

Post-it Power: Using Non-linguistic Labels to Help Children Notice Relations

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Abstract – Linguistic labels seem to help children respond according to subtle relational similarities. In an effort to understand the processes that labels take part in, children were trained with post-it labels to encourage processes of comparison and replacement separately in a perceptual similarity task. Preliminary evidence suggests that labels that invoke comparison allow children to make relational responses more than labels that replace the objects taking part in the relation.

Index Terms – Labeling, relational reasoning, highlighting, symbols.

I. INTRODUCTION

From the British empiricists [1] to Piaget [2] to modern developmentalists [3], there has been an assumption that children go from depending on physical similarity to using abstract similarity. Indeed, there have been many empirical demonstrations of early use of superficial perceptual similarity to more mature use of deeper abstract similarities [4][5][6].

But we should pause here to examine what is meant by perceptual and abstract similarities. Epstein [7] makes the distinction between projectable and nonprojectable properties of the environment, information available and unavailable to perceptual systems respectively. But this is not exactly what is meant by abstract since properties such as symmetry are perceptually available and yet more abstract than a property such as color. Relations seem computationally difficult because they are perceived in between other known ideas (i.e. objects). In particular, when relational responses are pitted against object responses, children often fail to notice relational similarity [4][8]. So for the purposes of this short paper, even though we will talk about children’s responses becoming more abstract, we are not committing to a physical/abstract property dichotomy. Instead the development of abstraction will be viewed as the process of responding to increasingly subtle partial matches such as matching relations rather than matching objects [9]. Seeing abstraction in this perspective we can ask, how do children notice particular kinds of partial matches? And more generally in development, how do children shift to respond according to these subtle, more abstract similarities?

Language has been one of the most resounding answers to both of these questions. It seems that verbal labels act as an effective attentional cue to perceptually subtle relations such as size relations [10] or spatial relations [11]. Kotovsky and

Gentner [12] used a paradigm of card matching where 4-year-olds were presented with a triad of cards, a standard and two answer choices, a relational match and a non-relational foil (see Figure 1). The elements in the answer choices were similar to each other (i.e. xXx and xxX) but differed from the standard (i.e. oOo) to ensure that the relational answer only shared relational similarity with the standard. When the relational answer was in the same dimension (i.e. size symmetry, oOo and xXx), they found that 4-year-olds succeeded in responding to relations such as symmetry. However when the relational dimension changed (i.e. oOo and light blue-dark blue-light blue) or the relational polarity changed (i.e. oOo and XxX), their performance went down to chance. In order to help these children respond relationally particularly in the more difficult cross-dimensional triads, Kotovsky and Gentner introduced linguistic labels (i.e. “even” to indicate symmetry) and categorization experience (i.e. putting the even cards in one basket). They found that children who succeeded on the labeling task were more likely to make relational choices in cross-dimensional triads. Such a finding inevitably leads one to ask: how do words this remarkable work of helping children notice rather subtle similarities?

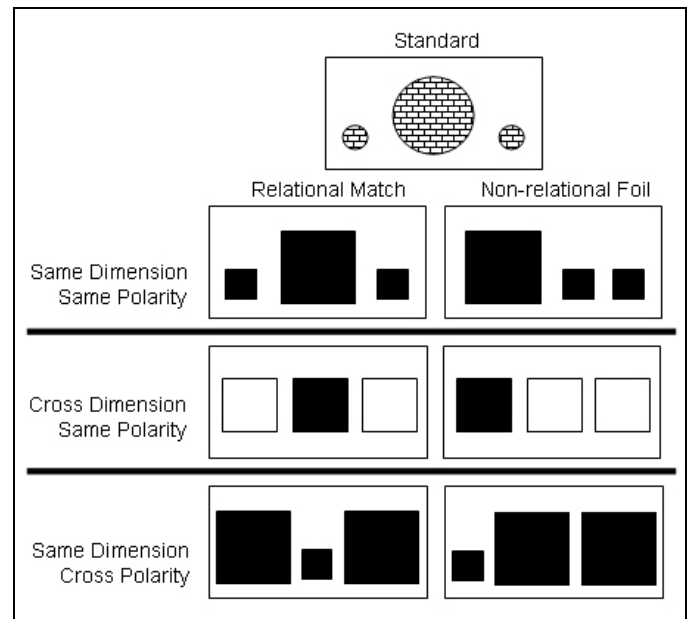


Fig. 1 Kotovsky & Gentner's [12] conditions.

This is a particularly loaded question with many directions to go for answers. We will focus on two ways that linguistic labels can point towards relations: (1) highlighting relations from competing perceptual information by initiating a process of comparison [6] and (2) acting as new unit of perception to make relations more computationally tractable by replacing messy perceptual information with a label [13]. Although these functions of labels probably work in tandem in most scenarios, we will present preliminary evidence from an experiment designed to dissociate these processes.

A. Linguistic Labels Highlight Relations via Comparison

A hallmark of abstract relational cognition is selective attention to parts of the situation. To make the relational choice to put xXx with oOo , one must attend to the size pattern and ignore shape information. Highlighting relevant information leads to relational responses so do linguistic labels lead to highlighting?

In Kotovsky and Gentner’s triad experiment [12], children were asked not only to label cards as “even” but also to classify them into one group. Putting cards in one pile may have allowed children to compare across the even cards to highlight the overarching similarity. If the main function of language is that it provides a cheap way of inducing comparison, any label system that induces comparison should also lead to more relational responses.

B. Linguistic Labels Replace Salient Perceptual Information

A different view of the helpfulness of labels might be best exemplified in a series of experiments by Thompson, Oden, and Boysen [14] who found that language naïve chimpanzees were able to respond relationally when trained to associate arbitrary tokens with pairs of same objects and pairs of different objects. These chimps were then able to do higher order relational tasks such matching two pairs of objects had the same relations. Given a triad with a standard (AA), a relational match (BB), and a non-relational foil (EF), the training with arbitrary tokens, acting as labels for same pairs and different pairs, enabled chimps to process the problem on a new level by reducing the impact of salient object-level perceptual information. Two buckets and two apples may seem like very different objects but the association of sameness with an arbitrary label allows chimps to ignore salient object-level difference for label level similarity. If the main function of words is to provide new computational units that reduce the impact of initially salient object information, any label system that can act as such an intermediary state should aid relational responding.

C. Non-Linguistic Label Systems as a Testing Ground

In cognitive research, the term “label” usually indicates verbal label even though colloquially, the term is broadly used to encompass stickers, tags, and other kinds of notes. In some sense, we have elevated language-based labels to a privileged state. But in order to separate the processes of comparison and

replacement which probably work together in verbal labels, we have designed an experiment using a physical label system.

We used Kotovsky and Gentner’s [12] cross-dimensional trials as the testing ground for noticing relations but introduced two training conditions with labels that induce comparison or labels that replace salient object information. Children are shown cards with objects such as animals, vehicles, and colored shapes on them. These objects are arrayed in an “even” relation like oXo (small-big-small; obj1-obj2-obj1) or a “following” relation such as Xoo (big-small-small; obj2-obj1-obj1). Four-year-olds are trained to label small objects with small post-its and large objects with large post-its. In the comparison condition, children are trained to place the post-its right below the object but in the replacement condition, children are trained to place the post-its right on top of the object (see Fig. 2). After the respective label training, all children were tested with cross-dimensional match triads.

II. LABEL-TRAINING EXPERIMENT

A. Method

1) *Participants*: 16 four-year-old children were recruited from daycares in the Bloomington, Indiana area. The average age of the participants was 52.28 months (the range 43 to 65).

2) *Materials and Design*: Children were randomly assigned to one of two conditions, comparison and replacement. There were 4 post-it training cards, each with a three object array (triangle-bear-triangle, cross-penguin-cross, car-diamond-diamond, boat-rectangle-rectangle). The labels for the symmetrical cards were two small blue post-its and one large pink one. The labels for the asymmetrical cards were two small purple post-its and one large yellow one. The post-it labels were large enough to cover the object it was intended for.

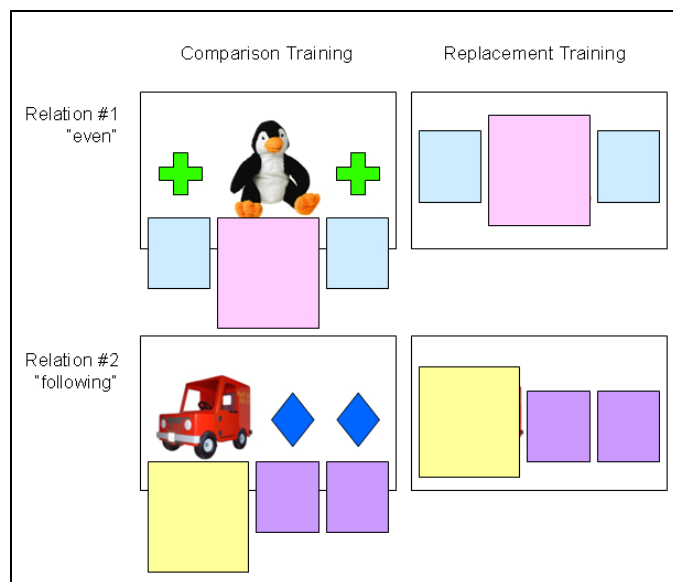


Fig. 2 Label training examples. Children only experienced comparison or replacement training, not both.

To measure relational reasoning, we had a triad task like [12] where children would choose between two answer cards to a standard card. A shoebox covered with colored paper had a card slot cut out on top and velcro on one side. Standard cards had velcro on the back so they could be attached to the box. Standard cards and answer cards were all 4 x 6.5 inches and laminated.

Children received two training triads where the matching card was identical to the standard. Interspersed in the test trials were two filler triads where the matching card was relationally similar but also shared a high overall similarity to the standard. For example, one filler standard was a large triangle with a circle around it. The two answer choices were both small triangles but the match also had a circle around it and the foil did not. These were designed to be very easy for children in this age range so that they would not be frustrated and also to provide a check to see that they were on task.

3) *Procedures*: Children were first introduced to post-it training. All children practiced labeling objects situated in two kinds of relations (the “even” relation, xXx, and the “following” relation, Xxx). There were four types of label training cards all with different objects on them. Two of the training cards depicted the even relation (triangle-bear-triangle, cross-penguin-cross) and two depicted the following relation (car-diamond-diamond, boat-rectangle-rectangle).

Critical test trials were cross-dimensional, going from standards with a particular size pattern to pattern matches in color or shape (see Figure 3). For example, a cross-dimensional size-to-color triad might have a standard of three blue diamonds that were small-large-small. The answer choice cards would each have three triangles of equal size. The relational match would have triangles that were colored light-dark-light green while the non-relational foil would have dark-light-light green coloring. There were four sets of cross-dimensional triads.

The experimenter would take a card and say, “We’re going to play a postcard game! I’m going to put these stamps on my postcard, watch me.” The experimenter would then place the labels on the laminated card either under or on the pictured objects. The child would be handed the same card with three labels and asked to place the labels on just as the experimenter had. The experimenter gave continuous feedback until the child could place the labels correctly on their own. Children mostly found this part of the task extremely easy and rarely needed guidance. After labeling each of the four cards in this way, children were introduced to the triad task.

In each trial of the triad task, the experimenter would velcro the standard to the box then present two answer choice cards. At each trial, the experimenter asked, “Which card is like this one (pointing to standard)? Pick the card like this one (pointing to standard)!” Starting with the two training triads, they were followed by the four cross-dimensional triads in one of two semi-random orders. The orders were designed so that the two size-to-color triads were not presented consecutively, one right after the other, and the same with the

two size-to-shape triads. Each cross-dimensional triad had two trials, one where the relational match was presented on the right and the second where the match was on the left. This made for a total of 8 trials (4 cross-dimensional triads x 2 trials each). A filler triad was inserted after every two cross-dimensional triads (once in the middle of the experiment, once at the end).

B. Results

We are still collecting data at this point so there are only 6 children in the comparison condition and 10 in the replacement. A t-test on the ages between the groups showed no significant differences, $t(15)=.142$. The mean age of the comparison group was 53.50 months (range 45-62) while the replacement group’s mean age was 51.70 months (range 45-60). Both groups exhibited almost perfect performance on the filler trials. Two children in the replacement condition and one child in the comparison condition made one mistake out of the four filler trials. They were left in the analysis since there are only a few participants in this study thus far. Four-year-olds showed above chance relational performance when they had comparison label training preceding the cross-dimensional test trials: $M=69%$ ($SD=.18$), $chance=50%$; $t(5)=2.823$, $p<.05$. However, replacement label training led to relational performance that did not differ significantly from chance: $M=51%$ ($SD=.25$), $t(9)=.156$.

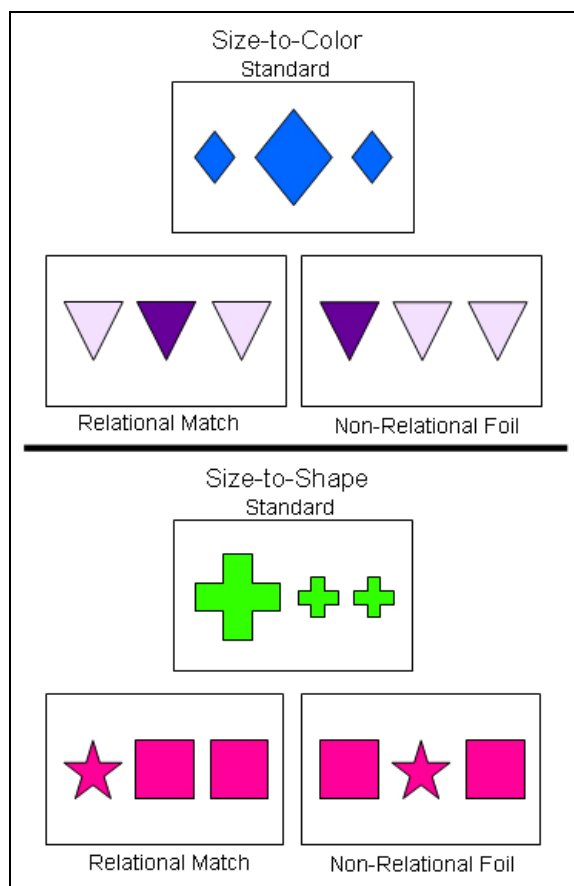


Fig. 3 Cross-dimensional test trials where the standard had a size pattern but the matches had color or shape patterns.

III. DISCUSSION & CONCLUSIONS

Although it is premature to make any firm theoretical commitments, we would like to put forth a few conjectures about the direction of these results. A careful examination of our procedure will show that this was a very subtle manipulation in training that is beginning to show a performance difference in a completely different task. The time spent with the training cards is the same and the children have no trouble with labeling the objects in both conditions. However, the resulting percept from juxtaposing or covering with the labels is very different. Placing the labels underneath the objects gives children an opportunity to compare their locally matched label-object pairs to highlight a more global pattern of similarity. However in the case of replacement, the distracting objects are covered up and more emphasis is on the resulting labels. Perhaps this experiment has pushed the children in the replacement condition to rely upon the post-it labels. Concurrently we are running a study to test whether these label-trained children are better at cross-dimensional and cross-polarity triads when the standard is made up of post-its. If replacement label training does contribute to relational thinking but children are still dependent on the labels, then children in the replacement condition should be able to make relational matches to the post-its but children without any label training should not.

Because we initially embarked on this line of experimentation because of the benefit of linguistic labels on relational reasoning, we should remark on the important differences between words like “even” and this post-it label system. First, there is no explicit classification in this system. Children were not placing even training cards in the same pile nor were they given a shared category label. Instead, the category was loosely implied because the colored labels they used were the same for even training cards. However, seen from an ecological perspective, children do not normally go around using the same stick-on labels for objects in the same category, so the impact of this implied cue is difficult to gauge. Also, this label system was extremely easy for children to learn. In the original study using the word “even”, 5 out of 12 children could not linguistically label *any* cards correctly. Unsurprisingly, the positive impact of language was mostly found for children who could label and classify cards. Many of the children were unable to pass the hurdle of labeling let alone reap the benefits of such experience. In our experiment, children could succeed in labeling just by mimicking the experimenter. Because post-it label training does not require mastery of any high level categorization, any potential benefits probably come from low level mechanisms.

Effectively utilizing simple mechanisms to bring about higher level reorganization echoes the purposes of progressive alignment [6][8][15]. This theory suggests that even comparing very similar items could lead to a more abstract re-description. For whatever reason, children find post-it labels and their corresponding objects very easy to align. According to progressive alignment, even this very easy local match could help children perceive more abstract relations. This

artificial labeling system provides an opportunity to test progressive alignment in a new way. Although the line of experimentation is just beginning, this training method could provide valuable insight to how higher level relations are made more tractable by symbol systems, linguistic labels, and processes like comparison and replacement.

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