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Artigo Científico

The role of naming in abstract conditional discrimination

O papel da nomeação na discriminação condicional abstrata

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Abstract

Vigotsky's double-stimulation method inspired this study of the effect of the presence or absence of category-name labels under chosen objects during the acquisition of abstract conditional discriminations by children. Forty elementary school students participated in Experiment 1. During Phase 1 they were asked to separate 13 blocks according to each of four properties and to name the separation criteria. They solved the task with prompting from the experimenter. Thirty-four participants passed to Phase 2. On each trial the experimenter separated one of 48 blocks of four different sizes and thicknesses to function as a sample. Then, choices of blocks matching the sample in size and thickness were reinforced. Participants were assigned to one of four Conditions: NNWQ: no-name, with questions after trials; NNNQ: no-name, without questions; WNWQ: labeled blocks (with name), with questions; WNNQ: labeled blocks, without questions. In Phase 3, four samples were separated simultaneously. Matching performances in Phases 2 and 3 were better in Conditions NN than WN and partial verbalization of relevant properties was observed. Few participants generalized matching to new objects (Phase 4). Experiment 2 replicated Experiment 1, but changing the experimenters in Conditions NN and WN, to rule out the possible role of experimenter's performance. Again, matching performance was faster and naming the properties was more accurate in NN conditions, showing a restricted stimulus control effect of name in WN Conditions. © Ciências & Cognição 2007; Vol. 10: 65-83.

Keywords: *naming; conditional discrimination; matching to sample; concept formation; children.*

Resumo

O método da dupla estimulação deVigotsky inspirou este estudo do efeito da presença ou ausência do rótulo com o nome da categoria sob os ojetos escolhidos durante a aquisição de discriminações condicionais abstratas por crianças. Quarenta crianças do ensino fundamental participaram do Experimento 1. Durante a Fase 1 pedia-se a elas para separar 13 blocos de acordo com cada uma de quatro propriedades, e nomear os critérios de separação. Elas resolveram a tarefa com ajuda do experimentador. 34 participantes passaram à Fase 2. Em cada tentativa o experimentador separava um de 48 blocos de quatro tamanhos e espessuras diferentes para funcionarem como modelo. Escolhas de

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blocos iguais ao modelo em tamanho e espessura eram reforçadas. Os participantes foram distribuídos em uma de quatro Condições: NNWQ: sem-nome, com questões após as tentativas; NNNQ: sem-nome, sem perguntas; WNWQ: blocos com etiqueta (com nome), com perguntas; WNNQ: blocos com etiquetas, sem perguntas. Na Fase 3, quatro modelos eram separados simultaneamente. Desempenhos de igualação nas Fases 2 e 3 foram melhores nas Condições NN do que nas WN e foi observada verbalização parcial das propriedades relevantes. Poucos participantes generalizaram o pareamento para os novos objetos (Fase 4). O Experimento 2 replicou o Experiment 1, mas mudando os experimentadores nas Condições NN e WN, para eliminar o possível papel do desempenho do experimentador. Novamente o desempenho de pareamento foi mais rápido e a nomeação das propriedades mais precisa nas Condições NN, mostrando um efeito de controle de estímulos restrito do nome nas Condições WN. © Ciências & Cognição 2007; Vol. 10: 65-83.

Palavras-chave: nomeação; discriminação conditional; pareamento ao modelo; formação de conceito; crianças.

1. Introduction

When learning abstract conditional discriminations by matching objects by one or more characteristics or attributes, participant's matching responses eventually may come under control of the characteristics of the objects. In human participants, naming of the relevant discriminative stimulus (*i.e.*, the characteristic or attribute) may emerge. This study investigated the function of the availability of artificial category names in learning abstract discriminations by first grade children.

This paper will use the following definitions: Naming is both a response guided by an event, and a response to an event guided by a stimulus (the name); naming, though, can be conceived of as a symmetric environment-behavior relation (but see Horne and Lowe, 1996). Abstract discrimination is the conditional stimulus control involved in matching objects that share one or more features, this definition is similar to "perceptual concepts" (Zentall *et al.*, 2002); defined this way, abstraction is possible in the absence of naming. Class is a set of objects that share a common property that control the matching response. Concept is the naming of a class in a generalized fashion, where different objects receive the same name on the basis of a shared property. Although there is no need for physical similarity between the members of a set, this is the case of the classes studied here.

Shimamune and Mallot (1994: 67) asserted that *"The learning process involving verbal definitions differs considerably from that involving no verbal behavior"*. In fact, children's ability to discriminate abstract properties, objects by color, for example, precedes their ability to discriminate the concepts, (*i.e.*, the verbal labels), correspond-ding to these abstractions. Children in the first grade of elementary school, for example, may eventually become confused when faced with apparently simple tasks such as that of separating objects by color when requested to do so. This difficulty corresponds to the increasing control of the concrete changing stimulation over responding and the decreasing control by an increasingly delayed verbal statement, over responding. Children's behavior is influenced relatively more by current environmental contingencies as opposed to rules, than is adult behavior. Also, correspondence of children's reports to events has been shown to be a function of contrived reinforcement contingencies for specific reporting content as opposed to reporting accurately (Ribeiro, 1989). Similarly, the reporting performance of adults may be controlled by arbitrary contingencies as opposed to "factual" or accurate descriptions of events (Torgrud and Holborn, 1990).

An interesting method to study such phenomena has been reported by Vigotsky (1986). He developed a method to study the process of concept formation using sets of wooden blocks all differing from each other in at least one attribute (*e.g.*, color, size, form, thickness). Using these blocks the experi-mentter would ask a participating child to separate the blocks in subsets according to

one or two of the attributes. The blocks had names written on one side, and were aid on a table with the name side down. There were four names, corresponding to four categories of blocks: large and thick, large and thin, small and thick, and small and thin. Basically, the procedure involved establishing a conditional discrimination. One of the blocks was separated by the experimenter, who asked the child to separate from the set, other blocks that the child thought had the same name as the one selected by the experimenter.

The arbitrary names were taught to designate the members of each subset, and the procedure allowed the observation of the relative control of physical attributes and labels as teaching progressed. Each block chosen correctly was separated, each block chosen incorrectly was returned to the pile. The stimulus control established was observed under conditions where the participant's choices were guided by the physical properties or by the names, as a result of the differential consequences of their choices.

Vigotsky reported different types of performance, that he called "stages of development": the syncretism, of very small children; the "thought in complexes", the associative or collection formation type, groupings according to variable (diffuse) criteria, the false-concept; and the concept itself. When the name of the blocks comes to guide the choices, the participant is not distracted by the number of stimuli present in the situation. Such performance representing abstract discrimination involved in the task. Differing from older participants of about 13-years-old, young children demonstrated little effect of differential consequences, repeating mistaken choices, and having difficulty verbalizing which properties were relevant for inclusion of the blocks into the subsets.

As noted by Siegel (1995), stages of development are discrete and separate, and a microanalysis of the development is necessary to complement the knowledge of how performance evolves in the individual child, confronted with a specific task. The method used by Vigotsky can, with appropriate adaptations, be a model of conditional discrimination and concept formation for the analysis of the changes in the performance as it allows observation of gradual changes in stimulus-response relations, including both verbal and non-verbal responses.

Galvão and colleges (1990) modified Vigotsky's double-stimulation method, using a set of 48 "attribute" blocks (see below) in a modified matching to sample procedure, with immediate differential consequences for matching blocks by both, size and thickness. The data indicated that given appropriate differential reinforcement abstract discriminations may be acquired by participants that do not yet name the discriminative stimuli.

Dienes (1966) attribute blocks are a set of 48 pieces of wood or other material, each one containing different values for each of the following properties: size (large, small), color (yellow, blue, red), thickness (thick, thin) and shape (triangle, square, circle, rectangle). All the pieces differed from each other in, at least, one attribute value, making possible a great number of combinations. For example, a square may be large, thick and red, or small, thin and blue, or small, thin and yellow, etc. Each block may be matched to others in many different ways, with different criteria, forming subsets of blocks that have in common the same value for one, two or three properties. However, with respect to the four properties being considered, there are no two blocks with the same features for all four properties, or in other words, no two blocks are equal in terms of the four properties.

The present study replicates Galvão and collaborators (1990) work, including a condition in which the blocks had no labels, to control for possible control of labels as stimulus attributes themselves. That is, if there was a label attached to the block, after each choice the experimenter showed the name of the block chosen to the participant; which name was either equal to or different from the name of the sample block. This procedure is different and may have a different effect from the procedure used for choices of blocks without names, which

consisted of the experimenter accepting the chosen block or putting it back in the pool.

A class denotes the objects or events that possess the class's defining properties. However, we may discriminate class pertinence without being able to name or identify the defining properties. We may, for example, separate diamonds in subsets by their forms, being unable to name their exquisite polygon forms. Once a name for a class is learned, correct naming may occur, even when this naming may not be under the control of the relevant properties, but rather of the concrete objects experienced.

The current study was concerned with the development of conceptual behavior as exemplified when we observe a person emitting a common name to the members of a subset, and applying the name to new objects having the defining property. In other words, the verbal label or naming corresponds to a concept when it occurs in the presence of members of a given class in a generalized manner, and does not occur in the presence of members of other classes.

A possible critical role of naming has been pointed out in studies of stimulus equivalence, which is one of the forms of studying concept formation, (de Rose, 1988). It is argued, for example, that the absence of the possibility of naming is a limiting factor, hindering the emergence of the equivalence relations in experiments of conditional relations (Horne and Lowe, 1996). Negative results with non-verbal and pre-verbal human individuals, and with subjects from other species, would be indications that the emergence of equivalence relations would depend on the previously installed verbal repertoire. One might argue however, that the relationship between the verbal and non-verbal behavior may affect the formation of stimulus classes in the context of equivalence experiments, and, possibly, in that of abstract conditional discriminations.

The present study investigated the effects of the presence or absence of verbal labels on the objects in a set on learning an abstract discrimination through matching the objects along the dimensions of size and thickness. Since during the learning of the task it is possible that verbalizations may be accompanying and even interfering with learning, we also investigated the role of the presence or absence of experimenter's questions asking the subject to name the relevant characteristics of the objects at the end of each trial.

2. Experiment 1

Confronted with a set of red and blue objects, and asked to divide the objects in two subsets according to color, a 6 years-old child may not complete the task correctly. The task is one of identity matching, (*e.g.*, put the blue blocks with blue blocks and do the same to the red blocks). However each successive choice may also come under control of the original verbal request temporally farther apart from successive choices. Thus, over several choices, the relative role of the original request and the immediately available features of the materials changes. Additionally, the blocks have other properties by which identity matching can alternatively be established (*e.g.* form or size). After receiving the instruction ("Separate the blocks by their colors") the child may start the task correctly, choosing the first block as requested. However, after several trials, and more temporally distant from the original auditory request, the child may eventually respond to the immediately available visual stimuli and pick a block that is identical to the last one chosen in its form, for example. In the first choice the task would be an arbitrary auditory-visual delayed identity discrimination, in the later choices it could be best described as a visual simultaneous identity discrimination. If this interpretation is correct, it explains much of the difficulties reported of children to follow instructions.

The question this experiment aimed to investigate is: has category name a different effect from correct/incorrect, as feedback for choices on an abstract discrimination learning task? Experimental data showing the role of naming on categorization are scarce and controversial (França and Galvão, 2000;

Horne and Lowe, 1996; McIlvane and Dube, 1996). The ability to match objects upon verbal request has been demonstrated to be hierarquically superior to matching them by their physical identity or resemblance in assessment research with low verbal level people (Cummings and Williams 2000; Sakko *et al.*, 2003). Normal children at the age level of six years-old can do abstract verbal-visual matching but when the situation implies many choices, visual-visual relations may overcome the verbal-visual relations, which occur to be simpler.

2.1. Methods

2.1.1. Participants

Forty children were recruited through contact with the school where they studied and after written authorization from the parents or legal guardians. Most of them were first grade elementary school students, without a history of repeated grades, with ages varying from 6 to 10. The exceptions were all in Condition NNNQ: S2 was repeating second grade; S3 was repeating first grade; S4, S5, S7, were in the second grade. Each group of ten participants was allocated to one of four experimental conditions. None of the participants possessed any history of participation in experiments.

2.1.2. Setting and materials

The sessions were conducted at a table (0.8 x 1.1 m) located in the middle of an isolated room (2.5 x 5.0 m). The participant and the experimenter sat in chairs on opposite sides of the table. The sessions were recorded by a video camera mounted on a tripod two meters away and in front of the participant. The data utilized were later obtained from the video tapes by two independent observers, and any disagreements were corrected.

Figure 1 illustrates the set of 13 wooden blocks, all differing in at least one property, and without labels, used in Phase 1. Figure 2 illustrates the set of blocks used in Phase 2. This latter set is made up of 48 different blocks ("attribute blocks "; Dienes, 1966: 27-31). Four properties were taken into consideration for data analysis: size (larger surface): large and small; thickness: thick and thin; color: yellow, red and blue; and shape: triangular, square, rectangular and circular. The blocks were divided into four subsets of 12 blocks; within each subset the blocks were identical in terms of size and thickness. In conditions WNWQ (with name, with query) and WNNQ (with name, no query) the blocks had a label affixed to the bottom surface. The 12 large and thick blocks had the "word" TAB written on the labels. The 12 large and thin blocks had the "word" LIM. The 12 small and thick blocks had the "word" TUS. The 12 small and thin blocks had the "word" VEC. The generalization objects used in Phase 4 were a box (18.0 x 26.0 x 4.0 cm), the lid of the box (16.5 x 25.0 x 0.3 cm), a box of pins (3.0 x 3.0 x 1.5 cm), and a coin (3.0 cm in diameter x 0.2 cm).

2.1.3. Procedure

At the beginning of the session the experimenter, using written instructions, asked the participant her/his personal data for the records and engaged the participant in some verbal interaction to habituate them to the situation and to the experimenter.

Phase 1.

The objectives of this phase were to verify whether (1) the participant could correctly divide the blocks according to size, thickness, shape and color upon request, and (2) if the participant could name the property that had been used as the criteria for division.

Trials began when the 13 blocks were spread out on the table and the experimenter asked the child to separate the blocks in groups by one property (*e.g.*, "Divide these blocks by color (or shape, or size, or thickness"). After the completion of division of the blocks (see below for correction procedures), the experimenter pointed to each subset, saying: "Very well, you divided by color (or shape, or size, or thickness), didn't

you? What difference is there in color (or shape, or size, or thickness) between this pile (pointing to one of the piles) and this one (pointing to the other pile)?" One block of trials consisted of four requests to divide blocks by a different property, and the participant answering the subsequent questions.

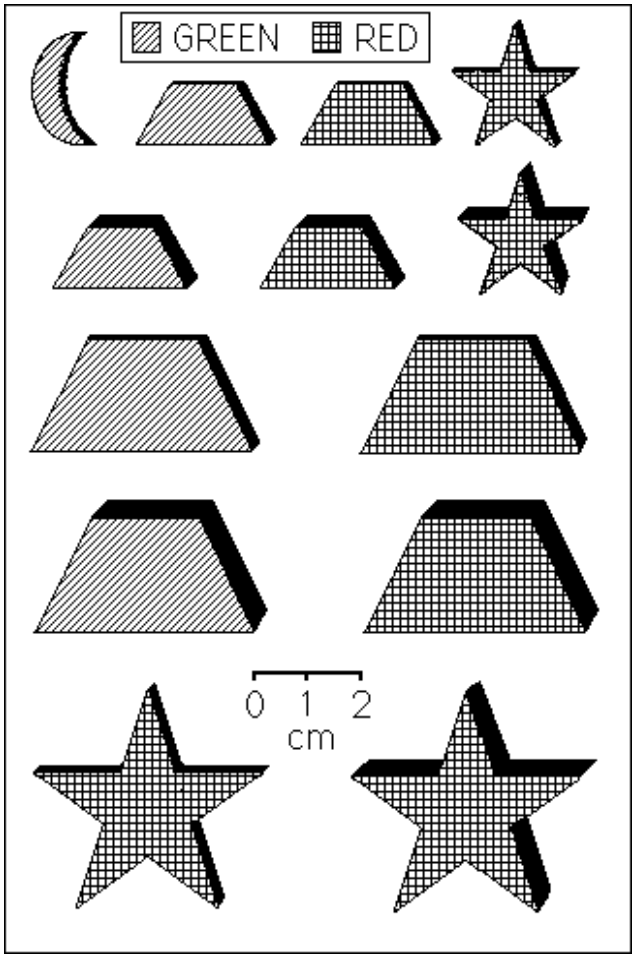

Figure 1 - Blocks used in Phase 1.

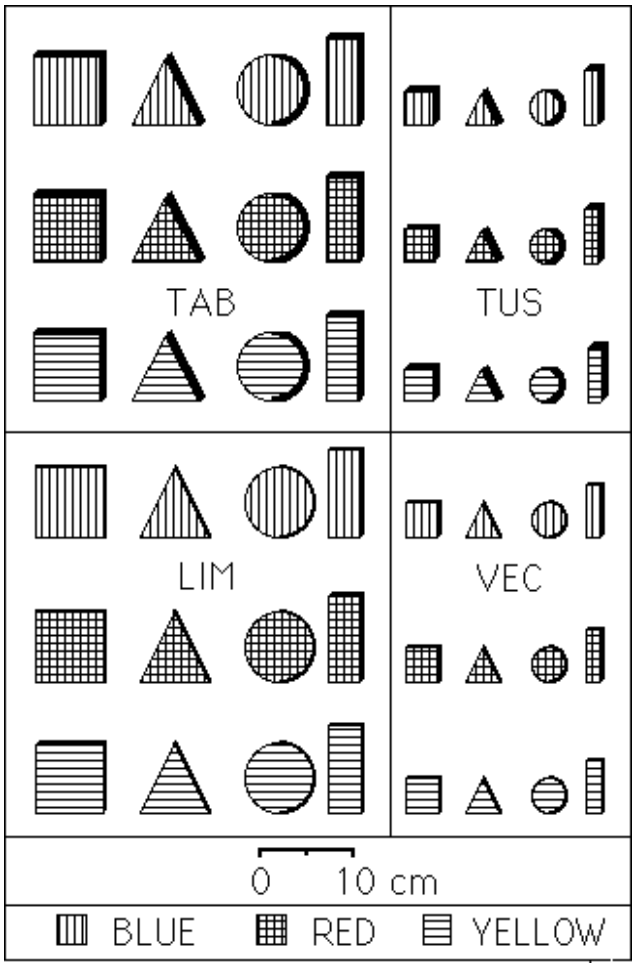

Figure 2 - Blocks used in Phase 2 and beyond.

To pass to Phase 2 the participant had to divide the blocks according to the request and name the relevant property within each of the four trials of a block of trials. When the participant did not correctly divide the blocks in a trial, the experimenter assisted him or her with up to three levels of prompting. Level 1: Divide these blocks "in two piles" by color (or other property); Level 2: Divide these blocks into two piles by color (or other property), "in greens and reds" (or the values correspondent to the property cited); Level 3: Demonstration of the task. If at this level of instruction the participant still was not responding correctly, the experimenter asked him or her to divide the blocks according to another property. If the participant divided the blocks according to the requested property, but did not verbalize correctly as to the difference between one pile and the other, the experimenter asked: "You divided by color (or other property), didn't you? Which color (or shape, or size, or thickness) do you put here (pointing to the pile)? Which here (pointing to the other pile)?"

Subjects participated of one of four Conditions: Condition NNWQ, No-named blocks, with question; Condition NNNQ, No-named blocks, without question; Condition WNWQ, Named blocks, with question and; Condition WNNQ, Named blocks, without question.

In Conditions NNWQ and NNNQ, participants who correctly divided the blocks and named the relevant property in Phase 1 went to Phase 2. In Conditions WNWQ and WNNQ the participants went to Phase 2 regardless of performance in Phase 1. This change was introduced because data form Conditions NNWQ and NNNQ indicated that the performances in Phase 1 were poor predictors of performances in Phase 2.

Phase 2.

This phase consisted of eight trials (due to experimenter failure, S7 received 6, trials 4 and 5 omitted). The sample block in each trial was different. The properties of successive samples and the corresponding labels in the WN Conditions were: (1) Square, blue, large, thick (TAB); (2) Triangle, red, small, thin (VEC); (3) Round, yellow, large, thin (LIM); (4) Rectangle, blue, small, thick (TUS); (5) Triangle, yellow, large, thick (TAB); (6) Rectangle, blue, small, thin (VEC); (7) Square, red, large, thin (LIM); (8) Round, yellow, small, thick (TUS).

On the first trial the experimenter spread out the set of 48 blocks on the table, picked up the sample block assigned to the trial, placing it near the edge of the table close to the participant, to his/ her left, saying “now a new game will begin with new blocks”. Then the experimenter said: "Look at this block (sample).Your task is to pick up a block from the pile of blocks, that you think may be of the same type as this (point) and put it near to it (point to the sample). If the block that you choose is of the same type as this (point to the sample), I will let it stay, if it isn’t of the same type, I am going to put it back in the pile. Then you will pick another block and do the same thing. You should always pick up one block at a time to put next to this one, OK? When you think that there are no more blocks in the pile of the same type as this (point to the sample) you tell me and your turn will be over." After these instructions, the experimenter asked the participant to repeat what had to be done. When the participant did not know how to describe the task, the instructions were repeated. If, upon execution of the task, the participant said that there were no more blocks of the same type as the sample before having separated them all, the experimenter said: "Continue, there are still more blocks in the pile that are of same type as this (point to sample)". In Conditions WQ, after the eleven correct blocks were chosen, and the participant had affirmed that there were no more blocks of that type in the pile, the experimenter asked: “Why are these blocks of the same type as this (point to sample)?". This question was asked at the end of each trial (after eleven correct choices to one sample) to verify whether the participant could or could not, at that point, name the relevant discriminative stimuli, or in other words, the relevant properties. At the end of each trial the blocks were mixed again and a new trial begun.

Phase 3.

Phase 3 involved the simultaneous presentation of four different samples, so that the participant was to simultaneously divide all 48 blocks into four subsets of 12 blocks. After Phase 2 the experimenter said to the participant: "Now I am going to pick up four blocks and put them here. Your task will be to pick up all the blocks from the pile that may be of the same type as this one and put them here (point to sample), of the same type as this one and put them here (point to the other sample), of the same type as this one and put them here (point to other sample) and of the same type as this one and put them there (point to other sample), always placing one block at a time, OK?" The feedback for the choices was the same as that used in Phase 2. In all four Conditions, after the participant had carried out the requested divisions, the experimenter asked: "How are these blocks the same?" (this question was repeated for each of the four subsets) and, then, "What is the difference between the blocks of this group (point to large and thick) and of this one (point to large and thin)?" Then, "What is the difference between the blocks of this group (point to small and thick) and of this

one (point to large and thick)?" Then, "What is the difference between the blocks of this group (point to large and thick) and of this one (point to small and thin)?" Next, "What is the difference between the blocks of this group (point to large and thin) and of this one (point to small and thick)?"

Phase 4.

Generalization test: With the four subsets that were separated during Phase 3 still on the table, the experimenter presented the generalization objects to the participant, and said: "If you had to put each of these objects in each of these four groups, where would you put each of them?" And finally: "Why did you put this object in this group?"

2.2. Results

In the Phase 1, five participants divided the blocks correctly in the first block of trials, eight in the second, twenty-two participants divided the blocks correctly in the third block of trials. Three did not divide correctly according to two properties and two participants did not divide correctly according to one property.

The different prompting levels, in general, were more used in the first trials. The number of errors decreased significantly throughout the trials.

Participants 2 and 3 assigned to condition NNWQ and participants 3, 4, 5 and 6 assigned to condition NNNQ did not pass to Phase 2 and beyond because of their poor performance in Phase 1. All participants assigned to conditions WNWQ and WNNQ continued until the last phase, except Participant 3 in Condition WNWQ, because he left the session during Phase 1.

Figures 3, 4, 5 and 6 show number of choices until and after the last correct block was chosen, for every participant, for conditions NNWQ, NNNQ, WNWQ, WNNQ, respectively. Performance was superior in conditions with no name under the blocks (NN) compared to conditions with a name (WN). In general, incorrect choices in Phase 2 were higher in the first trial, decreasing in the following trials.

Additional choices after the 11th (and last) correct block had been chosen were low in Condition NNNQ. In the condition NNWQ, with the exception of Participant 6, all participants made additional choices after the completion of the task only in the two first blocks of trials. In Condition WNWQ additional choices occurred throughout the eight trials for all the participants, except S4 (see Figure 5), the participants in this condition typically presented a higher rate of errors, especially before the 11th correct choice. In condition WNNQ additional choices occurred throughout the eight trials, with the exception of Participant 4 (see Figure 6). With the exception of Participant 9, participants presented an elevated number of errors in at least one trial.

Vocal responses to the question "Why are these blocks of the same type as this?" asked at the end of each trial were generally partial or incorrect. Participants in condition NNWQ mentioned only one property or value of one property, not the two relevant properties, answering, for example, that the blocks chosen were of same type of sample because they "were of the same size", or "of the same thickness", even though their choices had been made based on both properties, size and thickness. Participants in condition WNWQ did not mention, generally, any relevant property, mentioning instead the verbal labels affixed to the blocks.

In Phase 3 the number of errors made with four samples presented simultaneously was, in general, high, compared with the last trials of Phase 2. Again the participants of Conditions without names had better performances compared to the participants of Conditions with names on the blocks.

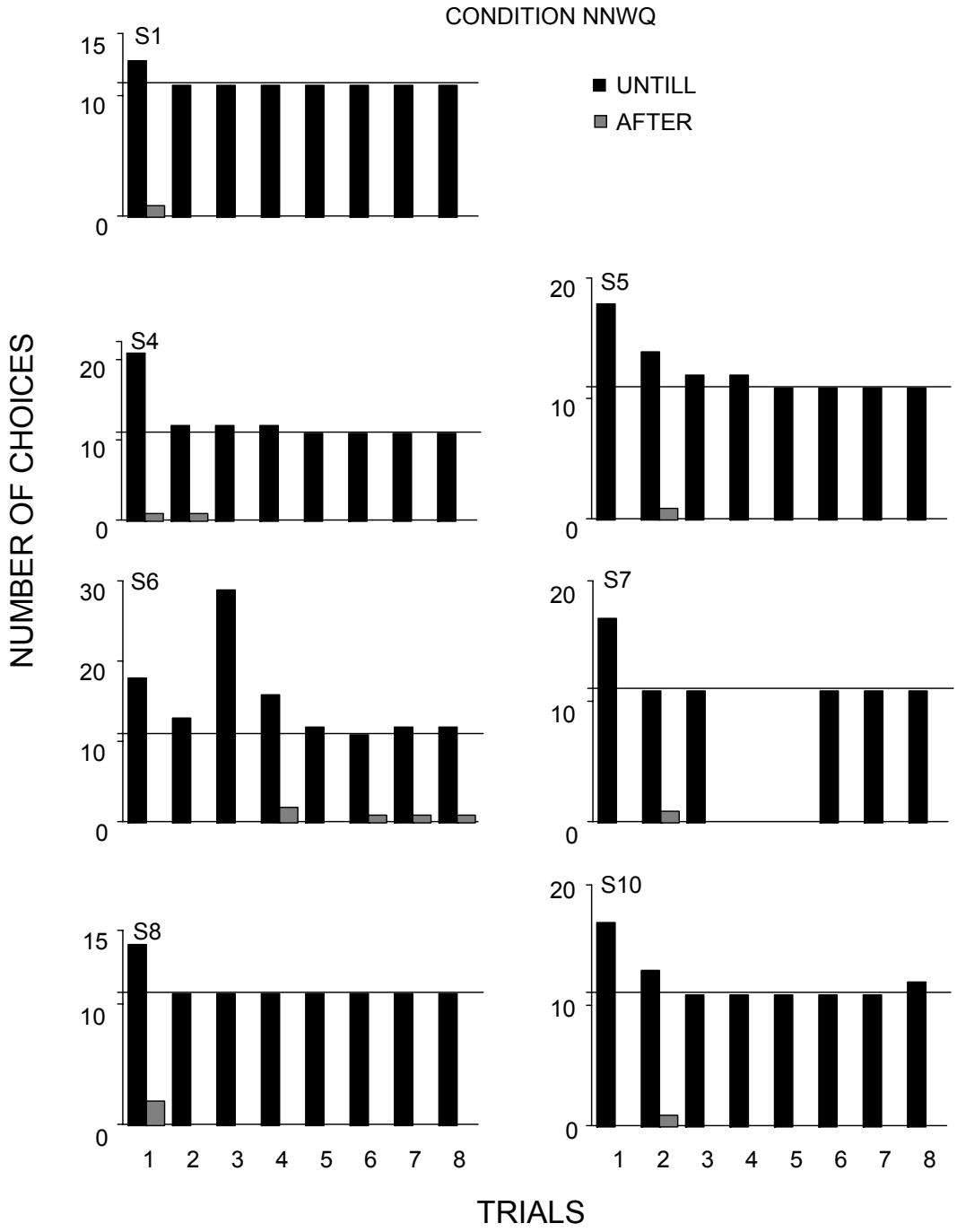

Figure 3 - Results by participant, by trial, of condition NNWQ, Phase 2. The black bars correspond to the number of choices made by the participant before having chosen the eleven correct blocks. The gray bars correspond to the number of choices made by the participant after having chosen the eleven correct blocks.

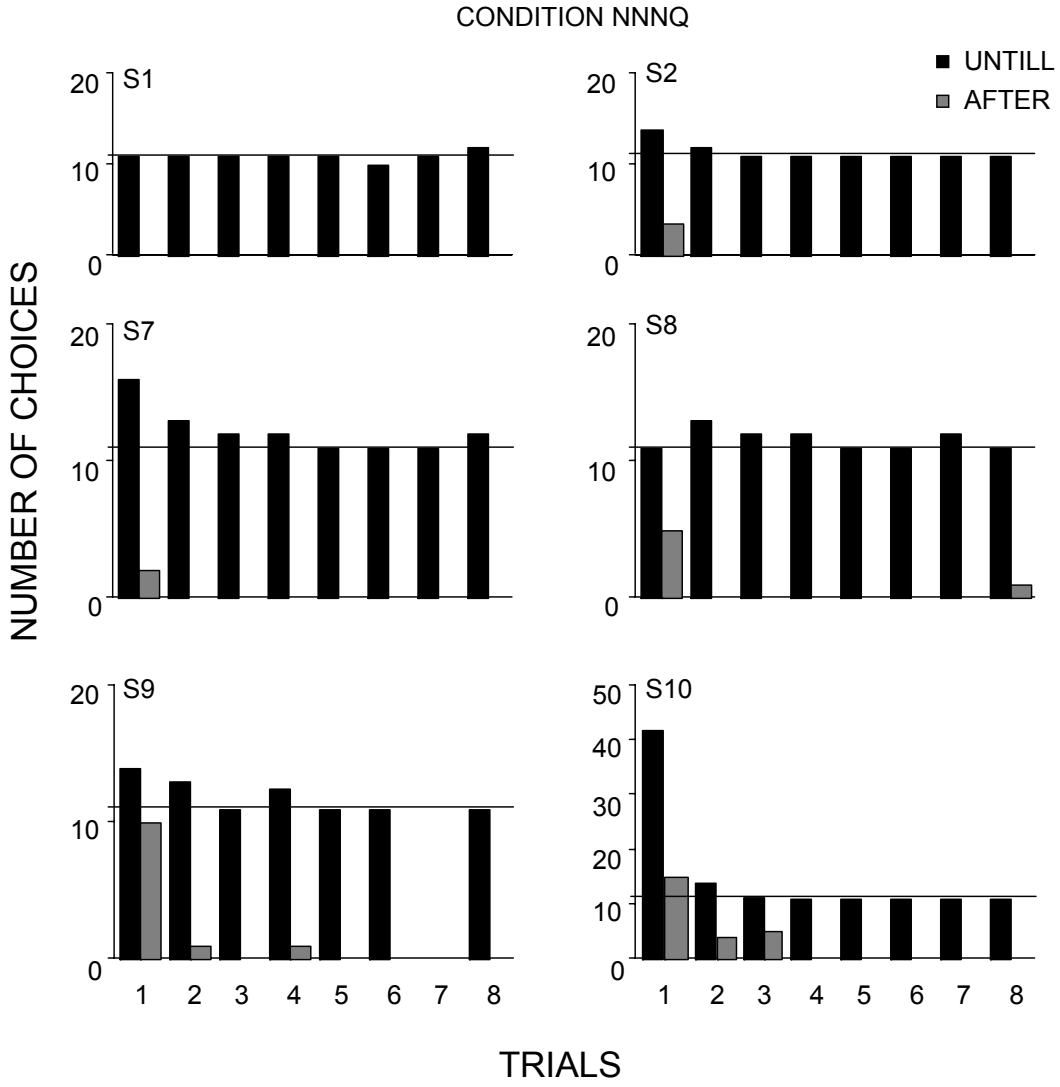

Figure 4 - Results by participant, by trial, of condition NNNQ, Phase 2. Details in caption of Figure 3 and text.

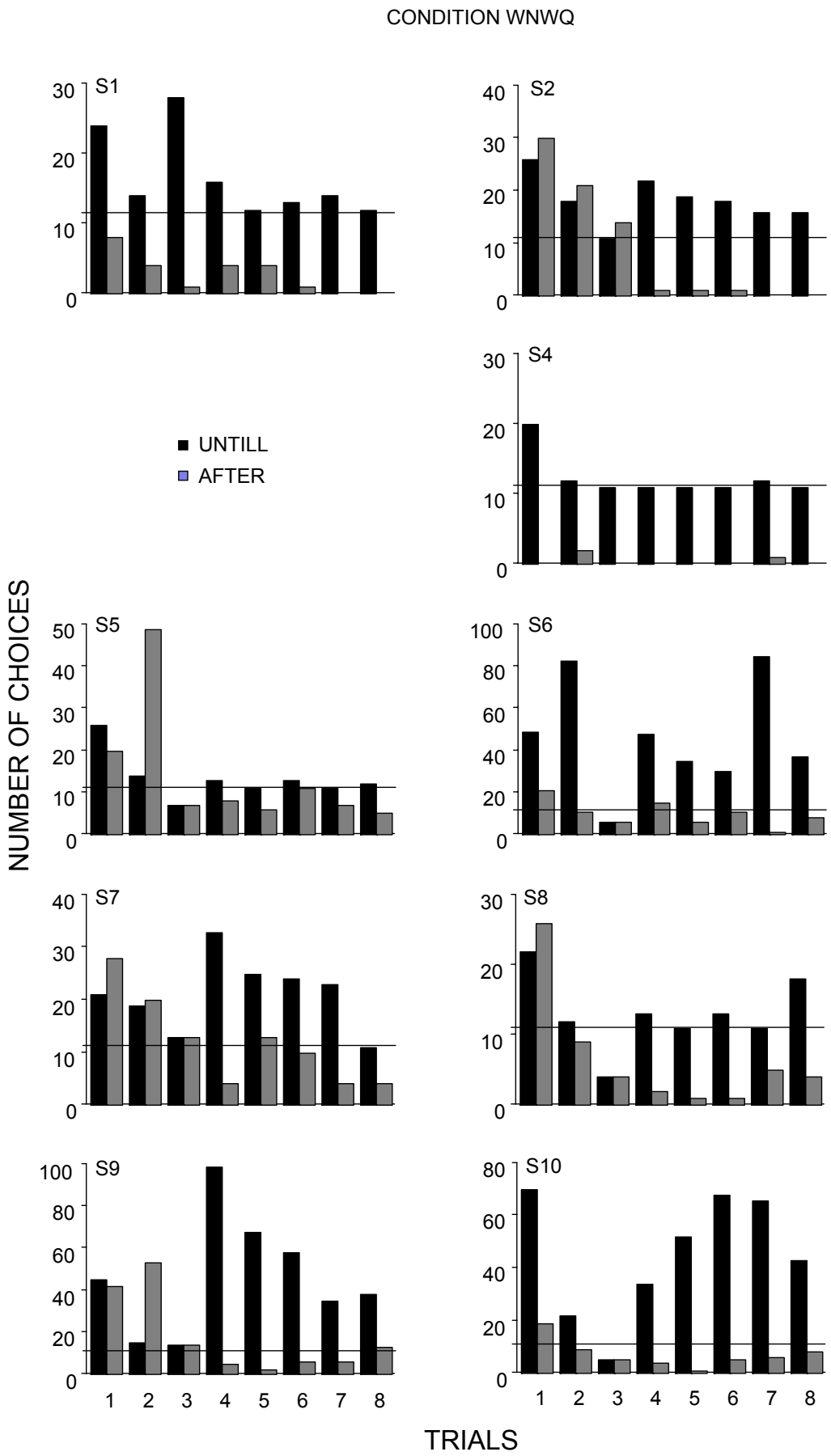

Figure 5 - Results by participant, by trial, of condition WNWQ, Phase 2. Details in caption of Figure 3 and text.

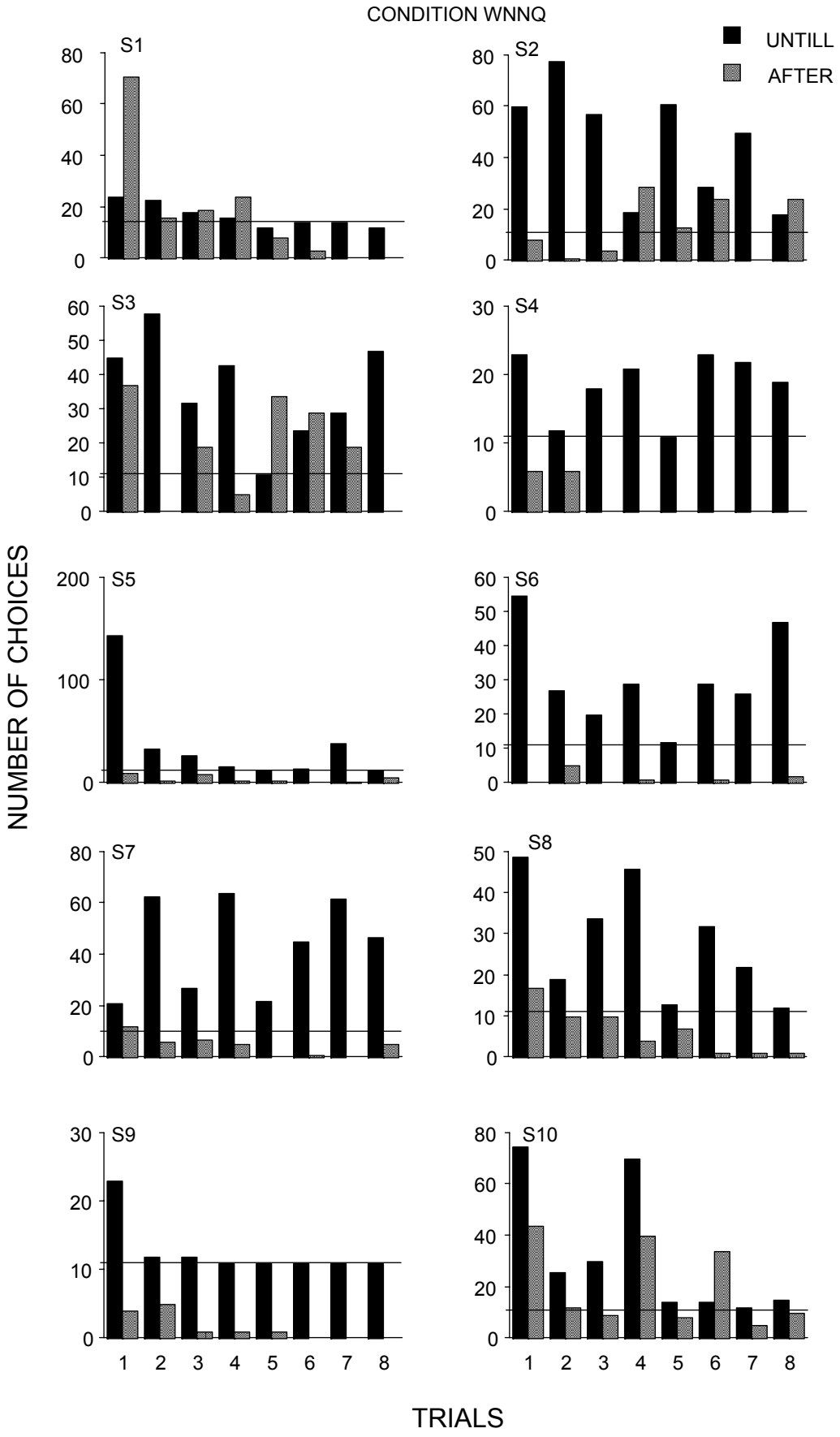

Figure 6 - Results by participant, by trial, of condition WNNQ, Phase 2. Details in caption of Figure 3 and text.

Responses to the question "Why are these blocks (pointing to the line of blocks) of the same type of this (point to sample)?" of participants in conditions NNNQ and NNWQ differed: all the participants of condition NNWQ mentioned a relevant property of the blocks; participants of condition NNNQ, except participant 2, did not mention a relevant property. Participants in the conditions with no name more frequently mentioned the properties of the blocks. Participants 1, 2, 4, 6, 7, 8, and 10 of condition WNWQ and 2, 5, 6, 8, 9, and 10 of condition WNNQ mentioned the name of the blocks in response to the same question.

In response to the question "What is the difference between the blocks of this line (point) and of this line (point)?", in other words, to the comparison between the subsets, most participants cited only one of the relevant properties. There was a marked difference between the answers given when comparing the blocks chosen and the samples and comparing the subsets. Comparing the subsets the participants mentioned properties of the blocks (except S10, condition. WNNQ).

In Phase 4, generalization test, three (3/7) participants of condition NNWQ (S5, S6, S7), two (2/5) of condition NNNQ (S2, S10), and two (2/9) of condition WNWQ (S9, S10) included the objects in the subsets according to their relative dimensions. None of the participants mentioned both relevant properties. Even participants that generalized correctly mentioned irrelevant properties (S5, NNWQ; S10, WNWQ).

2.3. Discussion

Attribute blocks, as described in this study, serve in teaching notions of sets in mathematics, using blocks' attributes to develop such abilities as inclusion of members within a class or set, comparison between different classes, union, intersection, subset formation, term-to-term correspondence, etc. (Dienes and Golding, 1976). In this study, attribute blocks were used for experimental investigation on the role of naming in the process of acquiring abstract discriminations.

In Phase 1, the participants needed help to divide the blocks based on only one property. These data show that the verbal request of an adult may not produce the correct result without additional help. This observation is contrary to the expectation that first grade children should be able to follow simple instructions. The novelty of the situation and the open ended nature of the situation, however, lead the participant to perform actions not linked to the experimenter's request. Vigotsky (1986) showed that without help, the control of each choice is exerted by the changing configuration of the blocks.

Possibly, when children follow instructions in a known context, they use additional cues for the execution of the task, such as peer's behavior, which may not be perceived by the adult, who judges that the performance was only controlled by oral verbal instruction. Other prompts may come from the material itself, and can be altered to enhance the probability of correct choices (Carlin *et al.*, 2003).

The results of Phase 2 of this study indicate that the procedure used to teach division of the 48 attribute blocks into four subsets based on the relevant properties size and thickness was more effective when the blocks did not bear the name of the subset in conditions WN. However, the verbal citation of the referred properties and the generalization did not evolved as the correct choices did. It may be said, therefore, that abstract discrimination occurred without a correspondent conceptual learning, or in other words, naming of the discriminative stimuli did not emerge.

Another aspect to be highlighted is the similarity of performance between participants of conditions NNWQ and NNNQ, and between participants of conditions WNWQ and WNNQ. In Phase 2, there were fewer errors in the two conditions with names in relation to the two conditions without names (Figures 3 and 4 vs. Figures 5 and 6). The presence of the name was associated with

greater difficulty in learning the task during Phase 2. It could be suggested that the name then becomes a "fifth property", and the child's attention to the name interferes preventing the development of discriminative control by the relevant properties. This suggestion is reinforced by the fact that the verbalizations in conditions NN referred more frequently to at least one of the relevant properties, while in conditions WN they referred more to the verbal labels.

In order to control for the possibility that the experimenters conducting conditions NNWQ and NNNQ could have had different abilities in dealing with the participants and with the procedure itself, which would have resulted in improved performance of the participants under these conditions, Experiment 2 replicated Experiment 1. Experiment 2 included 6 new participants, and reversed the experimenters for conditions while maintainning the procedures unaltered.

3. Experiment 2

In Experiment 1, Phase 2, participants submitted to the task with no-named blocks learned more rapidly than the participants submitted to the task with named blocks. However, each the of four experimenters collected data from one of the Conditions, therefore the observed difference in the results could be attributed to differences in the performance of the experimenters, and not to the absence or presence of names on the blocks.

To eliminate this uncertainty experiment 2 was carried out, repeating experiment 1 with the experimenters that collected data in conditions NNWQ and NNNQ in Experiment 1 collecting data in conditions WNWQ and WNNQ, and vice-versa.

3.1. Methods

3.1.1. Participants

Six children were participants of this study, five boys and one girl, between 7 and 8 years-old, all readers, in the first grade of a public elementary school near the University Campus. All the participants were invited to participate in the experiment after prior contact with the administration and teachers of the school and with authorization of the parents.

3.1.2. Setting and materials

The same setting and materials as were used in experiment 1 were used in experiment 2.

3.1.3. Procedure

The same procedures as were used in experiment 1 were used in experiment 2.

3.2. Results

During the initial conversation, the majority of the children did not present any difficulty in naming the properties of color, thickness, shape and size, when requested. Participant 5 (condition WNWQ) required some brief training in naming the colors. Participants gave different denominations to the trapezoid block shape, such as "boat" or "cup", such names being accepted by the experimenters.

In the Phase 1, participant 1 correctly divided the blocks by the properties of color, thickness and shape, receiving two levels of prompting during the division by the property of size. Participant 2 correctly divided the blocks, according to color and thickness, receiving two levels of prompting in the division by the properties of shape and size. Both participants correctly verbalized all the properties. Participant 3 correctly divided the blocks, according to the property of color, receiving two levels of help with the properties thickness and shape and three levels of prompting with the property of size. Participant 4 correctly divided the blocks according to the properties of color and shape, receiving the first level of prompting with the property thickness. As for the property of size, even after level 3 prompting, this participant was not able to divide the blocks

correctly. Participant 3 received prompting to verbalize the properties shape and size; Participant 4 correctly verbalized all the properties, without prompts. Participant 5 correctly divided the blocks according to the properties of color, thickness and shape, receiving level 3 prompting with the property of size. This participant correctly verbalized all the properties. Participant 6 correctly divided the blocks according to the properties of color, thickness and shape, having received level 2 prompting with the property of size. He correctly verbalized, without prompts, only the property of shape. In the other properties he verbalized correctly with prompting.

During Phase 2, participants 1, 2, of conditions NNWQ, and Participants 3 and 4, of conditions NNNQ, presented fewer numbers of errors than Participants 5 and 6 of conditions WNWQ and WNNQ. The participants of the conditions NN showed the greater number of errors in the first trials whereas participants of the conditions WN continued to make incorrect choices until the last trials of this Phase (see Figure 7).

To the question "Why are these blocks of same type as this (sample)?" asked in the conditions with questions, Participants 1 and 2 answered mentioning both relevant properties, while Participant 5 of condition WNWQ cited only the property shape.

In Phase 3, participants 3, 4, and 6, of conditions without questions in Phase 2 presented a greater number of incorrect choices, 17, 13, and 111 respectively, than participants 1, 2, 5, of the conditions with questions.

Regarding the questions "Why are these blocks of the same type as this?" (comparisons between sample and chosen blocks) presented at the end of Phase 3, the participants of condition NNWQ mentioned both relevant properties in three of the four answers given, and one of the relevant properties in the last answer. In condition NNNQ, Participant 3 cited one of the relevant properties in each answer, while Participant 4 cited both properties in the answer, and the relevant property in the other answers. The participants of conditions WNWQ and WNNQ did not mention the relevant properties; Participant 6 responded using the names.

As to the question "What is the difference between the blocks of this line and those of this line?" (comparisons between subsets), the participants of conditions NNWQ and NNNQ answered based on one of the relevant properties. Participant 5 of Condition WNWQ responded "I don't know"; Participant 6 of Condition WNNQ cited the property thickness.

In the Phase 4, only Participant 2 of condition NNWQ and participant 3 of condition NNNQ correctly responded to the generalization test, mentioning one of the relevant properties as the basis of choice.

3.3. Discussion

The results coincided with those of Experiment 1, supporting the position that the labels affixed to the blocks interfere with verbalizing the relevant properties by the participants, and, at the same time, discards the possibility that the difference in the results from conditions with and without labels could have been due to the differences in the experimenters' performance. Results of Experiment 2 indicated that the name on the blocks interferes and makes it more difficult to learn the task of matching to sample based on two properties of the blocks, in the context of the procedure utilized, and with first grade children of elementary school.

4. General discussion

In Phase 1 the experimenter waited until the participant finished the division of the 13 blocks according to one property, to provide prompts, but in Phase 2 immediate feedback for choices was provided. This apparently more complex task, involving separation of a 12-blocks subset from 48 blocks according to two properties was accomplished by almost all participants.

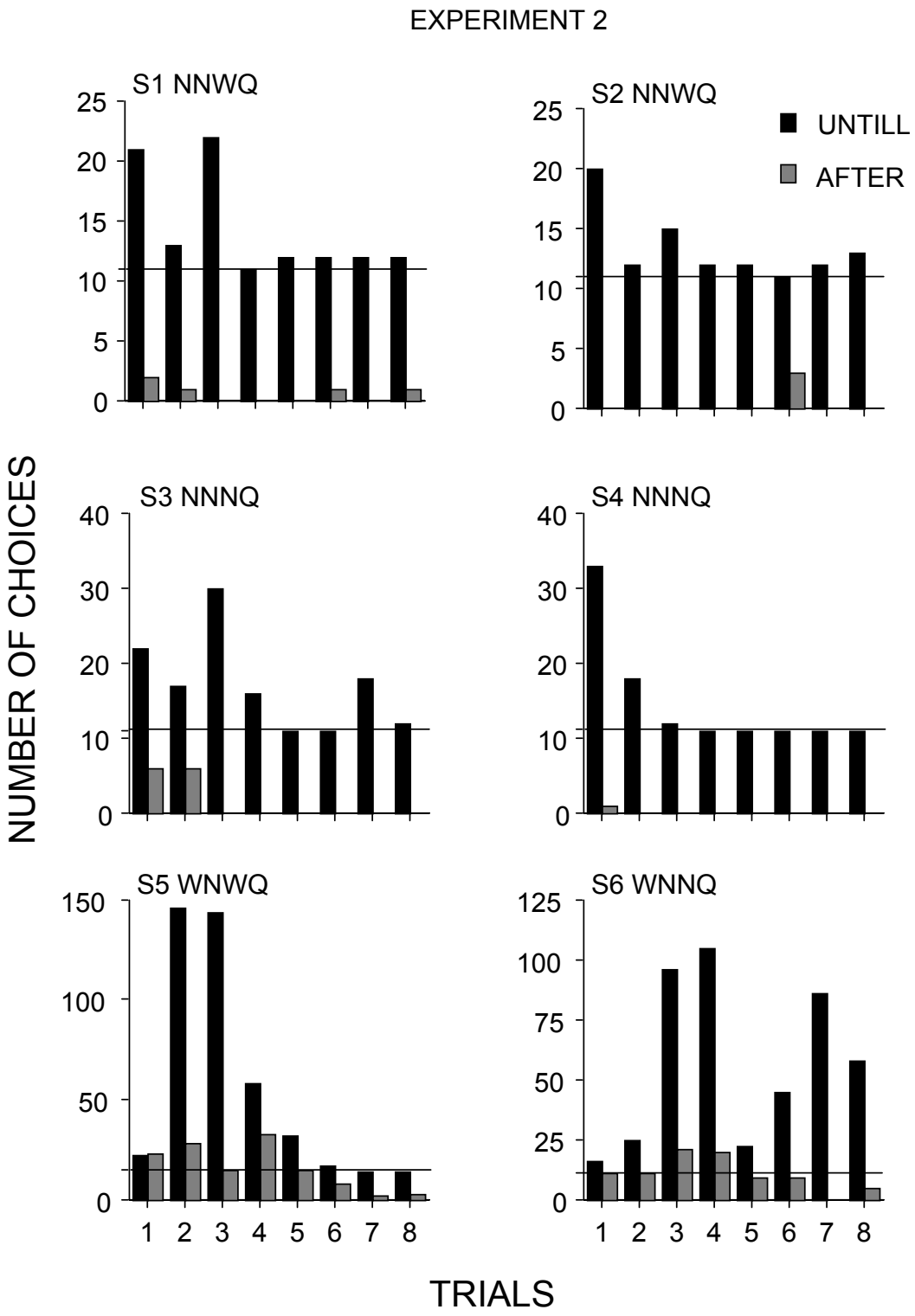

Figure 7 - Results of all the participants of Experiment 2, by trial. Details in caption of Figure 3 and text.

These results support the position that normal children of the age group studied here changed their behavior according to the contingencies, even in the absence of self-directed verbalizations to control their behavior (Pouthas *et al.*, 1990).

The literature refers to the use of self-rules during the execution of tasks. According to Bentall and collaborators (1985), the participants may have generated hidden rules that came to control their answers. Such rules may have emerged due to prior successes, within the experiment itself, or as fruit of similar situations experienced by the participant in their daily lives. As an example that corroborates this hypothesis, some set formation strategies may be mentioned that began by choosing blocks that shared a given property; for example, some participants chose only the blocks of one determined color or of one certain shape. Typically some correct choices coincided with the sample presented by the experimenter in color or shape, which could strengthen the use of an incompatible rule by the participant. Linked to this hypothesis may be the question of the discrepancy between the correct task and the incorrect verbalization.

In conditions with verbal labels there is the possibility that two types of matching were occurring. The first would be a visual matching between sample and comparison blocks, the other an auditory matching between the read name of the sample and the read names of the chosen blocks. The second type may have exerted greater discriminative control of responses to the verbal questions, which is evidenced from the observation that the participants cited the names of the blocks and not the properties, when questioned.

Mandell and Sheen (1994) reported that classes of phonologically correct words are formed more rapidly than classes of non-phonologic words. In this present experiment the names of the classes were phonologically correct, but their presence negatively interfered with the formation of the subsets. This apparent discrepancy is due to the fact that in the study by Mandell and Sheen the names were themselves members of the stimulus classes, while in this study the discriminative stimuli were the properties of size and thickness, and the name was the name of the class.

Bentall and colleges (1985), and Bentall and Lowe (1987), showed that the performance of pre-verbal children, on fixed interval schedules, was similar to that of animals, while verbal children presented performance similar to that of human adults. Therefore, verbal behavior interferes with the realization of complex tasks as learning abstract discriminations, but even verbal children still respond directly to the concrete aspects of the situation, without functional verbal mediation. In the other direction, Jones and Smith (2002), showed that in very young children generalization of object names is dependent on the objects' category.

The results of Phase 2 of this study corroborate the results obtained by Bentall and collaborators (1985), and Bentall and Lowe (1987) with schedules of reinforcement, indicating that even children's complex behavior such as the conditional abstract discrimination may be shaped by contingencies, and that, on the contrary, it is difficult for children in this age group to organize the experience of stimulus class formation under control of minds, *i.e.* verbal requests.

The results obtained allows one to consider the evolution of language function as part of complex stimulus identity and arbitrary discriminative control, involving different modalities as visual and auditory. Verbal requests to separate blocks according to a property presented to the child are arbitrarily related to the complex stimuli, and are no longer present while the child is responding, and therefore when the control may be switched to simultaneous identity matching by that property. Stromer and colleges (1993) and Dube and collaborators (2003) point to the fact that control by complex stimuli in humans with mental retardation and autism is restricted or over selective, and the results of this study showed

that restricted stimulus control can also occur in problem solving with normal children. Research with severely retarded people with the Assessment of Basic Learning Abilities Test also indicates a hierarchy from visual-visual to audio-visual discriminations (Yu and Martin, 1986; Ward and Yu, 2000). The developmental phases proposed by other traditions than behavior analysis can be seen as the gradual elimination of restricted stimulus control in the child. Visual stimuli have been more used in experimental behavior analysis for their easiness as compared to auditory stimuli, but studies combining both modalities are important to the understanding of late functional evolution of language in normal children.

This study emphasizes, together with several others, the multi-determination (verbal and not verbal) of behavior in children. In circumstances where the adult needs only the verbal enunciation to carry out the corresponding complex action, for the child, the verbal enunciation is only one of the possible elements that contribute in determining performance. Simpler stimulus control as visual identity may substitute a more complex relation involving arbitrary delayed relations. Immediate feedback for correct choices is effective to install and maintain the child choosing according to relevant properties, and with appropriate procedures may produce class formation even with individuals with minimal verbal repertoires (Carr *et al.*, 2000).

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