimuli produce little class enhancement, while the inclusion of at least one meaningful stimulus in a class of abstract shapes can influence the likelihood of forming an equivalence class among that set of stimuli (e.g., Arntzen & Mensah, 2020; Arntzen et al., 2015; Fields et al., 2012). This enhancing effect has also been shown in experiments with a many-to-one (MTO) training structure both with adults (Arntzen, 2004; Lyddy et al., 2000; Rustad Bevolden & Arntzen, 2018) and children (Arntzen & Lian, 2010; Smeets & Barnes-Holmes, 2005). In the present experiment, the MTO is used because it produces a high rate of yields (number of participants forming equivalence classes) (see Fields et al., 2020, for a discussion).

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Arntzen (2004) examined how responding in accordance with equivalence class formation changes as a function of the position of meaningful stimuli, pictures, and nonsense syllables among fifty college students using the MTO-training structure (AB, CB, DB, and EB). The main findings were that when A-stimuli were meaningful stimuli, 10 of 10 participants responded in accordance with equivalence, whereas five of 10 responded in accordance with equivalence when the meaningful stimuli were presented at the end of the training (as E-stimuli). In addition, when all stimuli were nonsense syllables, four of 10 participants responded in accordance with equivalence, and when all the stimuli were Greek/Arabic letters, only three of ten participants responded in accordance with equivalence. Furthermore, four of 10 participants responded in accordance with equivalence when the A-stimuli were meaningful stimuli, and participants were required to use keys on the keyboard. In another experiment, Arntzen and Lian (2010) examined the effect of meaningful stimulus as a node (C) in the formation of equivalence classes in children. The experiment was arranged as an MTO training structure training on six conditional discriminations (AC/BC) and testing for three 3-member equivalence classes. The main findings were that the children formed equivalence classes more likely when the nodal stimuli were pictures than when they were abstract. In sum, there seems to be a difference in outcome on equivalence tests between the reference groups (all abstract shapes and pictorial stimuli as a node) both for LS and MTO.

The present experiment was arranged to replicate and extend the outcome in Arntzen and Lian (2010) with larger classes by introducing sets of nodal stimuli degrading the effect of pictorial stimuli. Hence, we wanted to study discriminability (the degree to which a participant discriminates between stimuli (e.g., White et al., 1985)) when introducing mixed variants of abstract and pictorial stimuli. Since one way of degrading the effectiveness of the role of meaningful stimuli on stimulus equivalence class formation, we employed a morphing technique to change the stimuli used as nodes gradually. There are at least two ways to do morphing of stimuli. One way is to have two endpoints, and have the midpoint morphed to be 50% of each of the endpoints. Fields and colleagues (Fields, Matneja, et al., 2002; Fields, Reeve, et al., 2002) used this morphing technique to study linked perceptual classes and generalized categorization. Another morphing technique is when one endpoint is morphed into the other endpoint. Such a morphing technique was used in the present experiment where pictorial stimuli as one of the endpoints was morphed into abstract stimuli the other endpoint to study the effect of degrading of pictorial stimuli on the likelihood of forming stimulus equivalence classes.

We asked about the effects of degrading the pictorial stimuli from employing pictorial stimuli to abstract shapes as nodal stimuli in an MTO training structure (AE/BE/CE/DE) when children were trained conditional discriminations and testing for the emergence of three 5-member equivalence classes. Thus, a between-group design with five groups differing in the degree of morphing of the E-stimuli (nodal stimuli) in the stimulus set were used. Group 1 included all pictorial stimuli, and the pictures were gradually morphed into the abstract shapes through Groups 2, 3, 4, and finally, Group 5 with E-stimuli as abstract shapes.

METHOD

Participants

Fifty primary school pupils, 21 girls and 29 boys aged between 7–10 years (average 9.04 years) participated in the experiment. Their teachers and parents consented to participate after being briefed about what the experiment was about. The consent included an assurance that the children could withdraw from the experimental session at any time without any negative consequences. None of the children had previously taken part in any experiments. After finishing the experiment, the children were thanked and given small gifts, like pencils, markers, etc.

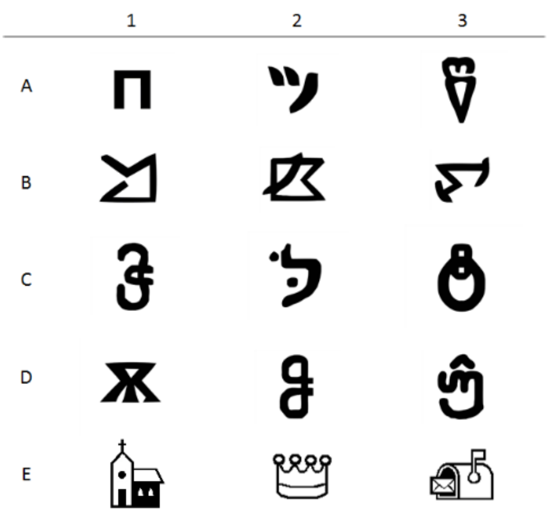
Setting and Apparatus

The experiment was conducted in a small room measuring approximately 5m2. There were two tables and two chairs on which children sat during the sessions. An HP Compaq nc6320 laptop computer running Windows 8 and a screen with a 16.8 in diagonal length and with a 16 X 9 horizontal-to-vertical ratio was used to conduct the experiment. The children used an external mouse to control the position of the cursor. A customized software developed in collaboration with the first author controlled the presentation of stimuli and the recording of all responses throughout the experiment.

Stimuli

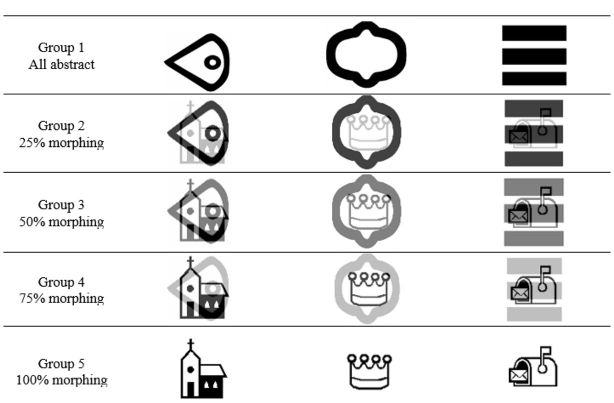
Abstract shapes and meaningful pictures were used as stimuli (see Figures 1 & 2).

Figure 1



Note. The Stimuli used in Experiment 1 for Group 5. The E-stimuli varied from one group to the other (shown in Figure 2).

Figure 2



Note. The variation of the E-stimuli used in the five conditions. This is the correct order.

Morphing

The morphing program used to create the stimuli was FantaMorph Version 5.4.1 (http://www.fantamorph.com/index.html). With the help of the program, one stimulus was "morphed" into another stimulus (see Figure 2).

Design

The experiment was arranged as a between-group design with children randomly assigned to five different groups, each with 10 participants. The difference between the stimuli used for each group was the degree of morphing of the E-stimuli in the stimulus set. For Group 1, the E-stimuli were pictorial stimuli. The meaningful stimulus was degraded across groups, from 25% into the abstract shapes for Group 2, then 50% morphing in Group 3, and 75% and 100% morphing in Groups 4 and 5 (ABS), respectively (see Figure 2). Each participant was trained with the baseline relations required to form three 5-member equivalence classes in an MTO training structure. All participants completed the experiment in a day.

Procedure

All baseline relations were trained in an MTO training structure and with a simultaneous protocol. Furthermore, the baseline relations were trained in a serialized basis, and programmed consequences were provided following the selection of comparisons for each trial (see Table 1). All conditional discriminations were established before introducing a test for all emergent relations, and the trials were randomly presented (see Table 2). Tables 1 and 2 show each of the trial representations; the first stimulus is the sample, and the other three are the comparison stimuli, whereas the underlined comparison is the correct comparison (e.g., A1/E1E2E3; see details in Table 1). The comparison stimuli were randomly presented in different positions in the four corners of the screen with one corner blank. Every correct response (experimenter-defined) to a sample-comparison pair, was followed by a textual stimulus on the screen as "awesome", "very good," etc. Every incorrect response (experimenter-defined) to a sample-comparison pair, was followed by the textual stimulus "incorrect" on the screen. The programmed consequences in a 36-trial block

Table 1

Overview of the Conditional Discrimination Training

Training Phase		Mastery Criterion	Likelihood of Programmed Consequences
Acquisition	A1/E1E2E3, A2/E1E2E3, A3/E1E2E3	9/9	100
	B1/E1E2E3, B2/E1E2E3, B3/E1E2E3	9/9	100
	A1/E1E2E3, A2/E1E2E3, A3/E1E2E3, B1/E1E2E3, B2/E1E2E3, B3/E1E2E3	17/18	100
	C1/E1E2E3, C2/E1E2E3, C3/E1E2E3	9/9	100
	A1/E1E2E3, A2/E1E2E3, A3/E1E2E3, B1/E1E2E3, B2/E1E2E3, B3/E1E2E3, C1/E1E2E3, C2/E1E2E3, C3/E1E2E3	25/27	100
	D1/E1E2E3, D2/E1E2E3, D3/E1E2E3	9/9	100
	A1/E1E2E3, A2/E1E2E3, A3/E1E2E3, B1/E1E2E3, B2/E1E2E3, B3/E1E2E3, C1/E1E2E3, C2/E1E2E3, C3/E1E2E3, D1/E1E2E3, D2/E1E2E3, D3/E1E2E3	33/36	100
Maintenance	A1/E1E2E3, A2/E1E2E3, A3/E1E2E3, B1/E1E2E3, B2/E1E2E3, B3/E1E2E3, C1/E1E2E3, C2/E1E2E3, C3/E1E2E3, D1/E1E2E3, D2/E1E2E3, D3/E1E2E3,	33/36	75
	A1/E1E2E3, A2/E1E2E3, A3/E1E2E3, B1/E1E2E3, B2/E1E2E3, B3/E1E2E3, C1/E1E2E3, C2/E1E2E3, C3/E1E2E3, D1/E1E2E3, D2/E1E2E3, D3/E1E2E3,	33/36	50
	A1/E1E2E3, A2/E1E2E3, A3/E1E2E3, B1/E1E2E3, B2/E1E2E3, B3/E1E2E3, C1/E1E2E3, C2/E1E2E3, C3/E1E2E3, D1/E1E2E3, D2/E1E2E3, D3/E1E2E3,	33/36	25
	A1/E1E2E3, A2/E1E2E3, A3/E1E2E3, B1/E1E2E3, B2/E1E2E3, B3/E1E2E3, C1/E1E2E3, C2/E1E2E3, C3/E1E2E3, D1/E1E2E3, D2/E1E2E3, D3/E1E2E3,	33/36	0

Table 2

Overview of Trial Types During Testing

Baseline	A1/E1E2E3, A2/E1E2E3, A3/E1E2E3, B1/E1E2E3, B2/E1E2E3, B3/E1E2E3, C1/E1E2E3, C2/E1E2E3, C3/E1E2E3, D1/E1E2E3, D2/E1E2E3, D3/E1E2E3,
Symmetry	E1/A1A2A3, E2/A1A2A3, E3/A1A2A3, E1/B1B2B3, E2/B1B2B3, E3/B1B2B3, E1/C1C2C3, E2/C1C2C3, E3/C1C2C3, E1/D1D2D3, E2/D1D2D3, E3/D1D2D3,
Equivalence	A1/B1B2B3, A2/B1B2B3, A3/B1B2B3, A1/C1C2C3, A2/C1C2C3, A3/C1C2C3, A1/D1D2D3, A2/D1D2D3, A3/D1D2D3, B1/A1A2A3, B2/A1A2A3, B3/A1A2A3, B1/C1C2C3, B2/C1C2C3, B3/C1C2C3, B1/D1D2D3, B2/D1D2D3, B3/D1D2D3, C1/A1A2A3, C2/A1A2A3, C3/A1A2A3, C1/B1B2B3, C2/B1B2B3, C3/B1B2B3, C1/D1D2D3, C2/D1D2D3, C3/D1D2D3, D1/A1A2A3, D2/A1A2A3, D3/A1A2A3, D1/B1B2B3, D2/B1B2B3, D3/B1B2B3, D1/C1C2C3, D2/C1C2C3, D3/C1C2C3

Note. No programmed consequences were presented in the test.

consequence was displayed in the middle of the screen for 500 ms. Termination of the programmed consequence was followed with a 500 ms inter-trial interval. Between trials, the mouse cursor was returned to the center of the screen.

Instruction

Each session started with the participant seated facing the computer monitor and presented with the following instructions on the computer screen, which was read out loud by the experimenter:

"In a moment, a stimulus will appear in the middle of the screen. Click on this by using the computer mouse. Three stimuli will then appear in three corners of the screen. Choose one of them by clicking on it with the mouse. If you choose the stimulus we have defined as correct, words like "very good," "excellent," and so on will appear on the screen. If you press a wrong stimulus, the word "wrong" will appear on the screen. At the bottom of the screen, the number of correct responses you have made will be counted. During some stages of the experiment, the computer will not tell you if your choices are correct or wrong. However, based on what you have learned so far, you can get all the tasks correct. Please do your best to get everything right. Thank you and good luck!" No further instructions were given after this before and after the experiment had started.

Acquisition of Baseline Relations

AE relations were trained first in a block containing nine trials, three of each trial type (see Table 1). A total number of nine correct trials out of the nine trials in the training block was required to proceed to the training of the next relation. BE relations were then introduced with the same requirements as AE, followed by a mix of AE and BE relations with blocks of 18 trials with a mastery criterion of at least 17 correct. Then, participants were exposed to the CE relations with the same requirements as for AE and BE training, followed by a mix of AE, BE, and CE relations with blocks of 27 trials with a mastery criterion of at least 25 correct. The last relation trained was the DE relation with the same requirements as AE, BE, and CE training. The final acquisition of the baseline training involved a block of all the relations in a mixed training: AE, BE, CE, and DE relations. The block had three presentations of each 12 trial types adding up to 36 trials. Out of the 36 trials, a minimum of 33 correct trials was required to complete the acquisition of the baseline relations. If the mastery criterion was no met for any of the trained relations as described above, the participants repeated the block until they did so.

Maintenance of Baseline Relations

Programmed consequences followed the selection of any comparison in every trial in all the blocks during acquisition. In the maintenance training, the percentage of trials that produced programmed was reduced first to 75%, then 50%, 25%, and finally to 0% (see Table 1). If the mastery criterion was not reached in any of the blocks, the blocks were repeated until the criterion was reached. When the participants reached the mastery criterion on the last block with no programmed consequences, the test for emergent relations was introduced.

Test for Emergent Relations

A test block that contained 180 trials followed the last block with no programmed consequences (see Table 2). Of the 180 trials, there were 36 baseline trials, 36 symmetry trials, and 108 equivalence trials. All of the trials were randomly presented and without programmed consequences. The formation of equivalence classes was defined by the selection of at least 90% correct comparisons that were consistent with the experimenter-defined classes for each type of relation.

RESULTS

Acquisition of Baseline Conditional Discriminations

The mean of the number of trials required to establish baseline conditional discriminations was computed for each group (see Figure 3). A visual inspection of the graph shows an inverted u-function across different stimuli with the highest number of trials for Group 3 and the lowest number of trials less variation for Group 1. A Welch's ANOVA test showed an effect of stimulus material W(4, 45)=7.006, p=0.0011. T-tests with Welch correction showed a significant difference in the number of trials to mastery criterion when comparing Group 1 (meaningful stimuli as node group) and Group 5 (abstract stimuli as the node group) (p=.016). Also, statistical differences were shown between Group 1 and Groups 4 (p=.0023) and 3 (p=.016), but not for Group 2 (p=0.136). Thus, the degree of degrading the nodal stimulus did to some extent influence the speed of acquisition of the baseline relations.

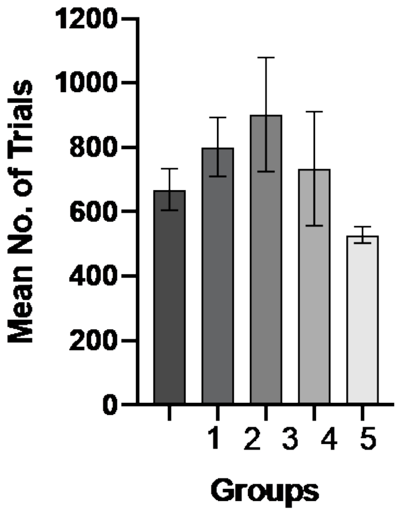
When the speed of acquisition (number of trials) was compared for all participants who went on to form equivalence classes and those who did not form classes, fewer trials were required to acquire the baseline relations for those who formed classes than those who did not (see Figure 4). However, a Welch's test showed that the difference was not statistically significant, t=1.779, p=.0855.

Equivalence Class Formation

As shown in Figure 5, there was a decrease in responding in accordance with stimulus equivalence as a function of morphing steps or degrading of the meaningful stimuli. In Group 1 (PIC as node), all children responded in accordance with stimulus equivalence, 70% of the children in Groups 2 and 3 formed the classes, and 50% of the children formed the experimenter defined classes in Group 4. When exposed to abstract shapes as the node, 10% of the children formed the experimenter-defined stimulus equivalence classes. A chi-square analysis showed the differences in yields to be statistically significant, X^2 (4) = 18.33, p =.001. Fisher Exact Tests indicated that equivalence yields of Group 1 participants differed significantly with Groups 5 (p=.000) and 4 (p=.033) and, but not Groups 2 and 3 (p=.211). The results suggest that the formation of equivalence was a function of degrading the pictorial stimulus as the nodal stimulus where greater yields were produced with meaningful stimuli and a decrease in the likelihood of equivalence class formation as the nodal stimulus becomes more and more abstract.

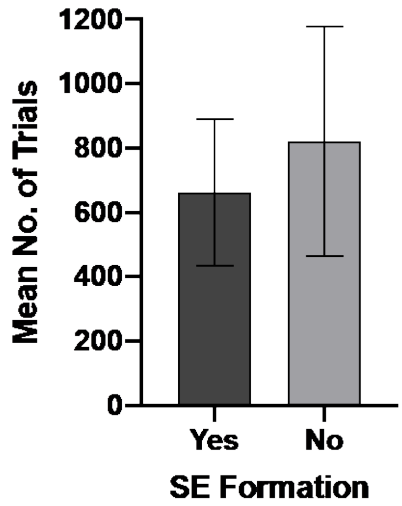
Figure 6 shows individual performance on separate relations in the test for emergent relations. In Group 1, all participants responded in accordance with experimenter-defined classes. In Group 2, only P4733 did not have the baseline relations intact, while two more participants (P4720 and P4719) did not respond in accordance with the experimenter-defined criterion for symmetry and equivalence trials. In Group 3, seven participants (P4705, P4713, P4716, P4736, P4706, P4722, and P4747) responded in accordance with the experimenter-defined criterion for all relations. In Group 4, five participants (P4741, P4737, P4727, P4703, and P4745) responded in accordance with the experimenter-defined criterion for all relations. For participants in Group 5, three participants (P4738, P4702, and P4721) had baseline relations intact during testing and P4702 had responded in accordance with the experimenter-defined criterion for symmetry, and P4721 also for equivalence.

Figure 3



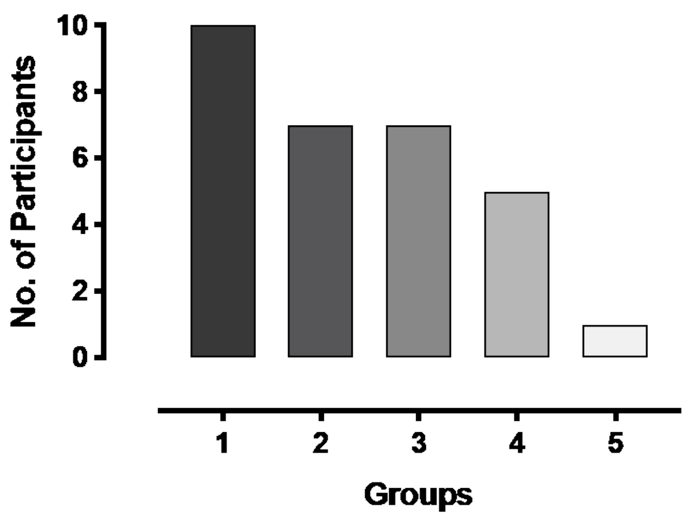
Note. Mean number of training trials across groups. Each line shows the standard error of the mean for the respective group

Figure 4



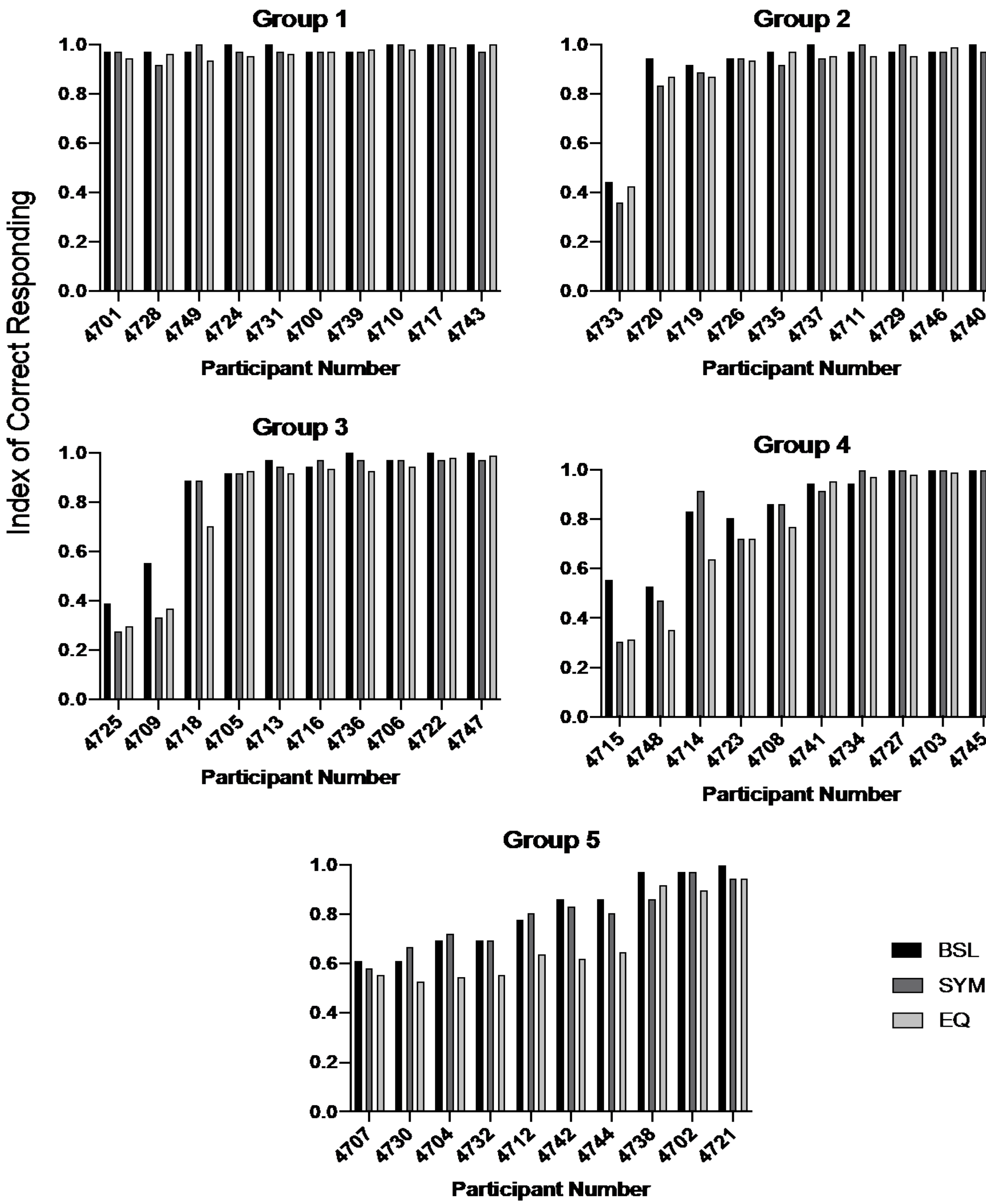
Note. Number of trials to criterion for participants who responded in accordance with equivalence (Yes) and participants who did not respond in accordance with equivalence (No). Each line shows the standard error of the mean

Figure 5



Note. Number of participants responding in accordance with stimulus equivalence.

Figure 6



Note. Index of correct responses across participants for baseline, symmetry, and equivalence trials in the test for emergent relations

DISCUSSION

The degrading of the pictorial stimuli which served as nodes were done by using a morphing procedure with gradually changing stimuli from meaningful or pictorial stimuli to abstract shapes. All children formed classes when the nodal stimuli were meaningful (the PIC group), while few children responded in accordance with equivalence when the nodal stimuli were abstract shapes (the ABS group). When the pictorial stimuli were degraded, there was a systematic reduction in yields across groups. Thus, the formation of equivalence classes was shown to be a function of the degrading of pictorial stimuli, which served as the nodal stimulus.

Number of Trials to Mastery Criterion

The results showed that the number of trials to meet the mastery criterion was lowest for the PIC group and highest for the ABS group. These findings are in accordance with Arntzen and Lian (2010). In the present experiment, there was no linear function decreasing number of training trials and the visibility of the pictorial stimuli as nodes. Thus, the speed (number of responses) at which participants acquired the baseline relations necessary for the formation of equivalence classes was only to some extent influenced by the degree of morphing of the nodal stimulus used. The variation of the number of trials to criterion is much smaller for the two reference groups compared to the three groups with degrading of the pictorial stimuli. Finally, it is also suggested that acquisition speed was not a determinant or predictor of subsequent equivalence class formation.

Effect of Degrading Meaningful Stimuli on Class Formation

A recent publication by Fields et al. (2020) discusses how yield has been used as a measurement in stimulus equivalence research, but also points out the necessity of analysis of individual data. The present experiment has included both group and individual data. Regarding the group data, the equivalence class formation for the reference groups (PIC and ABS groups) replicated the findings in Arntzen and Lian (2010) employing the same training structure. Also, these findings are consistent with results from the two reference groups in several experiments which have employed the linear series structure in testing for three 5-member equivalence classes in adult participants (e.g., Arntzen & Mensah, 2020; Arntzen & Nartey, 2018; Nartey et al., 2015).

The visual analysis of the individual data supports the notion about the analytic unit of analysis of equivalence relations (Sidman, 1994, 2000). One interpretation of Sidman's theory is that all relations should emerge if the necessary baseline conditional discriminations are established. Forty-seven of the 50 children showed a pattern of responding during testing in which all features of stimulus equivalence would prevail, if any. The three remaining children showed that the baseline performance was intact during testing.

Possible Mechanisms

There seem to be several possible mechanisms for the findings in the present experiment. Regarding the difference in class enhancement comparing the results from the PIC and the ABS groups, it has been argued that the enhancement could be related to that the pictorial stimuli have different behavioral properties. Hence, meaningful stimuli are stimuli that have at least two functions (e.g., Fields et al., 2012). The degree of meaningfulness may vary from one stimulus to the other, however, and also dependent on the participants learning history. Thus, the meaningfulness of a stimulus could be relative. Also, the enhancement effect of pictorial stimuli is because the meaningful stimuli are presumably members of already established categories prior to their use in the equivalence class formation research.

Another variable of importance in the comparison of the PIC and the ABS group could be the possibility of the naming of the meaningful stimuli presented as E-stimuli as for the participants in Group 1. This possibility of naming stimuli as a class enhancement mechanism is in accordance with other experiments (e.g., Ma et al., 2016). For the participants in Groups 2, 3, and 4 had a decreasing number of participants forming equivalence classes, the children could still be able to name stimuli even the degrading of pictorial stimuli.

Finally, the decreasing number of participants forming equivalence classes could be related to discriminability of stimuli. Other experiments have shown how the discriminability can influence the performance on training on conditional discriminations in non-humans (e.g., Jones & White, 1992; White et al., 1985) and humans (e.g., Doughty et al., 2014; Hayashi & Vaidya, 2008, 2012).

Design

In the present experiment, the arrangement of the experimental conditions was employed as a group design. We have presented individual data, however. Quite a high number of the earlier studies within stimulus equivalence research have been arranged as demonstrations without a strict experimental design, and lately, many experiments are arranged as group designs. Some of the reason for employing a group design in research within experiments on emergent relations is because of the possible effect of order and sequence when experiments are arranged as single-case research design, in particular the effect of order. We will emphasize the need for presenting individual data along with group data in experiments arranged as group design.

Generality of the Findings

Since the present experiment replicated the findings for different groups of participants, it will therefore be very important to successfully explore the effect of the inclusion of meaningful stimuli on the formation of equivalence classes as a single-case experimental design and with MTO. The suggestion of training structure is based on findings showing that MTO and OTM training structures produce higher yields than LS (see Arntzen, 2012, for an overview). An experiment arranged as a single-case experimental research design with different morphing steps will contribute greatly towards the generalization of the effect of meaningful stimuli on the formation of classes. In such an experiment, each participant will be exposed to a number of morphing steps, from 0% morphing to 100% morphing.

An LS training structure with more members could be useful in future experiments if the focus is on the effect of number of nodes. The LS will provide a sensitive measure for the experiment of the effect of the use of varying degrading the pictorial stimuli of the nodes on class formation within participants.

Also, experiments including eye-tracking technology, could give important information about the controlling variables for responding in conditions with morphed stimuli as in the three variants of degrading the pictorial stimuli as in the present experiment. Previous experiments have shown time spent observing positive stimuli than negative stimuli (e.g., Huziwara et al., 2016) and patterns as fixation time and transitions between stimuli (e.g., Sadeghi & Arntzen, 2018). Eye-movements analyses when presented the degrading pictorial stimuli could give essential information of what aspects of the stimuli participants are attending to.

Summary

In the present experiment, we explored how pictorial stimuli compared to abstract shapes influenced the outcome on number of training trials to reach the mastery criterion of baseline conditional discrimination and tests for the emergence of equivalence classes. A morphing technique was used to present three variants of degrading of the pictorial stimuli, which serve as nodal stimuli. The main findings showed a decrease of in responding in accordance with stimulus equivalence across the variants of degrading of the pictorial stimuli.

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