

Naming New Stimuli After Selection by Exclusion¹

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Abstract: Responding by exclusion in matching-to-sample tasks is a robust behavioral pattern in humans. A single selection, however, does not ensure learning of the arbitrary relationship between the sample and the selected comparison stimulus. The present study aimed to investigate the amount of exposure required until eight preschoolers were able to name two undefined pictures, matched by exclusion, to two undefined words. After establishing a matching-to-sample baseline between pictures and dictated words, two new words were introduced in exclusion probes. On each probe, a new word was dictated and the matrix of comparison stimuli included a new picture and two experimentally defined pictures. Naming emerged after three to 10 exclusion trials. Correct naming tended to occur more reliably when the teaching phase established stimulus control by selection.

Keywords: learning, children, vocabulary

Nomeação de Estímulos Novos a Partir da Seleção por Exclusão

Resumo: O responder por exclusão em tarefas de escolha de acordo com o modelo é um dos padrões mais robustos do comportamento humano. Contudo, uma única resposta por exclusão não assegura a aprendizagem da relação arbitrária entre dois estímulos. O presente estudo teve por objetivo investigar a quantidade de exposição necessária até que oito pré-escolares nomeassem duas figuras novas emparelhadas, por exclusão, a palavras novas. Após o estabelecimento de uma linha de base de emparelhamentos entre figuras e palavras ditadas, duas palavras novas eram introduzidas em sondas de exclusão. Em cada sonda, uma palavra nova era ditada e uma figura nova era apresentada entre outras figuras definidas experimentalmente. Sondagens em tarefas de emparelhamento e de nomeação das figuras mostraram aprendizagem das relações condicionais e emergência da nomeação depois de três a 10 tentativas de exclusão. A nomeação correta tendeu a ocorrer de forma mais regular quando a fase de ensino estabeleceu controle de estímulos por seleção.

Palavras-chave: aprendizagem, crianças, vocabulário

Nombramiento de Nuevos Estímulos Después de la Selección por Exclusión

Resumen: El responder por exclusión en tareas de igualación a la muestra es uno de los patrones más robustos del comportamiento humano. No obstante, una única respuesta por exclusión no garantiza el aprendizaje de la relación arbitraria entre dos estímulos. El presente estudio investigó la cantidad de exposiciones necesarias para que ocho estudiantes preescolares nominaran dos figuras nuevas emparejadas, por exclusión, con palabras nuevas. Después del establecimiento de una línea de base de emparejamientos entre figuras y palabras dictadas, dos palabras nuevas eran introducidas en pruebas de exclusión. En cada prueba, una palabra nueva era dictada y una figura nueva presentada entre otras definidas. Pruebas de aprendizaje en tareas de igualación al modelo y de nominación de las figuras mostraron que la nominación emergió después de tres a 10 ensayos de exclusión. Se observó que la nominación correcta ocurrió de forma más fidedigna cuando el control era por selección.

Palabras clave: aprendizaje, niños, vocabulario

Responding by exclusion consists of an emergent responding pattern that involves the immediate selection of a

non-familiar item in response to a non-familiar name (Costa, Wilkinson, McIlvane, & de Souza, 2001; Dixon, 1977; Wilkinson & McIlvane, 1997; Wilkinson, Rosenquist, & McIlvane, 2009). The concept of exclusion was presented for the first time in Dixon's (1977) work, who taught eight adults with intellectual deficits to perform a matching-to-sample task in which they would select a printed letter (among two that were presented simultaneously) conditionally to a dictated word (the letter's name). In one of the three sets of stimuli used, the dictated name was "pi" and the Greek letter pi was the correct choice; incorrect letters were either epsilon or theta.

In this study (Dixon, 1977), after participants had systematically selected the letter pi in the baseline trials,

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exclusion probes were introduced, presenting, as comparisons, the letter “pi” and one of the other printed letters (epsilon or theta). Probe trials were exactly as baseline trials, except for the fact that the samples (dictated names) were stimuli never before presented; in other words, “epsilon” in some trials and “theta” in others. All participants selected the letter epsilon or theta (instead of pi) on the first probe when these words were dictated. All participants continued to select the letter pi when that word was dictated.

The relevant discovery from Dixon’s (1977) results was the immediate differential control by the new name presented as an auditory sample (which permits to talk about emergent behavior). To explain this performance, the researcher hypothesized that participants had learned a specific relationship between the letter (e.g., P) and the name dictated during training (e.g., “pi”). When the probes were introduced, they would have discriminated the words dictated in the probes (“epsilon”, “theta”) as different from the word dictated in training (that is, “pi”), thus rejecting or excluding the letter pi when the dictated name was different than that related to that letter. Next, Dixon conducted a phase of discrimination probes to evaluate whether participants had learned the relation between the names and corresponding pictures matched in the exclusion trials. In six trials the comparison stimuli were the pictures theta and epsilon; the sample (dictated word) was the word “theta” in three trials and “epsilon” in the other three. For six out of eight participants, the undefined dictated names did not control the selection of the corresponding printed letter during four test sessions using the first set of stimuli, even though performance in exclusion and baseline trials remained close or equal to 100%. These data clearly indicate that the selection of a new stimulus, in the presence of an array of comparisons that combined a new and a previously trained stimulus, did not guarantee learning of the conditional relationship between dictated name and printed letter for the untrained components.

The regularity of responding by exclusion has been demonstrated in a series of studies subsequent to Dixon’s work (1977), that used matching to sample with auditory samples and visual comparisons with typically developing children (Costa et al., 2001; Domeniconi, Costa, de Souza, & de Rose, 2007; Wilkinson & McIlvane, 1997), individuals with intellectual disabilities (Dixon, Dixon, & Spradlin, 1983; McIlvane & Stoddard, 1981; Stromer, 1986; Wilkinson et al., 2009) and college students (McIlvane, Kledaras, Munson, King, de Rose, & Stoddard, 1987). Besides the rapid and regular occurrence of exclusion responding, researchers in the area are mainly interested in the possibility that Dixon’s experimental arrangement (1977) provides to investigate learning of relations between names and referents involved in vocabulary learning.

Wilkinson and McIlvane (1997) observed that two types of relations between stimuli can explain the occurrence of exclusion responding. In one possibility, exclusion could be a result of the rejection of defined stimuli (previously associated with other stimuli) in the presence of a new element,

that is, the sample-S⁻ relation controls the response to the undefined stimulus. The other possibility is that the relation between the undefined events is established directly, based on the property they share, that is, the novelty. In this case, the relation between stimuli controlling exclusion responding is the selection of the undefined comparison stimulus in the presence of the undefined sample (sample -S⁺ relation). To investigate these two possible routes of control over responding by exclusion (selection of a new stimulus or exclusion of known stimuli), Wilkinson and McIlvane (1997) suggested a new method, termed the blank comparison or mask, which would permit to measure directly the controlling relations between stimuli involved in responding by exclusion, making it possible to understand the necessary conditions for learning the relation between names and referents more broadly.

The exclusion probe trials used in the literature so far presented auditory samples and, as comparisons, one defined and one undefined picture (Dixon, 1977; McIlvane & Stoddard, 1981). In the study by Wilkinson and McIlvane (1997), the authors offered a third alternative choice, using the blank comparison procedure in the matching-to-sample task. According to the authors, the blank comparison allowed the participants to choose “none of these” if they considered that the available pictures were incorrect. This manipulation of the trial display permitted to verify the control route in each trial because, in those trials when both the blank comparison and a positive stimulus are present, the choice of a stimulus instead of the blank comparison indicated control through the selection of the correct stimulus; in those trials when the blank comparison is displayed with incorrect stimuli, on the other hand, choosing the blank comparison indicated their rejection. Eight typically developing children participated in the two experiments conducted by Wilkinson and McIlvane (1997). In Experiment 1, when the blank comparison was added as a choice in test trials, the authors found that children selected the blank option excluding defined comparisons when an undefined sample was presented. They also responded in accordance with a direct relation between an undefined sample and an undefined comparison, by selecting the undefined stimulus when it was available.

Experiment 2 by Wilkinson and McIlvane (1997) investigated another very important question for the area: if participants responded by exclusion, did they learn the auditory-visual relations involved in the tests? The choice of a new stimulus in the presence of an also new name, whether by exclusion of or by selection of the common property (novelty) was highly probable, but the variation in the participants’ responses on the discrimination probes indicated that exposure to a single exclusion trial was insufficient to learn the name-picture relation. These results were replicated by Costa et al. (2001), involving 52 Brazilian children between three and 13 years of age. Similar results were found by Domeniconi et al. (2007) in a study that involved four young children in a play situation.

Results from previous studies (Carr, 2003; Costa et al., 2001; Dixon, 1977; Domeniconi et al., 2007; Horst & Samuelson, 2008; Wilkinson & McIlvane, 1997) indicated that a single exposure to a trial with a high probability of exclusion responding does not guarantee that the children learn the relation between the new dictated word and the object or picture. Therefore, the number of exclusion trials can be an important variable for learning the name-object relation. In addition, research in the area has generally emphasized the investigation of learning based on exclusion in the context of matching-to-sample tasks only (more directly related to learning of receptive vocabulary) (Feldman et al., 2005). It is important to investigate the learning of name-picture relations in naming trials (expressive vocabulary) as well, as this type of repertoire is present and required in most social and educational contexts. Such investigations will enable the comparisons between the extent of exposure needed to learn naming and that needed to produce learning outcomes in matching-to-sample tasks.

In this context, the aim of this study was to investigate the number of trials needed for eight preschool children to name two new pictures, matched by exclusion to new words. Besides the learning about the relation between name and picture, the study also mapped the control relations established in baseline matching-to-sample tasks. This research can contribute to clarify possible learning processes deriving from exclusion responding and to identify the necessary and sufficient conditions for learning about the relation between names and pictures.

Method

Participants

Participated in the study eight typically developing preschoolers between four years and 11 months and five years and 10 months of age (four boys and four girls). All participants' chronological ages were equivalent to the age on the PPVT (*Peabody Picture Vocabulary Test-Revised*) (Dunn & Dunn, 1981).

Instruments

The experimental room, containing a table and two chairs, was equipped with a Macintosh Computer, iMac model. The MTS software version 11.3.4 (Dube, 1991) displayed the stimuli, recorded selection responses (performed with a mouse click) and controlled differential consequences presentation. The participant sat in front of the computer and a researcher stayed in the room during the sessions, sitting behind the participant. In addition, a form was used to register the naming responses. The children received school material and toys as gifts for their participation.

Procedure

Data collection. The sessions were conducted individually from three to four times a week and lasted for

approximately 10 minutes. The total number of sessions to achieve the learning criterion varied between three and 10. The experiment involved four phases: (1) Establishing the Baseline (BL), (2) Control probes, (3) Exclusion probes, and (4) Learning probes. In the BL trials, colored stars on the computer screen and an escalating sound followed correct responses; after incorrect responses, the screen darkened during two seconds. The display of a consequence was followed by the next trial. No differential consequences were programmed for the probe trials. In Phases 2, 3 and 4, BL trials were presented according to an intermittent reinforcement schedule (Random Ratio 2 or RR 2). The criterion to advance to the next phase was 100% of correct responses in the BL trials.

Phase 1 – Establishing the baseline (BL). There were three blocks of trials, all of which had a criterion of 100% of correct responses. The first block aimed to teach an auditory-visual conditional discrimination (a dictated word as the sample stimulus and pictures as comparisons). The samples were the dictated names: “Bola” (*Ball*), “Cachorro” (*Dog*) or “Bicicleta” (*Bicycle*) (Defined Words or DW 1, 2 and 3, respectively); the comparisons were pictures that represented a ball, a dog and a bicycle (Defined Pictures or D1, D2 and D3, respectively – see Table 1). Three trials with each of the samples were presented in a semi random order. The second block of trials in this phase established responding to the blank comparison (Wilkinson & McIlvane, 1997): across 18 trials, a black square (the blank) was gradually introduced (fading in) covering the correct comparison on half the trials and one of the incorrect comparisons on the other half; in initial trials, the blank was gray and, gradually, it was darkened and increased in size until it covered the stimulus completely. In the first two blocks, a continuous reinforcement schedule (CRF) was used. In the third block, the task with the blank comparison (B) was introduced from the beginning, under the intermittent reinforcement schedule (RR 2).

Table 1 presents the probe trials displayed in Phases 2, 3 and 4. In the probes, new stimuli (dictated words and pictures) were presented in different arrangements. These stimuli will be called Undefined Stimuli (U).

Phase 2 – Control probes. Two trials of control probes were inserted among 12 BL trials. One of the probe trials verified whether the blank comparison would actually serve as an alternative choice: the sample was a dictated undefined word (UW) and the comparisons were two defined pictures and the blank comparison. The other probe trial verified whether responding would be under the control of the novelty of the stimulus: the sample was DW2 and the comparison stimuli were D2, the blank (B) and a novel picture (U3). Responses to U3 suggested control by novelty of U3.

Phase 3 – Exclusion probes. Two exclusion probe trials were inserted among 12 BL trials. Each exclusion probe displayed an undefined dictated word as the sample and, as comparisons, one Undefined Picture (U), one Defined Picture (D) and the blank. Undefined Words were “Tiluco” (UW1) and “Polamo” (UW2); their corresponding pictures were U1 and U2. Responses to Undefined Pictures were considered to be consistent with responding by exclusion.

Table 1
Arrangement of the Probe Trials Presented in Phases 2, 3 and 4: Samples, Comparisons and “Expected” or Learning Consistent Responses

| Probes | Sample (auditory) | Comparisons | Expected answer |
|-----------|--|---|--|
| Control | “xivata” |  D1, D2 and B |  |
| | “dog” |  D2, B and U3 |  |
| Exclusion | “tiluco” (UW1) |  U1, D3 and B |  |
| | “polamo” (UW 2) |  U2, D2 and B |  |
| Learning | “what is the name of this figure?” (D) “what is the name of this figure?” (U) | | Naming D1, D2 and D3 Naming U1 and U2 |
| | “tiluco” |  U1, B and U4 |  |
| | “tiluco” |  D2, B and U5 |  |
| | “polamo” |  U2, B, U6 |  |
| | “polamo” |  D3, B, U7 |  |

Phase 4 – Learning probes. These trials verified whether, based on responding by exclusion in Phase 3, participants also learned the names U1 and U2 (1); and (2) whether the relation between the dictated word and the picture was effectively learned in matching-to-sample tasks. Nine probe trials were inserted among 12 BL trials: five required pictures naming (one for each defined [D1, D2, D3] and undefined [U1 and U2] stimulus) and four were matching-to-sample trials. Within the block of trials, naming probes were presented before the matching-to-sample probes. The latter were divided into two types: Sample/S+ Probes, which tested control by selection, and Sample/S- Probes, which tested control by rejection, as follows:

(a) *Sample/S+ Controlling relations probes.* one of the trials displayed UW1 as the sample and stimuli U1, B and U4 as comparisons. The other trial displayed UW2 as the sample and U2, B and U6 as comparisons. Responses to stimuli U1 or U2 were considered consistent with learning of the word/picture matching relation, controlled by the selection of the stimulus (Sample/S+ relation).

(b) *Sample/S- Controlling relations probes.* one trial displayed UW1 as the sample and D1, B and U5 as comparisons; the other trial displayed UW2 as the sample and D3, U6 and B as comparisons. Responses to the blank were considered consistent with learning of the word/picture matching relation (UW1/U1 and UW2/U2), controlled by the rejection of the stimulus (Sample/S- relation).

The sequence Phase 3/Phase 4 was represented until each participant correctly named U1 and U2 in the same block of trials (learning criterion); thus, individual participants were exposed to different number of presentations of Phase 3/Phase 4. It should be mentioned that the Undefined Words and Pictures are only considered new upon their first occurrence but the expression “Undefined” will be maintained throughout the text to identify them as the same stimuli used in probes.

Data analysis. Responses in the learning probes were displayed in tables (one for Pictures naming probes and another for matching-to-sample probes) so as to monitor the participants’ performance until they reached the learning criterion. The combination of both tables reveals whether the correct naming responses were followed by selection responses consistent with learning of the name/picture relation in the matching-to-sample tasks.

Ethical Considerations

Approval for this research was obtained from the Human Research Ethics Committee from the Universidade Federal de São Carlos (Protocol 007/2008). The director of the participants’ day care authorized the research. The parents were informed about the research objectives and the tasks the children were supposed to perform through an Informed Consent Form, which they signed before the start of data collection to authorize their children’s participation.

Results

Phase 1 – Baseline Teaching (BL)

All participants reached the learning criteria of the BL tasks in only one round of each of the three blocks in this phase. The performance of all participants in the BL trials remained accurate throughout the other phases of the procedure.

Phase 2 – Control Probes

Seven out of eight participants chose the blank comparison (B) in the first trial, indicating that the blank was an effective alternative. Participant LA selected D2 (dog picture), which could probably be explained by the fact that the participant considered the Undefined Word (*tiluco*) as being the dog's name. On the second probe, all participants selected the Defined Picture that corresponded to the defined word dictated as the sample, meaning that responding was not under the control of the novelty of the stimuli.

Phase 3 – Exclusion Probes

All participants performed consistently with responding by exclusion in all trials presented for both stimuli, that is, when the Undefined Words UW1 or UW2 were dictated they selected, respectively, Undefined Pictures U1 or U2, and not the Blank or the Defined Pictures.

Phase 4 – Learning Probes

All participants presented 100% correct naming of the Defined Pictures every time they were presented, confirming that the name-picture relation was well established for the baseline stimuli. Was Naming the Undefined pictures learned as a function of the exclusion probes? Table 2 displays individual participants' naming of U1 and U2 on all probe trials. The correct naming criterion of Pictures U1 and U2 was achieved after at least three and at most ten exposures to the exclusion trials (trials during which the Undefined

Pictures UW1- “tiluco” and UW2 – “polamo” were dictated). One participant (BI) named the stimuli correctly after three presentations in Phases 3 and 4, two participants (AM and MA) did the same after four presentations; one participant (FA) after six presentations, two (RA and GI) after seven, one (LE) after eight and another (LA) after 10 presentations.

Four participants (BA, GI, LE, LA) named Picture U1 correctly first, while three participants (BI, AM, RA) named first Picture U2. Participant FA named both pictures correctly in the same block of trials. Participants RA, GI and LA, at different points of the experiment, inverted U1 or U2 when naming, which indicated learning, until then, of undefined names, but not of the relation between them and their corresponding Undefined Pictures.

Table 3 presents participants' selections on stimulus control probes (Sample/S+ or Selection control and Sample/S- or Rejection control).

Concerning Selection control, for stimulus U1, all participants responding occurred under control of the sample/ S+ relation (Sample/S+ Type) on the first trial that was presented. This performance continued on the other presentations, except for one trial (3rd presentation) in which participant LE chose the blank comparison (B) (see upper section of Table 3 [Sample/ S+ - U1]). Hence, for all participants, the correct naming of U1 was accompanied by responding indicating the learning of the matching-to-sample relation between the dictated word UW1 and the Picture U1 (selection control). Data regarding stimulus U2 were more varied and showed control by the novelty of stimuli on some trials (see choices of U6 and U7 in the lower section of Table 3 [Sample/S+ - U2]). Only three participants maintained responding that was consistent with control by selection in all trials (BI, AM and GI); Participant MA only performed consistently in the fourth presentation of stimulus U2 (corresponding to the Phase 4 block in which picture naming was also correct); RA presented consistent responding in five out of seven probe presentations (presentations 1, 2, 5, 6 and 7), LE in three out of eight presentations (presentations 1, 4 and 8) and LA in nine out of 10 presentations (LA chose U6 only in

Table 2
Participants' Naming Responses of Undefined Pictures U1 and U2. Correct Responses Were UW1 (*tiluco*) to U1 and UW2 (*polamo*) to U2

| Block of trials | BI | | AM | | BA | | FA | | RA | | GI | | LE | | LA | |
|-----------------|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|-----|-----|----------|-----|--------|---------|
| | U1 | U2 | U1 | U2 | U1 | U2 | U1 | U2 | U1 | U2 | U1 | U2 | U1 | U2 | U1 | U2 |
| 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 2 | - | UW2 | - | - | - | - | - | - | - | - | - | - | - | - | - | UW1 |
| 3 | UW1 | UW2 | - | UW2 | UW1 | - | - | - | - | - | UW1 | - | xilofone | - | UW1 | - |
| 4 | - | - | UW1 | UW2 | UW1 | UW2 | - | - | - | - | - | UW1 | - | - | UW1 | tolango |
| 5 | - | - | - | - | - | - | tico | - | UW2 | UW2 | - | - | - | - | UW1 | UW1 |
| 6 | - | - | - | - | - | - | UW1 | UW2 | UW2 | UW1 | UW1 | - | UW1 | - | tolamo | UW1 |
| 7 | - | - | - | - | - | - | - | - | UW1 | UW2 | UW1 | UW2 | - | UW2 | UW1 | - |
| 8 | - | - | - | - | - | - | - | - | - | - | - | - | UW1 | UW2 | - | - |
| 9 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | UW1 | - |
| 10 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | UW1 | UW2 |

Note. Dashes indicate absence of a naming response.

Table 3

Participants' Performance in Learning Probes Sample/S+ and Sample/S-: Total Number of Presentations of Phase 4 per Participant and Comparison Stimulus Chosen (Undefined [U], Defined [D] or Blank Comparison [B]) in Each Presentation

| | | Probes and comparison stimuli presented during each trial | | | | | | | |
|--|-----------|---|------|--------|----------|------------|--------|--------------|------------|
| Participant/ Total number of presentations | | BI/3 | AM/4 | MA/4 | FA/6 | RA/7 | GI/7 | LE/8 | LA/10 |
| Sample/S+ U1 | U1 | T | T | T | T | T | T | 1, 2, 4 to 8 | T |
| | U4 | | | | | | | | |
| | B | | | | | | | 3 | |
| Sample/S- U1 | U5 | 1 | | | 1,3 to 6 | 1 to 4 | T | 1 | T |
| | D2 | | | | | | | | |
| Sample/S+ U2 | U2 | 2,3 | T | T | 2 | 5 to 7 | | 2 to 8 | |
| | U6 | T | T | 4 | 1 | 1,2,5 to 7 | T | 1, 4, 8 | 1, 3 to 10 |
| | B | | | | | 4 | | | 2 |
| Sample/S- U2 | U7 | | | 1 to 3 | 2 to 6 | 3 | | 2, 3,5 to 7 | |
| | D3 | | | | 3, 5, 6 | 1 to 4 | 2 to 7 | 2 | T |
| | B | T | T | T | 1, 2, 4 | 5 to 7 | 1 | 1, 3 to 6, 8 | |

Note. The letter T indicates the choice of the corresponding stimulus in all trials. The figures indicate the presentations during which the corresponding comparison stimulus was chosen. Stimuli in bold indicate the choice considered to be consistent with learning the measured sample/comparison relation.

the second presentation). FA only responded consistently with selection control of U2 in the first presentation; in all others, the blank comparison was chosen. Despite greater variability in the participants' choices when compared to stimulus U1, for seven out of eight participants, the correct naming of Undefined Picture U2 was accompanied by responding that indicated the learning of the matching-to-sample relations, controlled by the selection of stimulus U2.

In Sample/S- Type stimulus control probes or Rejection control, for U1 (see upper section of Table 3 [Sample/S- - U1]), AM and MA selected the blank comparison in every trial; BI and LE from the second trial; RA from the fifth trial; FA selected the blank (B) in the second probe and selected U5 in the remaining probes; GI and LA consistently selected Picture U5 in all probe presentations. Hence, for U1, five participants (BI, AM, MA, RA and LE) showed systematic control by rejection of the defined and undefined pictures (not related to the sample U1) presented as comparisons in the trial block where naming was correct, while three participants (LA, GI and FA) showed control by the novelty of undefined stimuli, although the naming relation had been established.

For U2, three participants presented consistent responses in all trials (BI, AM e MA); RA responded on the blank on the three last trials from a total of seven; participant FA presented varied responding, whereas U7 was chosen in the trial in which the stimulus was named correctly; participant GI responded on the blank in the first trial presentation and chose stimulus U7 on the others; participant LE responded on the blank in six (including the presentation that followed correct naming) out of eight trials; participant LA responded consistently on Picture U7. In sum, for five out of eight participants (BI, AM, MA, RA and LE) correct naming was also accompanied by responding consistent with learning of the word/picture relation under Rejection control.

The main results can be summarized by the simultaneous analysis of Tables 2 and 3. For five (BI, AM, MA, RA, LE) out of eight participants, the correct naming of U1 and U2 was accompanied by responding consistently with the learning of the Sample/S+ and Sample S- relations in the matching-to-sample probes. For participants LA and GI, correct naming of both undefined pictures in the same presentation in Phase 4 was followed by responses consistent with the selection relation (Sample/S+) of the matching-to-sample probes. Participant FA presented a consistent choice in only one trial: the Sample/S+ relation for U1.

Discussion

The aim of this study was to investigate the number of trials needed until eight preschoolers named two new pictures, which were matched to new words by exclusion. In addition, the experimental procedure mapped the routes of stimulus control in the matching-to-sample tasks (Selection control or Sample/S+ and Rejection control of Sample/S-) to enhance knowledge about the necessary and sufficient conditions to learn the relation between names and pictures.

The results confirm earlier studies regarding the systematic and regular occurrence of responding by exclusion (Costa et al., 2001; Dixon, 1977; Domeniconi et al., 2007; Wilkinson & McIlvane, 1997). As regards learning by exclusion, the naming of the two new pictures was never observed before the third exposure to the trial blocks. Therefore, the exposure to a single exclusion trial was not sufficient to promote learning to name new stimuli.

As some participants correctly responded in the learning probes that involved matching-to-sample tasks before they correctly named the stimuli, it is important to systematically investigate whether differences exist between the number of trials needed to learn the word/picture relation in the two response

modalities: responding in matching-to-sample tasks (listening, or comprehension tasks) and responding in naming tasks (speaking, or expression tasks). An eventual difference in the rate of learning acquisition would be coherent with Skinner's (1957) analysis of the functional independence of verbal operants.

Overall, responding consistent with the learning of the relation between the words and the Undefined pictures U1 and U2 in the matching-to-sample trials demanded fewer exposures to the trial blocks than the correct naming of the undefined pictures, except for participants FA (who did not display consistent responding for one of the pictures) and LE (who displayed consistent responding in the correct naming block for one of the pictures, but displayed varying performances in earlier presentations). These results suggest that learning of the conditional relation between spoken word and picture, object or event precede the acquisition of picture naming. Although this inference calls for cautious investigation, it is in accordance with the literature on initial speech development in young children. Authors in this field (Barrett, 1985; Brown, 1973; Van Riper & Emerick, 1997) affirm that, long before they pronounce their first words, children already behave under control of gestures, inflections and other dimensions of their parents' speech (or part of their speech). The results of this study also confirm Michael's (1982) analyses about the role of selection-based tasks and tasks that require the emission of differential responding (topography-based) on establishing verbal repertoires.

Another aspect related to the probes that involved matching-to-sample tasks is that responding that is consistent with learning of the dictated word/picture relation in one presentation is not necessarily followed by responding consistent with learning in subsequent presentations of the same probes. Therefore, caution is due when asserting that the learning outcome of the dictated word/picture relation has been established when the participant shows consistent responding in a single presentation of the learning probes.

On the whole, the present study results provide empirical support for the assertion by Wilkinson and McIlvane (1997) that learning by exclusion can gain stability over time. If, on one hand, a sole exclusion trial is insufficient to establish the naming of a picture, on the other, it can be affirmed that naming is learned after few exposures to exclusion trials.

For the two pictures (U1 and U2), correct naming was always accompanied by responding that was consistent with learning the word/picture relation on exclusion trials under Selection control, that is, under the control of the direct relation between the undefined stimuli (both the word and the picture) based on their shared novel characteristic (except for one of the pictures, for one of the participants). Conversely, three participants correctly labeled the two pictures without responding by rejection in the matching-to-sample trials. These data may suggest that, in the context of the task under analysis, naming can merely depend on the direct relation of a word and the corresponding picture under selection control. The naming task may set a context in which participants have to pay attention to the distinctive features of the stimuli, resulting in greater stability of

responding by selection. In this case, one may question whether using solely Type S probes (Selection control) would be appropriate to test the learning the word/picture relation via matching-to-sample. Even though naming performances appeared to be mostly related to control by selection, results of the matching-to-sample tests indicated that control by selection and rejection are not mutually exclusive. They can vary in each trial or even take place simultaneously in the same trial, as pointed out by Carrigan and Sidman (1992). According to Wilkinson, de Souza and McIlvane (2000), the simultaneous control by the two types of stimulus control topographies may ensure the regularity of responding by exclusion and foster learning by exclusion.

One further consideration concerns data from learning probes involving matching-to-sample (Type S and Type R stimulus control), that were more varied for stimulus U2, which was always the second stimulus to be presented in each block in Phases 3 and 4. This suggests that introducing two new names in a new block of trials may have hindered acquisition of dictated word/picture relations for the second stimulus. For experimental purposes, it would be important to balance the order of stimulus presentation in future studies, as well as to investigate the rate of acquisition as a function of the number of relations taught simultaneously.

Final Considerations

The present study results entail important scientific implications, as they raise new possibilities to investigate the naming of novel stimuli based on exclusion trials and confirm the utility of the blank comparison procedure to identify the stimuli control routes that may support responding by exclusion, permitting a more comprehensive assessment of this emerging response pattern.

The results point towards responding by selection (Sample/S+) as a necessary condition to learn naming. However, further investigation should verify the generality of these results. Further research focused on variables to enhance the learning of naming new stimuli and the matching-to-sample relations between names (dictated words) and pictures using of the exclusion procedure can explore some variations in this procedure.

As a suggestion, only one new stimulus could be present in each block of trials. This would avoid potentially interfering effects such as blocking or overshadowing, or responding under control of the dictated names without attention to the name/picture relations. Another possibility would be to require the oral reproducing of the dictated word (echoic responding or vocal imitation) in the exclusion trials. Such active responding could foster the correct identification of the syllables that compose the words. This is justified by the data of some participants that indicate learning of the name/picture relation, yet with imprecise identification of the word (e.g., "tico" instead of "tiluco", "tolango" instead of "polamo").

Another possibility would be to present a trial that requires naming of the new picture immediately after the exclusion trial. In this study, picture naming was required in a block of trials after the block with exclusion trials and, during

the interval between exclusion and naming trials, different tasks were demanded (BL and defined picture naming trials), which may have hampered their performance. Further studies could also elucidate whether there is a correlation between the amount of naming required and the maintenance of the learned relation, for example, by introducing follow-up measures.

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