Auditory Overshadowing and Categorization: When Decreased Visual Processing Facilitates Categorization

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Abstract

The role of labels in categorization is well documented: when different entities are associated with the same label, young children are more likely to group these entities together. The current research tests the hypothesis that labels affect categorization by attenuating the discrimination of labeled entities. The results not only indicate that labels can facilitate categorization by decreasing the discriminability of labeled entities but also that these effects (a) persist beyond the labeling episode and (b) stem from decreased attention to the differences between compared entities, as opposed to increased attention to the common features.

Keywords: Cognitive Development, Attention, Language Acquisition, Psychology, Human Experimentation.

Introduction

Labels play an important role in cognitive development. When different entities are referred to by the same label, children are more likely to perceive these entities as being more similar to each other (Sloutsky & Lo, 1999), more likely to group these entities together (Balaban & Waxman, 1997; Sloutsky & Fisher, 2004; Sloutsky, Lo, & Fisher, 2001), and more likely to make inferences from one entity to the other (Gelman & Markman, 1986; Sloutsky & Fisher, 2004; Welder & Graham, 2001). Furthermore, when different entities are referred to by different labels, young children are more likely to individuate these entities (Xu, 2002; Xu, Cote, & Baker, 2005). Why do labels affect performance on similarity, categorization, induction, and individuation tasks?

According to the language-specific explanation, young children understand that entities belong to categories and labels serve as proxies for these categories (Gelman & Markman, 1986). While effects of labels change considerably across development (see Waxman, 2003 for a review), it has been argued that even young infants are "equipped with a broad, universally shared expectation, linking words to commonalities among objects" (Waxman, 2003, p. 220). Thus, labels facilitate categorization because they direct children's attention to the commonalities of the to-be-categorized entities. Labels not only facilitate categorization early in development, but linguistic input may also help children individuate object kinds. For example, it has been argued that labels may serve as "essence placeholders", and infants who hear two labels expect two object kinds (Xu, 2002; Xu, Cote, & Baker, 2005). In sum, according to the language-specific position, hearing common labels and different labels facilitate categorization and individuation by increasing attention to commonalities and differences, respectively, and these effects are specifically tied to linguistic input.

While effects of labels on cognitive tasks are well documented, it is also known that auditory input (including words) often overshadows visual input (Napolitano & Sloutsky, 2004; Robinson, Howard, & Sloutsky, 2005; Robinson & Sloutsky, 2004a; 2004b; Sloutsky & Napolitano, 2003). In these studies, infants and young children are more likely to encode a visual stimulus when it is presented in isolation than when it is paired with an auditory stimulus.

Auditory overshadowing may not only explain why children often pay less attention to appearance information when appearance is pitted against a label

(e.g., Gelman & Markman, 1986; Sloutsky & Fisher, 2004), but overshadowing may also underlie some of the facilitative effects of labels on categorization. In particular, it has recently been demonstrated that labels may facilitate category responding by overshadowing the differences between compared entities, thus, decreasing the discriminability of compared entities (Sloutsky, Robinson, & Timbrook, 2005). In Sloutsky et al's (2005) study, children were trained on different entities that were either accompanied by the same label, the same vowel stream (e.g., "[ā] [ōō] [a]"), or the entities were presented without an auditory stimulus (no auditory condition). After training, discrimination of the trained entities was tested and children heard no auditory input at test. Discrimination of the trained pair dropped for those children who heard the same label or the same vowel stream during training, compared to children who did not hear auditory input during the training phase. Furthermore, these effects persisted beyond the labeling episode and stemmed from decreased attention to differences, as opposed to increased attention to commonalities: discrimination of novel entities that shared the same set of commonalities as the trained set did not significantly decrease.

The goal of the current research was to further examine how labels affect the discrimination of entities. In the current task, children were trained on two different entities and the entities were either paired with a common label or presented in isolation (no auditory condition). After training, children were simultaneously presented with two visual stimuli and the task was to determine if the two visual stimuli were exactly the same or different. No auditory input was provided at test. It was hypothesized that linguistic labels would attenuate visual processing and decrease the discriminability of the labeled entities (compared to the no auditory condition). Furthermore, it was expected that this decrease in discrimination would stem from decreased attention to differences, as opposed to increased attention to the common features.

Experiment 1

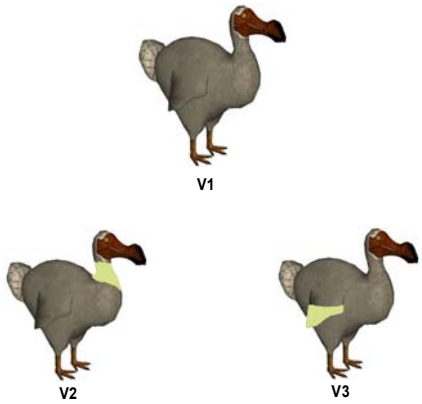
The goal of Experiment 1 was to replicate Sloutsky, Robinson, and Timbrook (2005) using different stimuli to ensure that their findings were not stimulus-specific, and to further examine how labels affect the discrimination of corresponding visual input.

Method

Participants Eighty-one four-year olds (40 girls and 41 boys, M = 4.45 years, SD = .29 years) participated in this experiment. Children were recruited through local day-care centers located in middle- and upper-middle-class suburbs of Columbus, Ohio. The majority of children were Caucasian.

Stimuli Visual stimuli were constructed so that all of the images shared the same set of commonalties (see Figure 1), whereas, there was only one feature that distinguished V1 from V2 (e.g., tan band around the neck) and a different feature that distinguished V1 from V3 (e.g., tan wing tip). Each visual stimulus was approximately 8 cm x 13 cm and was presented on a Dell Inspiron laptop computer with Presentation software. The auditory stimulus consisted of a nonsense label that was presented by an experimenter in child-directed speech (i.e., "This is a gatu."). The label was presented for approximately 1500 ms.

Figure 1. Visual Stimuli used in Experiments 1 and 2.



Procedure The procedure consisted of two phases: a training phase and a testing phase. Approximately half of the children were trained on one set of visual stimuli (e.g., V1 and V2), and the remaining half of the children were trained on another set (e.g., V1 and V3). Prior to training, children were explicitly told they were going to see different animals, and these animals were going to be similar to each other so they had to pay close attention because they were going to be asked about them later. During training, each image was presented individually six times (1500 ms stimulus duration) for a total of 12 presentations, and the order of stimulus presentation was randomized. Forty-two children were trained in the common label condition (i.e., both trained stimuli were referred to by same label) and 39 children did not hear any auditory input during training.

After the training phase, children were presented with 24 test trials. The testing phase was identical for both the common label and no auditory conditions: no labels were provided at test. During testing, children had to determine if two simultaneously presented images looked exactly the same or if they looked different. Stimulus pairs were presented until children made a response. The experimenter then

recorded children's responses by pressing 1 of 2 buttons on the computer. Twelve of the testing trials were *same* trials in which children were presented with two identical stimuli (e.g., V1-V1 trials). The remaining 12 trials were *different* trials: Six of the different trials consisted of simultaneously presenting the two trained stimuli (e.g., V1-V2 for children trained on V1-V2) and the other six different trials consisted of pairing one of the trained images with an untrained image (e.g., V1-V3 for children trained on V1-V2). Recall that the untrained stimuli shared the same set of commonalities as the trained set. The order of test trials was randomized.

An additional six catcher trials were randomly presented with the test trials. No children were excluded for missing the catcher trials in the current experiment.

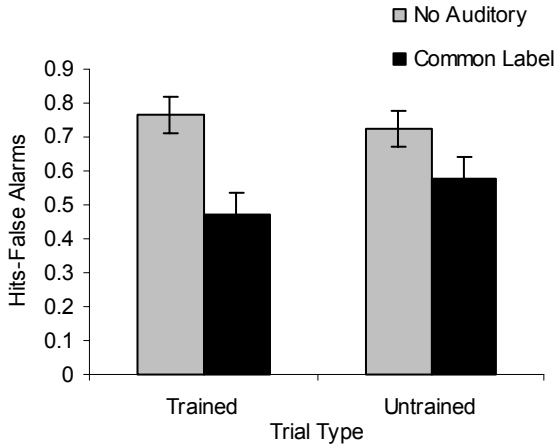
Results and Discussion

Accuracy (i.e., hits minus false alarms) on the trained and untrained sets was calculated separately for the common label and no auditory conditions. In the current experiment and all following experiments, outliers (i.e., ±2 *SD* of the mean) were excluded from the analyses. One child was excluded from the current experiment. A 2 (Condition: Common Label vs. No Auditory) x 2 (Trail Type: Trained vs. Untrained) ANOVA revealed a significant Condition x Trial Type interaction, F (1, 79) = 10.44, $p < .005$, which suggests that labels had different effects on the trained and untrained stimuli. As can be seen in Figure 2, discriminating the trained items dropped significantly in the label condition compared to the no auditory condition, t (79) = 3.52, $p < .001$, whereas, the effect was less pronounced for untrained stimuli (i.e., stimuli that shared the same set of commonalities), t (79) = 1.76, $p = .082$.

The findings of Experiment 1 replicated previous research using different stimuli (Sloutsky, Robinson, and Timbrook, 2005), which suggests that the effects are not stimulus-specific and are reliable across different stimulus sets. In particular, compared to the no auditory condition, hearing the same label associated with different entities decreased the discriminability of these entities. Furthermore, discrimination of entities that shared the same set of commonalities was less likely to decrease, which suggests that some of the effects of labels stemmed from labels helping children overlook the differences between the trained entities, as opposed to directing children's attention to the common features.

Although the current study did not assess categorization per se, Experiment 1 demonstrates that labels may affect performance on a variety of tasks by decreasing the discriminability of compared entities (due to overshadowing effects), and consequently increasing similarity of these entities. This increased similarity, in turn, increases the likelihood of grouping these entities together as well as making inferences from one entity to another.

Figure 2. Children's discrimination across Condition and Trial Type in Experiment 1



Note: Error bars represent Standard Errors.

Experiment 2

Given previous research demonstrating that hearing a single label associated with different entities has vastly different effects on categorization and individuation tasks than hearing different labels (e.g., Balaban & Waxman, 1997; Xu, 2002), we deemed it necessary to manipulate the labeling context in Experiment 2. Can the previously reported overshadowing effects be generalized to a labeling episode where multiple labels are presented or are the effects more likely to occur in the presence of a single word or single, speech-like sound (e.g., Sloutsky, Robinson, & Timbrook, 2005)?

Method

Participants Thirty-four four-year olds (18 girls and 16 boys, M = 4.6 years, SD = .31 years) participated in this experiment. Three children were tested but not included in the following analyses: Two children missed more than two catcher trials and one child's data was an outlier.

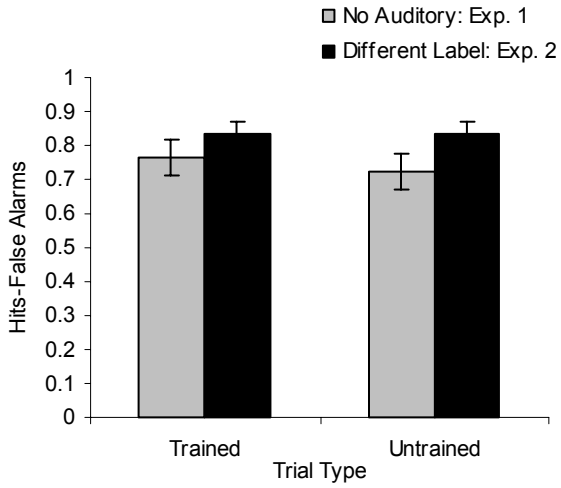
Stimuli and Procedure The procedure was identical to Experiment 1, except for one important change. During training, the two visual stimuli that were associated with the same label in Experiment 1, were now associated with two different labels (e.g., V1 was referred to as "gatu" on six different occasions and V2 was referred to as "vika" on six different occasions).

Results and Discussion

To determine if hearing different labels associated with different objects during the training phase

affected discrimination at test, children's accuracy on the trained and untrained sets in the current experiment was compared to the no auditory condition of Experiment 1 (see Figure 3). In contrast to Experiment 1, a 2 (Condition: Different Label vs. No Auditory) x 2 (Trail Type: Trained vs. Untrained) ANOVA revealed no significant effects or interactions, Fs < 2.18, ps > .15. Thus, hearing different labels associated with different entities did not significantly increase or decrease discrimination compared to the no auditory condition. While nonsignificant effects could stem from a variety of factors, Experiment 2 demonstrates that not all labeling episodes have lasting effects on a visual discrimination task.

Figure 3. Children's discrimination compared to the baseline condition from Experiment 1



Note: Error bars represent Standard Errors.

General Discussion

The results of the study point to several important findings. First, hearing the same label associated with different entities decreased the discriminability of these entities. Second, these effects stemmed from labels overshadowing the differences between the trained entities, as opposed to increasing children's attention to the common features: recall that discrimination of untrained entities that shared the same set of commonalities did not decrease. Third, the effects of labeling persisted beyond the labeling episode.

These findings have important implications for understanding the mechanisms underlying the effects of labels on categorization. Many studies have shown that children are more likely to group two objects together if they share the same label (e.g., Balaban & Waxman, 1997; Waxman & Booth, 2003). According to the language-specific view, these effects stem from common labels directing attention to the commonalities in the to-be-categorized objects.

The current study provides an alternative account that does not make the assumption the children understand the conceptual importance of labels: common labels may overshadow differences between compared entities, thus, making the entities more perceptually similar and increasing the likelihood of grouping these entities together.

How does hearing the same label associated with different entities affect discrimination and why do these effects persist beyond the labeling episode? We believe that the effects of labels in the current study originate from two necessary conditions (a) partial auditory overshadowing and (b) learned inattention (e.g., Kruschke & Blair, 2000; Mackintosh, 1975; Mackintosh & Turner, 1971). While strong overshadowing effects would completely eliminate visual processing, partial overshadowing effects would allow some aspects of the visual stimuli to be processed. Second, it is likely that the features that are overshadowed are those features that are less frequent in the input. Given that the distinguishing features in the current study (e.g., colored wing tip) were less frequent in the input, it is not surprising that the distinguishing features were overshadowed first. While future research will need to determine whether effects of labeling continue to affect children's attention across longer delays, the current findings suggest that the immediate effects of labeling impact the way children perceive and discriminate objects.

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