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Participant-given Names to Stimuli and Stimulus Equivalence

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Abstract

The aim of the current study was to test if names given by participants to stimuli during a delayed matching-to-sample (DMTS) procedure, when asked to talk aloud, becomes part of the established stimulus classes after training baseline relations and testing for responding in accordance with stimulus equivalence. The participants were exposed to a Many-to-one training structure with potentially three 3-member classes of abstract shapes with arbitrary experimenter defined relations. After the test for stimulus equivalence responding the names given by the participants were scored and included as textual stimuli in sorting tests. The main results are that the names given to the stimuli by the participants became a part of the stimulus classes if they responded in accordance with stimulus equivalence. Hence, it can be argued that if participants give names to the stimuli when exposed to DMTS procedures the classes are potentially larger than the experimenter defined classes. For example, the results show that five of the six participants gave individual names to each stimulus, which means that the three 3-member classes potentially are 6-member classes. Also, since the participants vocally named the stimuli, and those were transformed by the experimenter to text before the sorting task, one might even argue that 9-member classes were established after DMTS-procedure.
Key words: delayed matching-to-sample, sorting, stimulus equivalence, talk-aloud.

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Novelty and Significance

What is already known about the topic?

- Stimulus equivalence is typically tested through matching-to-sample procedures.
- Delayed matching-to-sample has been shown to increase the likelihood of responding in accordance with stimulus equivalence, possibly due to increased probability of verbal behavior in such procedures.
- Verbal behavior has been linked to enhanced stimulus equivalence outcomes.

What this paper adds?

- This study demonstrates that participant-given names during a Delayed matching-to-sample task can become part of the experimenter-defined stimulus classes, potentially expanding the class size beyond what is typically measured.
- The use of sorting tasks following DMTS reveals that these participant-given names are incorporated into the stimulus classes, highlighting the sensitivity of sorting in detecting class expansions.
- The findings indicate that traditional measures of stimulus equivalence may underestimate the extent of stimulus classes.

Stimulus equivalence is defined by the three properties reflexivity, symmetry and transitivity. To test for these properties baseline relations are commonly first trained, with programmed consequences, until participants respond in accordance with some experimenter defined criterions (e.g., showing two or more A to B relations, and two or more B to C relations before a test for responding in accordance with stimulus equivalence are initiated -without programmed consequences). The stimulus equivalence test often consists of symmetry and transitivity trials. Symmetry is defined as if A to B and B to C (baseline trials), then C to B and B to A (symmetry trials). Transitivity is defined as if A to B and B to C (baseline trials), then C to A (transitivity trials). Reflexivity is defined as if A to B and B to C (baseline trials), then A to A, B to B and C to C (reflexivity trials). If the participant responds in accordance with the experimenter's defined criterion -often 90 % on the stimulus equivalence trials (Arntzen, 2012)- it is inferred that the participant responds in accordance with stimulus equivalence.

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One of the most used procedures to train and test for stimulus equivalence responding is simultaneous matching-to-sample (SMTS). Alternative procedures have also been investigated. Sorting tasks, for example, have gained attention as a method that can quickly assess class formation with high correspondence to traditional MTS outcomes (e.g., Arntzen, Dechsling, & Fields, 2021; Arntzen, Norbom, & Fields, 2015). Sorting has proven to be time-efficient, offering an effective tool in equivalence research. Given its efficiency, sorting is increasingly recognized as a valuable alternative to more resource-intensive methods like SMTS.

Beyond MTS and sorting, research suggests that delayed matching-to-sample (DMTS) procedures may further enhance the likelihood of participants responding in accordance with stimulus equivalence (e.g., Arntzen, 2006; Saunders, Chaney, & Marquis, 2005; Vaidya & Smith, 2006). The difference between SMTS and DMTS are that the sample stimulus remains available to the participants when the comparison array is present in SMTS, while in DMTS the sample stimulus disappears before the comparison array is presented. It has been proposed that the higher probability of responding in accordance with stimulus equivalence may be the result of DMTS increasing the likelihood of participants self-echoically rehearsing the stimuli (e.g., Arntzen, 2006; Arntzen & Vie, 2013; Vaidya & Smith, 2006).

Such an interpretation is maybe strengthened by studies which show that verbal behavior may facilitate responding in accordance with stimulus equivalence. For example, a common name to each stimulus within a class of stimuli increases the likelihood of responding in accordance with stimulus equivalence (e.g., Eikeseth & Smith, 1992). Also, intraverbal naming (Horne & Lowe, 1996) or bidirectional naming (Miguel, 2016) have led to positive stimulus equivalence outcomes. In intraverbal naming each stimulus class member has a different name and verbal rules are created to link the members within a stimulus class together which could form equivalence classes (Horne & Lowe, 1996). For example, Santos, Ma, and Miguel (2015) trained students to tact stimuli with individual names, and then to relate the names intraverbally to the experimentally defined classes (e.g., "A goes with B"). Then six participants were exposed to matching-to-sample trials with the same stimuli and showed the A to B relations. Four other participants were exposed to the same type of matching-to-sample trials -however the trials were arranged as symmetry trials to test if "B" would go with "A". The results also showed for these participants that the verbal training was enough to produce experimenter defined correct matching-to-sample performance.

To study the role of verbal behavior in stimulus equivalence responding verbal reports have also been used. For example, Sidman, Willson-Morris, and Kirk (1986) used post-session questionnaires to see if participants used the same name or different names to each stimulus within each class. However, one limitation of such verbal reports can be that asking participants if they gave names to the stimuli may lead to participants creating names to the stimuli when presented with the question (Arntzen, 2006). Another type of verbal reports is to collect concurrent verbal reports while participants are exposed to matching-to-sample trials. In stimulus equivalence research such verbal reports have been used to correlate the content of the verbal reports to the outcome on stimulus equivalence tests. For example, Wulfert, Dougher, and Greenway (1991) asked participants to talk aloud about what they were thinking during the whole experiment, and categorized the verbal responses into four categories: describing the relation between stimuli (e.g., "the hand goes through the hole", "the hand and the hole went with the farmer" and to a common name for the class "both belongs to the hand") the second category was common physical features (e.g., "both stimuli have straight lines"), the third was stimulus compounds which refers to integrating stimuli together (e.g., "together the stimuli looks like a castle"), and the last category consisted of all responses which could not be classified in the three aforementioned categories. The authors found that high yields of stimulus equivalence responding correlated with participants described the relations between sample and comparison stimuli.

In two other studies (García & Rehfeldt, 2008; Rehfeldt, Dixon, Hayes, & Steele, 1998) it has also found that participants often talked about the relations between sample and comparisons, and in a recent study it was found that the participants, in general, said one name when selecting a sample stimulus and another name when selecting a comparison stimulus when trials were presented in a DMTS-format (Vie & Arntzen, 2017). Thus, it seems that when participants are asked to talk aloud, they give names to the stimuli and talk about the sample-comparison relation.

One interesting implication regarding participants giving names to stimuli is that if the given names become a part of the experimenter defined stimulus classes, then the stimulus classes might be bigger than what is usually measured in stimulus equivalence research. For example, if 3-member experimenter defined classes are used -and the participants are giving individual names to each stimulus in each class. Then the 3-member classes might be 6-member classes. The current study investigates if names given by participants becomes part of the experimenter defined classes by first instructing the participants to talk aloud when exposed to training and testing in a DMTS-format in the same manner as Vie and Arntzen (2017). Then, in addition, the names given by the participants are included in a sorting test to see if they sort the names with the experimenter defined classes. Sorting was used since it is quick to setup with new stimuli, which leads to participants only having to take a short brake. In addition, sorting is a swift method of assessing class memberships, which have high correspondence with ordinary equivalence test outcome (e.g., Arntzen *et alii*, 2015; Fields, Arntzen, & Moksness, 2014).

Method

Participants

Six female adults with the average age of 25.5 years participated in the study. Participants were recruited from Oslo Metropolitan University and via personal contacts. The experimental session started with the participants reading an informed consent form, where they were informed on the background of the project and the experimental situation. Also, the participants were explicitly, both in writing and vocally that they could withdraw from the experiment at any time without any negative consequences. After the experimental session the participants were fully debriefed and thanked for their participation. Participants were not given extra credit or money for serving as participants -however, they were offered a small snack during a short break between the DMTS tasks det sorting tasks.

Design

The current experiment used an AB design. In the A-phase baseline relations were trained in a Many-to-One training structure with gradually thinning the programmed consequences. In the B-phase, baseline relations and equivalence properties (reflexivity trials were not presented) were tested for without any programmed consequences.

Setting and Apparatus

An office cubicle, containing a table and a chair was used when conducting the experiment. The measurement of the cubicle was 4.83 m^2. A laptop computer with a 17-inch screen was used to run the custom-made matching-to-sample software. To click on the stimuli participants used a computer mouse. Data gathering was done automatically by the software and consisted of information about every trial -which included the sample stimulus that had been presented, the selected comparison stimulus, and whether or not the selected comparison choice was the experimenter defined correct choice. Also, CamStudio 2.7 (http://camstudio.org) was used to record the screen and sound from the microphone on the laptop computer. To secure the anonymity of the participants -their voices were masked with the use of MorphVoX Jr. (http://screamingbee.com/Product/MorphVOXJunior.aspx). In addition, a custom-made sorting software were used after the participants had been trained and tested for responding in accordance with stimulus equivalence. The experiment was conducted in one session, with only a short break after the equivalence test and before a sorting test.

Stimuli

The stimulus set were the same stimuli which were used by Vie and Arntzen (2017). The set included nine black abstract shapes and were presented on a white background. All stimuli were presented in rectangular zones which were clickable with a computer mouse (see Figure 1). The click-sensitive areas were 10.5x3.8 cm, and the stimuli averaging in size of 3.5x3.2 cm. The distance diagonally between the sample and the comparison were 17 cm. The sample stimulus was presented in the center, and the comparisons were presented in three of the four corners of the screen. The comparison positions were randomized in each trial. In each trial the mouse cursor was positioned 3 cm above the left side of the click-sensitive area of the sample -right before the sample stimulus was presented.

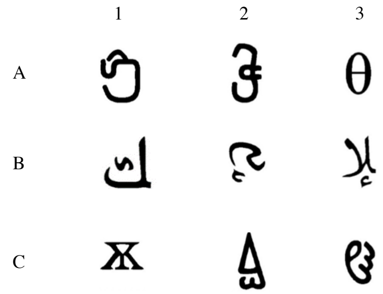

Figure 1. The Stimulus Set used in the experiment. The numbers indicate the experimenter defined classes and the letters indicate the different class members.

Procedure

As in Vie and Arntzen (2017), training and testing were arranged as a DMTS procedure. Clicking the sample lead to offset of the sample, which were followed by a 6 s delay before the onset of the comparisons. The participants were instructed both textually and vocally to start to talk aloud about what they were thinking from the beginning of the experiment. In addition, the software was programmed to give instructions when they could stop talking aloud -after the 18 first trials- and when they should start to talk aloud again when the programmed consequences had been thinned to 0 %.

The talk-aloud instructions (Instructions) were the same as in previous studies (García & Rehfeldt, 2008; Vie & Arntzen, 2017; Wulfert *et alii*, 1991). When the participants had signed the informed consent form, the participants were tested if they talked aloud in a correct manner. This was done by asking them to solve a math task. The task was "What is 127 plus 35?" If the participants only stated the answer "162," then the experimenter demonstrated how the participant should think aloud by solving another math task for example 123 plus 42: "23 plus 12 makes 135, plus 30 makes 165." After this demonstration the participants were asked to solve similar math tasks and were instructed to talk aloud. This was repeated until the participants talked aloud in the manner as described above two consecutive times. Then, the participants were placed in the office cubicle and instructed to read the instructions on the computer screen. The following instructions were presented in Norwegian, and read as follows:

> A stimulus will appear in the middle of the screen. You should click on it with the left mouse button. Three other stimuli will appear. Choose one of these with the use of the left mouse button. If you choose the stimulus we have defined as correct words like "correct", "great", etc. will be presented on the screen. If you press an incorrect stimulus, "wrong" will be presented on the screen. At the bottom of the screen, the number of correct responses will be counted. During some stages of the experiment, the computer will not give feedback about whether the choices are correct or wrong. However, based on what you have learned, you can get all the tasks correct. We are interested in understanding how people solve problems. You should from the beginning of the experiment talk out loud what you are thinking. What you are saying will be recorded. Your voice will be distorted to keep you anonymous. It is important that you do not say your name or something else that can identify you as a participant. Do your best to get everything right. Good luck!

After the 18 first training trials an instruction was presented with the following message on the screen "You can now stop talking aloud." Later, when the programmed consequences were thinned to 0 %, the following message was presented "You are now going to start to think out loud again". The reason for asking the participants to stop talking aloud was to reduce the amount of data to be scored.

The programmed consequences (*Training*) were presented on the screen for 500 ms followed by a 500 ms intertrial interval. All baseline relations were presented in blocks, with each relation being presented three times. Since each of the three stimulus classes consisted of two relations, and those relations were presented three times -each block consisted of 18 trials. Programmed consequences were thinned to 75%, 50%, 25%, and 0% with the trials in each block being presented in a randomized order. The criterion for thinning the programmed consequences were 100% responding in accordance with the experimenter defined stimulus classes. If the participants responded below the 100% criterion, then the programmed consequences were not thinned, and a new block with the same probability of programmed consequences was presented again.

Since an MTO training structure were employed, AC trials and BC trials were mixed in one block. Thus, A1, A2, A3, B1, B2, and B3 was presented as samples, and C1, C2, and C3 was presented as comparisons. One notation that can be used to illustrate the trials is to first refer to the sample (e.g., A1), then using a slash mark (/) to indicate that the rest of the code is the comparison array (e.g., C1C2C3), and finally, to illustrate the correct experimenter-defined correct comparison, an underscore can be used (e.g., C1C2C3). Thus, the baseline trials during training can be shown as follows A1/C1C2C3, A2/C1C2C3, A3/C1C2C3, B1/C1C2C3, B2/C1C2C3, and B3/C1C2C3.

(*Testing*) After the participants had responded 100% correctly in accordance with the experimenter-defined baseline relations in a block with 0% programmed consequences, then the test block was initiated. In the test no programmed consequences were presented. The test block consisted of baseline, symmetry and equivalence trials. Also, in the test block, as during training, each relation was presented three times, which resulted in a test block with 54 trials. The criterion for responding in accordance with stimulus equivalence was set to 90% correct responding on the experimenter-defined baseline, symmetry and equivalence trials. The test for symmetry comprised of C1/B1B2B3, B2/B1B2B3, B3/B1B2B3, C1/A1A2A3, C2/A1A2A3, and C3/A1A2A3 trials, and the test for equivalence consisted of B1/A1A2A3, B2/A1A2A3, B3/A1A2A3, A1/B1B2B3, A2/B1B2B3, and A3/B1B2B3 trials.

Scoring the Verbal Reports

The purpose of scoring the verbal reports was to find which names the participants had given the stimuli. Participants were offered a small snack when they finished the matching-to-sample task and was asked to come back to the office cubicle in approximately 20 minutes time. During the brake the first author listened to the talk-aloud recordings from when the programmed consequences had been thinned to 0%, and the participants had started to talk-aloud again. The criterion for experimentally defining the name as given to a stimulus was that the participants said the same name three times in a row in the presence of the stimulus, or if the participants said, “X goes with Y”, then X was scored as the sample stimulus and Y as the selected comparison stimulus. If the participants did not give the same name three times in a row -the criterion changed to participants having to give the same name in six trials. If a participant did not give a name to one or more of the stimuli, then they were presented those stimuli after the scoring and asked what they thought about the stimuli. It must be noted that only one participant (P3251) did say a name to all but one stimulus, and when asked about which thoughts she had about the stimulus she said that she did not want to say the name aloud during the experiment, then she said that the name she had given the stimulus was testicle. The name was then included in the sorting test.

The Sorting Task

The sorting task was conducted on the same computer as the DMTS tasks. The sorting consisted of drawing stimuli from the middle of the screen like a deck of cards (see Figure 2). There was a total of 12 stimuli in a deck. The three first stimuli in the stack were names given by the participant to the stimuli as text, and the last three stimuli in the stack were the stimuli they had given the names to. The remaining six stimuli was presented between the three first stimuli, and the three last stimuli. For example, in the first sorting tests the names of A1, A2, and A3 (presented in a randomized order) were presented first in the stack, the A1, A2, and A3 stimuli (presented in a randomized order) were presented last, while B1, B2, B3, C1, C2, and C3 (presented in a randomized order) were presented in between the participant-given names and A1, A2, and A3 (the stimuli which participants had given names to). Also, if the participants put a stimulus

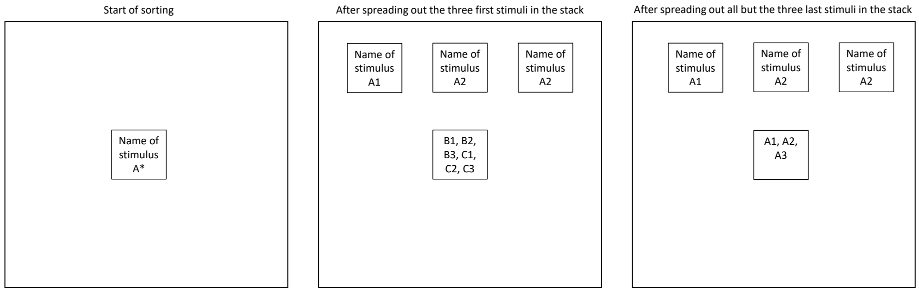

Figure 2. A Visual Illustration of the Sorting Tests. The left square shows how the sorting task started -with all the stimuli in a stack. The middle square shows how the sorting task could look like when the participants had spread out the names, they had given three of the stimuli -one name from each class. If the participants put a stimulus on top of one of the three names, the stimulus would disappear behind the names. Finally, the square to the right show how the sorting test looked like after the participants had sorted all but the three last stimuli in the stack -with the three last stimuli in the stack being the stimuli they had given names to.

on top of one of the three names, that stimulus would disappear behind the participant-given name. Furthermore, if the participants placed one of the stimuli on the screen, and then draw a new stimulus from the stack in the middle of the screen, the previous stimulus drawn from the stack would be locked in its position. The participants were exposed to three sorting tests. The first test consisted of the names given to the A1, A2, and A3 stimuli, the second test with the names given to the C1, C2, and C3 stimuli, and lastly in the third sorting test the names given to B1, B2, and B3.

When the participants came back from the short break, they were asked to sit down in the office cubicle again. There they were instructed to draw the stimuli from the middle of the screen and sort the stimuli as they would with a deck of cards. In addition, they were instructed that if they did draw a new stimulus from the stack in the middle of the screen before they were finished with the sorting of the previous card, the previous drawn stimulus would be locked in its position.

Results

Results showed that the five of six participants (P3246, P3247, P3249, P3250, and P3251) responded in accordance with stimulus equivalence, with an average of 226.5 training trials before testing (see Table 1 for individual performances). The five participants who responded in accordance with stimulus equivalence sorted the experimenter-defined stimulus classes with the names they had given the stimuli (see Figure 3). For example, in the first sorting test, the participants who responded in accordance with stimulus equivalence, sorted A1, B1, and C1 to the name given to stimulus A1, likewise for the second class i.e. sorting A2, B2, and C3 to the name given to stimulus A2, and also

Table 1. Number of Correct Trials on the Equivalence Tests.

P#	TBR	BR	SYM	EQ	ECF	SRT
3246	216	**18**	**18**	**17**	**Y**	**Y**
3247	306	**18**	**18**	**18**	**Y**	**Y**
3249	216	**18**	**18**	**18**	**Y**	**Y**
3250	162	**18**	**18**	**18**	**Y**	**Y**
3251	180	**18**	**18**	**18**	**Y**	**Y**
3248	279	16	**18**	14	N	N

Notes: P#= Participant number; TBR= Training of Baseline Relations; BR= Baseline Relations, SYM= symmetry; EQ= equivalence; ECF= Equivalence Class Formation; SRT= Sorting the classes of stimuli to the participant-given names in a class consistent manner; Bold numbers= responding within the 90% experimenter-defined criterion.

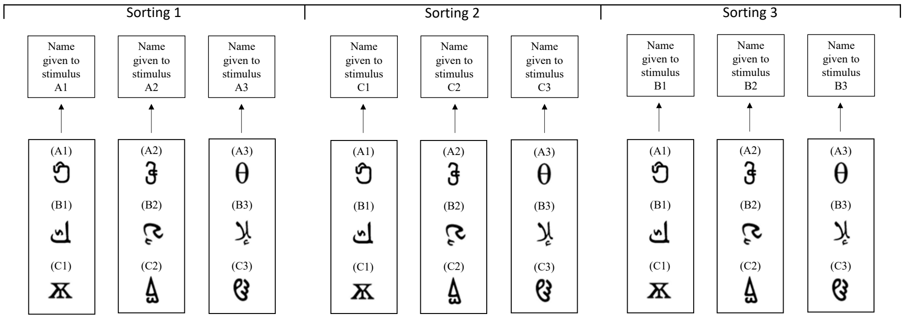

Figure 3. Sorting Results for the Participants who Responded in Accordance with Stimulus Equivalence. The squares refer to the names given by participants to the respective stimuli. The arrows indicate that the stimuli in the rectangles was sorted to the stimuli specified in the square.

Table 2. Table Showing the Names Given by the Participants to the Stimuli.

P no.	A1	B1	C1	A2	B2	C2	A3	B3	C3
3246	Big C	L	K	Three	R	A	O	C	E
3247	C	L	X	First no. three	S	Triangular	O	H	Second no. three
3248	Coffee	LS	X	Doodle	RS	Heart	O	HC	Three O
3249	Apple	Opposite L	Greek letter	Socket	Front symbol	Pointy thing	Ø	The second font symbol	Round ting
3250	Russian	Russian	Russian	Ice Cream	Ice Cream	Ice Cream	Arabic	Arabic	Arabic
3251	Cup	Sami	K	Testicle	Yoga	Shorts	Ø	Feel horn	Tree

Notes: P no.= Participant number; The header row refers to the participant number (P no.), and the stimuli used in the experiment (A1, B1, etc.); Each row illustrates the names given by the participants to each stimulus, for example, participant 3246 gave the name "K" to the stimulus C1.

sorting A3, B3, and C3 to the name given stimulus A3 (see Figure 3 for an illustration of all three sorting tests for the participants who responded in accordance with stimulus equivalence). Four of the five participants who responded in accordance with stimulus equivalence gave individual names to each stimulus (P3246, P3247, P3249, and P3251), while P3250 gave a common name to all stimuli within each stimulus class (see Table 2).

P3248 only responded within the criteria on the symmetry trials in the test. The errors during testing, was related to selecting comparisons from the third stimulus class when a member from the second class was presented as sample (i.e., A2/B1<u>B2</u>**B3**, B2/C1<u>C2</u>**C3**, and B2/C1<u>C2</u>**C3** with bold indicating the selected comparison), and selecting comparisons from the second stimulus class when members from the third stimulus class was presented as sample (i.e., A3/B1**B2**<u>B3</u>, A3/B1**B2**<u>B3</u>, and B3/A1**A2**<u>A3</u> with bold indicating the selected comparison). In the sorting tests stimuli in the second experimenter defined class was sorted to the participant-given names in the first class two times, and to the names in the third class two times which might indicate that the experimenter defined errors in the stimulus equivalence test is related to the errors in the sorting test - however, in the stimulus equivalence test the participant never selected a stimulus form the first class, only the third class. The sorting test, in sum, shows that P3248 did not sort the names given to the stimuli in a class consistent manner (see Figure 4).

DISCUSSION

The purpose of the present experiments was to test if names uttered when establishing conditional discriminations and during testing became part of the stimulus classes established in a DMTS procedure. The main finding is that all participants who

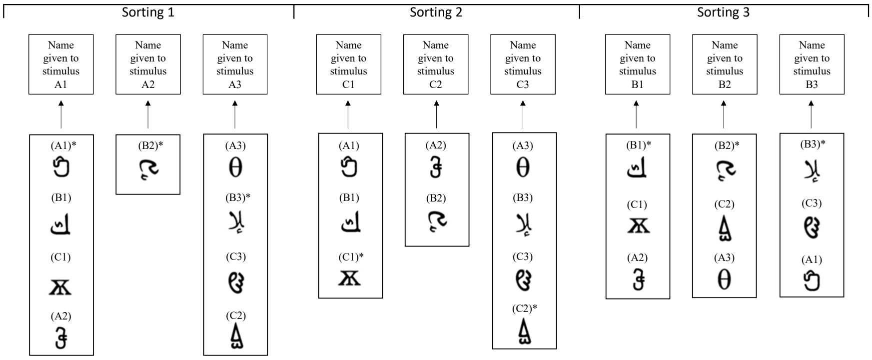

Figure 4. Sorting Results for Participant 3248 who did not Respond in Accordance with Stimulus Equivalence. The squares refer to the names given by participant 3248 to the respective stimuli. The arrows indicate that the stimuli in the rectangles were sorted to the stimuli specified in the squares. An asterisk refers to the stimulus which corresponded with the participant-given name.

responded in accordance with stimulus equivalence sorted the established classes with their own given names (e.g., stimuli B1, C1 and A1 to the name given to A1, stimuli A1, C1, and B1 to the name given to B1, etc.). In addition, five of six participants gave individual names to each stimulus in each class, thus the sorting data, for these participants, suggests that the stimulus classes in the current experiment are bigger than the explicitly trained experimenter defined classes. Hence, the experimenter defined 3-member classes may be 6-member classes which includes the three participant-given names. Also, even if it is not tested for, one might argue that one is dealing with 9-member classes for the participants who gave individual names to the stimuli -based on that the names uttered by the participants was transformed from speech to text by the experimenter and used as textual stimuli in the sorting test. P3250 who uttered the same name to all the stimuli within each class the three member classes might be viewed as 4-member classes since each stimulus within a class was sorted to the same name, or 5-member classes if one takes in account that the uttered names was converted to text for the sorting test.

The present study adds to the growing body of research supporting the use of sorting tasks as an efficient and reliable measure of stimulus equivalence. Recent studies have demonstrated that sorting tests can accurately document class formation and expansion, often producing results that closely match those of MTS tests (e.g., Arntzen et alii, 2021). This is particularly relevant in the current study, where participant-named stimuli appeared to expand the size of the stimulus classes, and sorting tasks were well-suited to capture this expansion.

The finding that five of six participants gave individual names to the stimuli, replicate the pattern found in Vie and Arntzen (2017) where participants typically gave individual names to each stimulus. However, in the current experiment P3250 gave the same name to all members within each stimulus class, which does not replicate the finding in Vie and Arntzen (2017). Thus, the current study shows that participants can give individual names to each stimulus, and the same name to each member within each stimulus class -even if the experimenters does not explicitly arrange for participants to do so. This means that the results in the current study can be used in support of findings in studies that demonstrate that giving the same name to each stimulus within each class facilitate responding in accordance with stimulus equivalence (e.g., Eikeseth

& Smith, 1992), and studies that show that individual names to each stimulus which are intraverbally related facilitate responding in accordance with stimulus equivalence (e.g., Carp & Petursdottir, 2015).

Sidman (2000) suggest that every element involved in a reinforcement contingency can become a member of an equivalence class. The results in the current study may support such notion since its demonstrated that the stimuli have been sorted in a class consistent manner to the names given to the stimuli. The results are also in line with research showing that responses may become part of the classes in addition to the sample and comparison stimuli when the responses are specific to that class (e.g., Dube, McIlvane, Maguire, Mackay, & Stoddard, 1989; Shimizu, 2006). However, it must be noted, that in the current study the experimenters did not explicitly arrange for differential response topographies to the stimuli or the classes. The experimenters may have indirectly arranged for such contingencies since the participants were asked to talk aloud during training and testing for equivalence responding. Also, it has been argued that DMTS might lead to a higher probability of participants giving name to stimuli (Vie & Arntzen, 2017).

Since naming the stimuli was not required procedurally by the experimenters, the naming might be viewed as adventitious reinforced behavior as shown in for example Blough (1959) where some of the pigeons showed discrete stereotypical repetitive responses to each stimulus in a DMTS procedure -which lead to the respective pigeons not showing decreased matching performance when the delay was increased. While the pigeons who did not show the stereotypical repetitive responses showed a decrease in matching performance when the delay was increased.

Whether or not naming stimuli is necessary to respond in accordance with stimulus equivalence cannot be determined by the results in the current study, and that participants gave names to the stimuli might be a byproduct of the procedure where participants are asked to talk aloud, and in addition is exposed to the matching trials in a DMTS procedure. However, several stimulus equivalence studies have reported that participants often during the debriefing, after the experiment, or in post experiment questionaries reports that they have given names to the stimuli used in the study they have participated in (e.g., Arntzen, 2006; Lane & Critchfield, 1996). If giving names to the stimuli in stimulus equivalence research is a normal occurrence, one might argue that the measurements normally used (i.e., baseline relations and the emergent relations) does not include all class members. In addition, since participants have the opportunity to give individual names to each stimulus, a common name to each class, a combination of both, no names, or only names to a small number of stimuli in the experimenter defined classes -it is difficult to get an indication how big the established stimulus classes might be without asking participants to talk aloud.

One of the participants, P3251, did name all but one stimulus during the DMTS tasks. Right before the sorting test, the participant was asked what they thought about the stimulus and responded that saying the name out loud during the previous task was something they did not want to do. The participant then explained naming the stimulus testicle based on a previous yoga experience. The name testicle was then included in the sorting test, and the participant sorted the members of the procedurally correct class to the name. The result may indicate that the participant used the name during the DMTS tasks but did not say it out loud. If this is the case, the results could indicate that participants may not verbalize all their thoughts when asked to talk aloud about what they are thinking. Another interpretation might be that naming the stimulus once is enough to become part of the DMTS established stimulus class if the participant only gave the name right before the sorting test. A third interpretation might be that when the names of A2, B2 and C2 was presented during the second test, the participant might have sorted the procedurally correct class members to A2 (testicle) based on rejection of B2 and C2. Such an interpretation is supported by several studies which have shown that selection can be based on rejection of other stimuli (e.g., Pérez, Tomanari, & Vaidya, 2015).

Participant P3248 did not respond in accordance with stimulus equivalence or sorted the stimuli used in the DMTS procedure to names the participant had given the stimuli. The experimenter defined errors during the equivalence test is related to selecting comparisons from the third stimulus class when a member from the second class was presented as sample and selecting comparisons from the second stimulus class when members from the third stimulus class was presented as sample. In the sorting only three of the six experimenter defined sorting errors was related to stimulus class two and three, while the remaining three experimenter defined errors were related to sorting the second class to the first class, or the first class to the third class. One interpretation might be that the stimulus equivalence classes in general was not established, and thus the participant was not able to sort the stimuli in a class consistent manner in the sorting tests. Such an interpretation is supported by several studies which have shown high correlation between equivalence outcome and sorting tests (e.g., Arntzen *et alii*, 2015). Another interpretation can be that the there was some scoring errors by the experimenter, such an interpretation might be supported by that the participant sorted the C2 stimulus to the name of C3 instead of C2. However, the main criteria for including a name in the sorting test should limit such a possibility.

One limitation of the current study is that all the stimulus equivalence properties of the participant-given names is not tested for in the sorting test. Thus, in future research one should try to include the names given by the participants in a test for stimulus equivalence. Another study one might do is to include the names as auditory stimuli as well as the textual stimuli to test whether or not the classes are as big as it is argued for in the current study (i.e., that the three 3-member classes might be 9-member classes if participants give individual names to each stimulus).

In sum, the current study shows that in a DMTS setup where participants are asked to talk aloud -the participants give names to the stimuli, and the names the participants give the stimuli seemingly becomes a part of the stimulus classes established during the DMTS setup. Thus, if giving names to stimuli are an often-occurring byproduct of matching-to-sample procedures, then the stimulus classes seemingly are bigger in equivalence research than what is usually tested for in a matching-to-sample setup.

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