Learning Conditional Relations in Elderly People With and Without Neurocognitive Disorders

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Elderly people with neurocognitive disorders (NCDs) present difficulties in learning and maintaining arbitrary conditional relations between stimuli. The aims of Study 1 were to (a) verify the efficacy of a procedure of teaching conditional relations by exclusion in elderly people with and without NCDs and (b) determine the presence or absence of the formation of equivalence classes based on this procedure. Five elderly people without NCDs (control group [CG]) and 6 elderly women with NCDs (experimental group [EG]) underwent a teaching-by-exclusion procedure (linear structure) with 4 classes of stimuli with 5 stimuli each (dictated names of people, photographs, written names, degrees of relatedness, and profession). The formation of equivalence classes was then tested. All of the participants in the CG learned the conditional relations, and 3 of the 5 formed equivalence classes. However, none of the participants in the EG learned the AB relations, despite demonstrating performance by exclusion. The aim of Study 2 was to determine the efficacy of a procedure that combined teaching by exclusion and the delayed-cue procedure to teach arbitrary relations to elderly people with NCDs. Four elderly women with NCDs underwent a teaching procedure (one-to-many structure) with 3 classes with 3 visual stimuli each (photographs, written names, and names of professions). All of the participants learned the conditional relations, and 2 named some of the photographs that were presented. The procedure effectively taught arbitrary relations and may be promising for studying intervention procedures in elderly people with NCDs.

Keywords: teaching by exclusion, delayed cue procedure, conditional discrimination, cognitive impairment, elderly people

Alzheimer’s dementia (AD) is classified as a neurocognitive disorder (NCD) that causes, among other symptoms, a decline in one or more cognitive domains, such as learning, memory, and language (DSM–5; APA, 2014). Behavior analysts have investigated the maintenance/learning of conditional discriminations and formation/maintenance of classes of equivalent stimuli in elderly patients with and without a diagnosis of AD, with the goal of determining the effects of advancing age on processes that involve stimulus control (Aggio & Domeniconi, 2012; Gallagher & Keenan, 2009; Pérez-González & Moreno-Sierra, 1999; Steingrimsdottir & Arntzen, 2011a; Steingrimsdottir & Arntzen, 2011b; Steingrimsdottir & Arntzen, 2014) because these processes appear to be central to NCDs and conditions of dementia that are associated with aging.

Many of these researchers have focused on studying processes associated with the formation of equivalence classes using the stimulus equivalence paradigm. This paradigm suggests that by teaching a set of conditional relations between stimuli, other relations that are not directly taught can emerge, thus favoring the
formation of equivalence classes (de Rose & Bortoloti, 2007; Sidman & Tailby, 1982). Some authors suggest that equivalence classes are involved in symbolic phenomena. Based on the formation of these classes, the stimuli that comprise them begin to share functions and meanings that tend to be maintained while the stimulus classes remain intact (de Rose & Bortoloti, 2007). The biological processes that are involved in dementia likely contribute to the deterioration of equivalence classes, but still unclear is the way in which this occurs.

Studies on stimulus equivalence with elderly subjects without NCD show that they are able to learn conditional relations, form equivalence classes, and maintain these relations over time, regardless of the modality of the stimuli and training structure that is used (e.g., Aggio & Domeniconi, 2012; Gallagher & Kennan, 2009; Haydu & Morais, 2009; Rossit, Ramos, & Lopes, 2010; Saunders, Chaney, & Marquis, 2005). Although these elderly people exhibit the formation of equivalence classes, their performance may be lower compared with adolescents and adults (Pérez-González & Moreno-Sierra, 1999; Wilson & Milan, 1995).

In a series of case studies of patients with dementia, Steingrimsdottir and Arntzen reported the difficulties that some elderly people with these conditions have in learning arbitrary conditional relations in matching-to-sample (MTS) tasks (Steingrimsdottir & Arntzen, 2011a, 2014). These subjects also presented positive performance in identity-matching-to-sample tasks (Steingrimsdottir & Arntzen, 2011b, 2014). These authors stated that procedures that teach identity relations to these elderly people are most effective when a sample and comparisons are presented simultaneously (or with a 0-s delay when only two comparison stimuli are presented), with longer periods of training and the use of specific instructions. Nonetheless, it is still necessary to further study the learning and maintenance of identity and arbitrary conditional discriminations in elderly people with NCDs to better understand the types of defects in stimulus control relations that are present in this population (Steingrimsdottir & Arntzen, 2011a, 2014). Based on the literature, elderly people with NCDs appear to require specific teaching conditions to learn conditional relations between stimuli. The present study investigated the effectiveness of a teaching-by-exclusion procedure (de Souza & de Rose, 2006; Dixon, 1977) for teaching conditional relations in elderly people with a diagnosis of NCD.

Responding by exclusion reflects emergent performance when an undefined sample stimulus is related, without prior teaching, to an also undefined comparison stimulus (Wilkinson, de Souza, & McIlvane, 2000). For example, an unknown word can be related to an unknown object when it is dictated in the presence of a set of three objects that are already known by the participant and only one that is completely new. In this situation, an individual tends to relate the auditory stimulus (word) to the unknown object, without direct training. This performance can be used for teaching procedures (i.e., teaching by exclusion), allowing the learning of conditional relations with a low number of errors (McIlvane & Stoddard, 1981; Ferrari, de Rose, & McIlvane, 1993). In teaching by exclusion, a new conditional relation (i.e., sample and comparison) is only introduced into training together with other previously established relations. This can occur in two ways. In one way, an unknown sample is presented (e.g., A2), and two stimuli are presented as comparisons (one that is already associated with another sample [e.g., B1] and one that is completely new [e.g., B2]). In this case, it is expected that the subject relates B2 to the A2 sample, excluding the already known B1 comparison stimulus (Dixon, 1977). In another way, only one conditional relation (A1B1) may be initially presented in a certain number of trials. A second conditional relation is then included (A2B2), and the B1 comparison functions as the negative comparison when presented together with B2. In this case, all of the conditional relations are taught, with no previous baseline from which a new relation can be taught.

Teaching by exclusion has proven to be effective for teaching conditional relations in children and adolescents with typical and atypical development and adults (e.g., de Rose, de Souza, & Hanna, 1996; Ferrari, de Rose, & McIlvane, 2008), but to our knowledge no studies have reported performance in this type of procedure in elderly people with or without NCDs. The general aim of Study 1 was to determine the efficacy of a teaching-by-exclusion procedure of conditional relations in elderly people with and without NCDs. We also
evaluated whether conditional relations can be learned by elderly people to verify the possible formation of equivalence classes with auditory and visual stimuli.

**Study 1**

**Method**

**Participants.** The study included 11 participants who lived in a residential institution for elderly people in a Brazilian city. They were divided into two groups. The control group (CG) consisted of five elderly people (Cassia, Eva, Flora, Leila, and Vagner; mean age, 77.8 years) who did not have a diagnosis of NCD according to Mini Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975 - scores between 18 and 29 points). The experimental group (EG) consisted of six elderly women (Ana, Adelia, Bete, Dirce, Julia, and Paula; mean age, 81.6 years), all of whom were diagnosed with AD (MMSE score between 12 and 17 points). None of the participants presented symptoms of depression according to the Geriatric Depression Scale (Yesavage et al., 1982). None of the participants used medications that could affect their waking state, and none had visual problems that would prevent them from observing the visual stimuli that were presented.

The participants or their guardians (if the participants were unable) signed an informed consent form. The study followed Brazilian ethical standards in research with human subjects and was approved by the Human Research Ethics Committee of the Faculty of Philosophy, Sciences and Letters at Ribeirão Preto (CAAE authorization no. 12939513.8.0000.54087).

**Equipment, stimuli, and experimental setting.** A Hewlett-Packard computer with a 23-inch touchscreen was used. A digital camcorder (Sony Handycam, CDR-SR 20) was used to record the performance of the participants in the sessions. The visual stimuli were presented on the computer using PowerPoint (Microsoft Office, 2007), and auditory stimuli were presented by the researcher. Visual samples were presented in the center of the screen (9 cm × 7 cm). Each comparison stimulus (2 cm × 5 cm; each with the same dimensions) was presented in one of the four corners of the screen in random positions. The participants’ responses were recorded by the video camera and manually recorded by the researcher.

Five sets of stimuli were used, with four stimuli in each set. In the CG, Set A was composed of four auditory stimuli that were related to names of people (i.e., Celso, Paulo, Elza, and Rita), and the other sets were visual, referring to photographs of people (B), written names (C), written degrees of relatedness (i.e., brother, father, cousin, and mother; set D), and written professions (i.e., accountant, builder, lawyer, and salesman; set E). In the EG, Set D consisted of written names of professions, and Set E consisted of written names of hobbies. The stimuli for the CG were devised by the researcher (with the exception of the photographs, which were taken from an image bank). The stimuli for the EG made reference to employees who worked at the institution where the participants lived.

In the auditory-visual trials (AB), the researcher said “Show me the photograph of ___. “ The participant indicated which picture on the computer screen that he or she thought was correct, and the researcher presented the consequences for correct and incorrect responses (“Congratulations, you got it right!” or “No, you were wrong.”). During the auditory-visual trials, the researcher repeated the sample every 5 s until the participant selected the comparison on the screen.

In the visual-visual trials, the sample stimulus was presented in the center of the screen, and the experimenter said “Look carefully at this photograph/word.” After 10 s, the comparisons were presented, and the experimenter asked the participant to look at each of the stimuli that were available (with a maximum of four per trial). After the participant inspected the stimuli, the researcher asked the participant to indicate which stimulus corresponded to the sample.

**Procedure.** The data collection procedure was divided into four phases.

**Phase 1: Pretest.** This phase sought to verify whether the participants in the EG attributed any names to photographs that would be used in the procedure. The photographs of employees who worked in the institution were presented individually to the participants. Photographs that were not named within 10 s were selected for the procedure.

**Phase 2: Baseline establishment.** This phase sought to teach conditional relations between auditory stimuli (dictated words) and vi-
Step 1: Teaching AB auditory-visual discriminations. This step had five blocks. In the first block (18 trials), A1B1 and A2B2 relations were taught. During the first six trials, the A1 stimulus was presented as the sample, and only the B1 stimulus was presented as the comparison. In the following six trials, the sample was A2, and the comparison stimuli were B1 and B2, with gradual introduction of the comparison stimuli. In the final six trials of the block, A1 and A2 were alternated as the samples, and the comparison stimuli were always B1 and B2. In the second block (34 trials), A3B3 and A4B4 relations were taught. In the first six trials of the block, the auditory stimulus sample was A3, and the comparison stimuli were B1, B2, and B3. Subsequently, 12 trials were presented, in which A1, A2, and A3 were alternated as the samples. Eight trials were then presented, with A4 as the sample and B1, B2, B3, and B4 as the comparisons. Finally, eight additional trials were presented, in which the four stimuli of set A were alternately presented as the sample.

In the third block (complete reinforced baseline [CRBL]), the four relations that were taught in the previous blocks were presented to verify the maintenance of learning the relations that were taught up to that point. Each relation was presented five times, and consequences were provided for all of the responses. The fourth block (complete baseline in extinction [CBLE]) was identical to the previous block, but no consequences were given for correct or incorrect responses, and only the next trial was presented.

The fifth block of Step 1 (naming) consisted of presenting the participants with the photographs of Set B, one at a time, and asking them to say the name of the person in the photograph. Each photograph was presented twice. There was no learning criterion in the naming task and no trial had differential consequences.

Step 2: Teaching BC visual-visual discriminations. The aim of this step was to teach BC conditional relations between photographs of people and their respective written names. The structure of this step and the learning criteria of the blocks were the same as in Step 1, with the exception that the fifth and final blocks tested CB symmetrical relations. The CB symmetry test had 20 trials that were not reinforced, in which each relation was nonconsecutively presented five times. If the participant failed to achieve the criterion of 90% correct responses in one block, then the test was repeated up to three times. If the participant still failed to achieve the criterion, then the block was repeated, but consequences were given in the trials. Upon achieving the criterion, the symmetry test was presented again but without differential consequences for performance in the trials.

Step 3: Teaching CD visual-visual discriminations. The aim of this step was to teach CD conditional relations between written names and degrees of relatedness in the CG or between written names and written names of professions in the EG. The structure of this step was identical to Step 2, including the DC symmetry test.

Step 4: Teaching DE visual-visual discriminations. The aim of this step was to teach DE conditional relations between degrees of relatedness and written names of professions in the CG or between written names of professions and written names of hobbies in the EG. The structure of this step was identical to Step 2, including the ED symmetry test.

Phase 3: Tests. This phase sought to verify the learning of relations that were taught and emergence of equivalence classes. Initially, one block of 48 trials was presented, in which each relation that was taught was randomly presented three times, without differential consequences for correct or incorrect responses (CBLE). Subsequently, equivalence tests were presented. BD, BE, CE, EC, and EB relations were each presented twice, interspersed with 12 baseline trials with a total of 52 trials. No correct response criteria were used in this block. Because of difficulties that were encountered in the institution during this phase, the CBLE block and equivalency testing block were presented only once for the participants.

A second observer watched 20% of the videos of the sessions and recorded correct and incorrect responses. The average percent agreement between observers was 91.6%.
Results

Figure 1 shows the individual performance of the participants in the CG in Phase 2 (teaching AB, BC, CD, and DE relations) and Phase 3 (CBLE and equivalency tests).

The performance of Eva, Flora, Leila, and Vagner was similar during the steps of Phase 2. All of them achieved the learning criterion (90% correct responses) with only one presentation of each block, including the symmetry tests and complete baselines (reinforced and in extinction). Cassia, however, required repetition of the CRBL-AB and CRBL-BC blocks, in which she systematically confused the last two relations that were taught in both blocks.

In Phase 3, which occurred 1 day after completing Phase 2, Eva, Flora, and Leonor presented similar performance. All of the participants had at least 90% correct responses in the CBLE block and equivalence test block. Cassia achieved 89% correct responses in the CBLE block, but this performance did not support the emergence of equivalence relations. The participant presented 69% correct responses in the equivalence test block. Vagner presented 85% correct responses in the CBLE block and did not demonstrate the emergence of equivalence relations in the following block (66% correct responses).

The performance of the EG was worse than the CG. With the exception of Julia, none of the participants reached the learning criterion for AB relations. Although achieving the learning criterion in the first block (A1B1), they systematically failed in Block 2 when all four AB relations appeared together (Phase 2, Step 1), even after three or four repetitions. Only Julia managed to achieve the learning criterion of 90% correct responses, but she dropped out of the study after the naming probes.

One of the reasons why the EG failed to learn the conditional relations would be the absence of performance by exclusion, which would interfere with the effectiveness of the proposed teaching procedure. To verify this possibility, we analyzed the performance of the participants in the six sequential trials of Blocks 1 and 2 (Step 1), in which the new relations were introduced (A1B1, A2B2, A3B3, and A4B4). The occurrence of performance by exclusion was considered when the participant selected the new comparison stimulus in the first trial in which a new sample was introduced.

Figure 2 shows that all of the participants responded correctly in the A1B1 trials, which presented a forced choice. However, when the A2B2 relation was introduced, variable performance was observed. Ana, Julia, and Bete presented performance by exclusion in all of the first trials that introduced new relations, but Julia and Bete presented errors in the A3B3 trial sequence. Paula and Adelia only failed to present responding by exclusion in the first trial of the A4B4 relation and presented difficulties maintaining this performance in the A3B3 and A4B4 trials, which had a greater number of comparisons that were available. Dirce only failed to present performance by exclusion in the initial presentation of the A2B2 relation. However, all of the participants responded by exclusion in the majority of the trials in which this performance could be tested. For all of the participants, with the exception of Ana, this good performance for the new relations that were introduced in the teaching was not sufficient to ensure maintenance of the relations that were established in the initial trials.

Discussion

The data from Study 1 generally indicate that the participants without NCDs were able to learn the conditional relations that were taught, and three of the five participants showed clear evidence of the formation of equivalence classes. The participants with NCDs, however, were unable to learn the conditional relations from the proposed teaching procedure, although they presented performance by exclusion, which is a necessary condition for transition in the teaching procedure.

The results of the elderly participants without NCDs replicated other studies that also evaluated the elderly (Aggio & Domeniconi, 2012; Gallagher & Kennan, 2009; Haydu & Morais, 2009; Peréz-González & Moreno-Sierra, 1999; Saunders, Chaney, & Marquis, 2005). The teaching-by-exclusion procedure effectively promoted the learning of conditional relations in these participants, notwithstanding the fact that the training structure that was used (i.e., a linear structure) has been referred to in the literature as a procedure that hinders the forma-
Figure 1. Percentage of correct responses for the participants in the teaching of AB, BC, CD and DE conditional relations, as well as in the complete reinforced baseline, baseline in extinction, naming, and symmetry trials and in the naming and equivalence tests—Study 1. A = Cássia; B = Eva; C = Flora; D = Leonor; E = Vagner. Bl = block; BLR = baseline reinforced; BLE = baseline extinction; Nam = naming; Sim = symmetry; CBLE = complete baseline in extinction; Eq = tests of equivalence. “This participant did not perform this test because she was hospitalized.”
The negative results for Cassia and Vagner in the equivalence tests should be considered. One limitation of this study was the presentation of only one equivalence test block for these two participants, as well as the nonrepetition of the complete baseline in the extinction block for Vagner, because of difficulties that were encountered in the institution for the follow-up of the study. This single presentation prevented verification of the delayed emergence of the formation of equivalence classes, which has also been reported in other studies with different populations (e.g., Aggio & Domeniconi, 2012; Bush, Sidman, & de Rose, 1989; Fields & Watanabe-Rose, 2008; Holth & Arntzen, 1998).

The most interesting finding in Study 1 was the negative performance of the participants in the EG in learning conditional discriminations. Although all of them presented performance by exclusion, this performance did not support the maintenance of learning the new relations that were introduced throughout the teaching procedure for five of the six participants. The only participant who achieved the learning criterion for the AB relations required repetition of the complete baseline blocks (both reinforced and in extinction). These results suggest that the teaching-by-exclusion procedure...

Figure 2. Performance of the EG participants in the exclusion trials in the teaching of AB relations (Study 1). A = Ana; B = Beta; C = Dirce; D = Julia; E = Paula; F = Adelia.
itself was insufficient to promote the learning of conditional relations, and other variables must have negatively interfered with this process.

One such variable may be the high number of comparison stimuli that were presented in the task. Steingrimsdottir and Arntzen (2011b) reported that MTS trials that were composed of three or more comparison stimuli led to low accuracy in responding in elderly people with NCDs, although Saunders et al. (2005) did not observe this difficulty in elderly people without cognitive impairment. As the new conditional relations were introduced into the procedure, the number of errors increased, even in successive trials that introduced new relations (see Figure 2). This supports the likelihood that the high number of comparisons may have compromised the performance of the participants. One other consideration is that the AB training, because it was auditory-visual, required the participant to hear the word that was dictated and then select the corresponding visual stimulus. Although the researcher repeated the auditory stimulus every 5 s throughout the trial, the sample was not, in fact, continuously available. Studies with elderly people with dementia indicated that delays in MTS tasks have deleterious effects on performance (Steingrimsdottir & Arntzen, 2011a), suggesting that auditory-visual tasks can be more difficult for elderly people under these conditions.

Considering the variables mentioned above, Study 2 was conducted, in which changes were planned in the conditional relation teaching procedures. The aim of Study 2 was to reduce the maximum number of comparison stimuli that were present in the trials and ensure that the sample would remain available on the screen throughout the duration of the trial (i.e., simultaneous MTS). Furthermore, to circumvent possible difficulties in tracking the comparison stimuli on the computer screen, the location of the stimuli was changed. The sample was presented at the top center of the screen, and the comparisons were presented at the bottom, one beside the other. We also combined the exclusion procedure with the delayed-cue procedure (Browder, Ahlgrim-Delzell, Spooner, Mims, & Baker, 2009; Touchette, 1971) during the introduction of the new conditional relations throughout training. Both procedures favor the learning of discriminations with fewer errors, thus preventing (in the case of the delayed-cue procedure) impulsive responses to select stimuli that were previously related to other samples.

The aim of Study 2 was to verify the efficacy of a teaching procedure that combined teaching by exclusion and the delayed-cue procedure to teach visual-visual conditional relations in elderly people with NCDs.

### Study 2

#### Method

**Participants.** The participants were four women who lived in a residential institution for elderly people in a Brazilian city. Izilda (80-years-old; MMSE score = 14) and Linda (85-years-old; MMSE score = 14) had been diagnosed with AD. Malfalda (75-years-old; MMSE score = 16) had a diagnosis of mild cognitive impairment. Marta (85-years-old; MMSE score = 16) did not have a defined diagnosis. None of the participants used medication that could affect their waking state and did not have visual problems that would prevent them from observing the visual stimuli that were presented. All of the participants were evaluated for the presence of depression, but none presented scores that were indicative of this condition.

**Experimental setting and stimuli.** The same computer and application that were described in Study 1 were used to present the stimuli. Three sets were used, consisting of three stimuli each. Set A consisted of photographs of three employees at the institution. Set B consisted of the written names of the people who were shown in the photographs. Set C consisted of the written names of the professions of these people (i.e., nurse, cook, and director). None of the participants were able to say the names of the employees or what their functions were in the institution. They were also unable to say the names of the employees in their presence or identify their functions.

The procedure for teaching conditional relations was structured in MTS tasks. The trials began with presenting the sample stimulus at the top center of the computer screen. After the participant touched the sample, the comparison stimuli appeared at the bottom of the screen, side by side when two or three comparisons were presented. The participant was instructed to select the stimulus by touching it on the screen. After 1 s, a new trial was initiated.
Eventually, the researcher instructed the participant to touch the sample (“Have you seen the photograph [or word] here on the screen? You can put your finger on it to continue”) or inspect all of the available comparison stimuli (“Look carefully at each word written here below [or photograph] and choose one of them”). These instructions were provided when the participant failed to look at the screen and began to talk to the experimenter or when the participant spent more than 20 s looking at the screen without making a selection (generally talking about other issues unrelated to the task). The consequences for correct and incorrect responses were the same as in Study 1.

**Procedure.** The procedure was structured into two phases (see Table 1).

**Phase 1: Pretest.** This phase sought to determine whether the participants knew some information about the pictures that would be used in the procedure. This phase was similar to Phase 1 of Study 1.

**Phase 2: Establishment of baseline.** This phase sought to teach the AB (photographs and written names) and AC (photographs and written function names) conditional relations. This phase consisted of two steps.

**Step 1: Teaching AB relations (photograph-written name).** The teaching of AB relations was divided into five blocks of trials. When the sample stimulus was presented, the researcher pointed to it and asked the participant if she was looking at the picture. If the participant said “yes,” then the researcher asked her to put her finger on it, and the comparison stimuli were presented at the bottom of the screen. After the participant selected the comparison stimulus that she thought was correct, a new trial was initiated. Consequences were provided for correct and incorrect responses throughout all of the trials of this step.

In the first block, A1 was the sample, and only the B1 comparison stimulus was presented in one of three positions at the bottom of the screen (right, middle, or left). In Trials 11–20, the A2 stimulus sample was presented, and the B1 and B2 comparison stimuli were available. During these trials, however, the incorrect comparison stimulus B1 (S') was gradually introduced. In Trials 11 and 12, B1 remained available on the screen for only 1 s and then disappeared. In Trials 13 and 14, the S' remained available for 3 s. In Trials 15 and 16, the S' remained available for 5 s. In Trials 17–20, it remained on the screen for an indefinite period of time until the participant made a selection response. The positions of the comparison stimuli varied throughout the trials. In the final 10 trials of the block, the A1 and A2 samples were alternated almost randomly, and the two comparison stimuli were presented in alternate positions throughout the trials, remaining indefinitely until the participant made a response. The criterion for proceeding to the next block was 27 correct responses in the block. If the participant did not achieve this criterion, then the block was repeated up to three times. If the criterion was achieved, then the second block of Step 1 began.

In the second block (30 trials), the A3B3 relation was taught as described above. The learning criteria and consequences for correct and incorrect responses were the same as in the previous block.

The third block of Step 1, called the AB reinforced baseline (BLR AB), had 15 trials (five of each relation A1B1, A2B2, and A3B3, presented in an almost random sequence). The learning criterion in this block was at least 13 correct responses. If the criterion was not achieved, then the block was repeated up to three times. If the criterion was still not achieved after these repetitions, then the subject repeated blocks 1 and 2. The fourth block of Step 1 (AB baseline in extinction [BLE AB]) followed the same structure and criteria as the third block, but correct and incorrect responses had no specific consequences (extinction). Before beginning this block, the researcher instructed the participant about the absence of differential consequences.

In the fifth block of Step 1 (symmetry test), BA symmetrical relations were tested. The block consisted of 15 trials, five for each relation (B1A1, B2A2, and B3A3). No consequences were given for correct responses or errors, and the instructions that were given at the beginning of the fourth block were repeated. The participant had to provide at least 13 correct answers to proceed to Step 2, otherwise the symmetry test was repeated up to three times. In these representations, however, consequences were provided in the trials. When the participant achieved the criterion of 13 correct responses in the block of reinforced symmetrical relations, a
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<td>C1-C2-C3</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Symmetry test</td>
<td>CA</td>
<td>C1/C2/C3</td>
<td>A1-A2-A3</td>
<td>10</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CBLE</td>
<td>AB</td>
<td>A1/A2/A3</td>
<td>B1-B2-B3</td>
<td>11</td>
<td>30</td>
<td></td>
</tr>
</tbody>
</table>

**Note.**  
A = stimulus related to photos of people; B = stimulus related to written names; C = stimulus related to written names of the professions; CRBL = complete reinforced baseline; CBLE = complete baseline in extinction; t = trial.
new symmetry test was performed but without consequences for correct or incorrect responses.

Step 2: Teaching AC relations (photograph-written function name). This step sought to teach AC relations and had the same structure as the five blocks of Step 1. After the symmetry test, one complete baseline-in-extinction block was conducted, with all of the AB/AC trials taught (CBLE AB/AC). The order of presentation of the trials was random. This block had no learning criterion, and the teaching procedure ended after its completion. At the end of Step 2, a naming test was conducted. In the naming test block, three trials were presented. In each trial, a photograph (A1, A2, and A3) was displayed at the center of the computer screen, and the participant was given the following instruction by the experimenter: “Tell me the name of the person in the photograph.”

A second observer assisted with approximately 30% of the videos of the sessions. The reliability index between observers was 93%.

Results

Figure 3 shows the general performance of the participants in learning the AB and AC relations, performance in the BLR and BLE blocks of each relation and symmetry test (Phase 1), and performance in the CBLE AB/AC block.

All of the participants achieved the criterion for learning the AB relations with a single presentation of each teaching block. Likewise, all of the subjects achieved the learning criterion in the baseline blocks of the AB relations, regardless of whether consequences were provided in the trials. Marta and Izilda presented immediate emergence of symmetry (BA). Linda and Mafalda needed the presentation of one and two blocks of reinforced symmetry trials, respectively, to achieve the learning criterion.

All of the participants learned the AC relations. Mafalda, Linda, and Marta (90%, 86%, and 83% correct responses, respectively). Izilda correctly responded in only 60% of the trials. In the naming test, Marta and Linda correctly named two photographs, and the other participants did not name any.

Discussion

Studies on conditional discrimination learning with elderly people with NCDs have described difficulties in learning arbitrary conditional relations (Gallagher & Keenan, 2009; Steingrimsdottir & Arntzen, 2011a, 2014). The present results, however, are different from those reported by these earlier studies. The success of the teaching procedure likely results from the set of manipulated variables, including the specific procedures that are used.

The delayed-cue and teaching-by-exclusion procedures have yielded good results in the literature (e.g., Sidman, Wynne, Maguire, & Barnes, 1989; de Souza & de Rose, 2006; Glat, Gould, Stoddard, & Sidman, 1994; Johnson & Sidman, 1993; McIlvane & Stoddard, 1981, 1985). The main advantage of combining these two procedures is the gradual introduction of new relations that are to be taught, always with the concurrent presentation of relations that were previously established. This gradual introduction prevents the occurrence of errors (Terrace, 1963), which can have negative effects on the participants’ engagement in the task, especially with elderly participants who have some form of NCD (Steingrimsdottir & Arntzen, 2014).

The procedure that was utilized in the present study also included the use of familiar stimuli (photographs and names of people who were part of the daily lives of the participants), simultaneous MTS tasks, a low number of comparison stimuli in each trial (three), and a one-to-many training structure (Arntzen & Holth, 1997, 2000). Some studies indicate that the use of familiar stimuli in MTS tasks favors the learning of conditional relations (e.g., Arntzen, 2004; Wilkinson & McIlvane, 1994). However, the study by Steingrimsdottir and Arntzen (2014) with elderly people with NCDs suggested that the use of only this type of stimulus is insufficient for the successful learning of conditional discrimination, although the nature of the visual stimuli that have been used in studies on the acquisition of conditional relations is an
important variable (Wilkinson & McIlvane, 1994). People with NCDs appear to have difficulties to learn new conditional discriminations with arbitrary stimuli, and negative learning data that were reported in previous studies with elderly people (e.g., Gallagher & Keenan, 2009) may have been attributable to the effects of using unfamiliar or meaningless stimuli. In the present study, the use of photographs of people who were present in the daily lives of the participants might have favored learning, but the use of such photographs may also be considered
a limitation. The potential presence of these people in the everyday lives of the elderly participants may be considered additional uncontrolled exposure to the stimuli, which might exert effects that are impossible to measure. Nonetheless, the pretest data indicated that the participants were unable to recognize the people in the photographs that were presented.

The configuration of the teaching trials and tests may have also had positive effects on the participants’ performance in the present study. In other studies, elderly people with NCDs presented better performance in simultaneous MTS trials than in delayed MTS trials (Money, Kirk, & McNaughton, 1992; Steingrimsdottir & Arntzen, 2011a) and in MTS tasks with only two comparison stimuli available (Steingrimsdottir & Arntzen, 2011b). In the present study, the tasks involved simultaneous MTS trials and three comparisons. Although the number of comparisons was greater than the number that was recommended by Steingrimsdottir and Arntzen, the good results may be attributable to the use of the delayed-cue procedure, which may have minimized any possible problems that arise from the initial simultaneous presence of three comparisons.

The combination of all of the aforementioned factors likely contributed to learning conditional relations by the participants. After learning all of the AB and AC relations, the participants were exposed to the CBLE-AB/AC block, and Mafalda, Linda, and Marta responded correctly in at least 25 of the 30 trials (83%), demonstrating that they learned the relations that were taught, even in nonreinforced trials. However, Izilda did not present performance that was indicative of maintaining her baseline performance. For this participant, conducting the block of trials in extinction had deleterious effects on her performance, indicating the need for more studies on the effects of extinction in tests with participants with these characteristics (Steingrimsdottir & Arntzen, 2011b).

Finally, in the naming tests, the participants’ performance was variable. Izilda and Mafalda did not name any of the photographs in any of the tests, whereas the other participants correctly named some of the photographs. Linda and Marta, for example, were able to say the profession of the people in the photographs, especially for the photograph of the director, who was the person who was at the institution every day. Notably, the director’s profession is not an easy one to recognize, unlike that of the cook or nurse, and the director was not wearing a badge to identify his profession. Although some studies have demonstrated the emergence of naming performance from teaching conditional relations and from the formation of equivalence classes (e.g., Sidman, Kirk, & Willson-Morris, 1985), the participants’ naming performance may have been favored by a number of conditions that were external to the procedure, such as the length of residence in the institution and natural and frequent exposure to the people who were portrayed in the procedure. This study did not seek to systematically investigate naming that was derived from the teaching procedure of arbitrary relations; it also did not seek to control the conditions that could favor this. Given the data presented herein, studying the processes that are associated with the acquisition of naming is important because such performance is critical to an individual’s social repertoire and can promote the functioning of elderly people with NCDs.

**General Discussion**

The general aim of the present study was to test conditional discrimination teaching procedures for the formation of equivalence classes in elderly people with and without cognitive impairment and participants without a diagnosis of NCDs. The data from Studies 1 and 2 showed that elderly people with NCDs were able to learn arbitrary conditional relations when presented with specific teaching conditions. However, further studies on the conditions that are necessary to teach such relations to elderly patients with NCDs are still necessary. In the specific case of the participants in Study 2, the teaching-by-exclusion and delayed-cue procedures were shown to be adequate for teaching conditional relations, although the present experimental procedures did not allow separation of the effects of each of these procedures alone.

Importantly, the teaching-by-exclusion and delayed-cue procedures are not new. Both have been used in the last four decades for interventions with people with disabilities (e.g., Dixon, 1977; Touchette, 1971). However, NCDs are a relatively new problem, and new approaches need to be developed to rehabilitate and main-
tain the repertoires of these patients. Unknown is whether the positive results obtained herein would generalize to individuals with greater cognitive impairment. This is an empirical issue that must be addressed in future studies. Further studies should also evaluate the formation of equivalence classes in elderly people with NCDs. For example, the negative results with regard to the formation of equivalence classes that were reported by Gallagher and Keenan (2009) with elderly people with NCDs may be attributable to the type of stimulus used, the organization of the conditional relation teaching procedure, or other conditions that have not been sufficiently studied. The necessary and sufficient conditions for the occurrence of equivalence class formation (or functional classes) by these individuals are still unclear and require further investigation.

Both studies presented herein have limitations that should be considered in future research. Although the familiar stimuli that were used in the procedures may have favored the participants’ performance, they may have also obscured some important variables in studying the learning of conditional relations by individuals with NCDs. Future studies should employ unfamiliar stimuli, although they are less frequently present in the daily routines of the participants. It is also necessary to verify whether the procedure that was used in Study 2 is effective in larger samples with different levels of impairment to more clearly understand the deficits that arise from these disorders.

References


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