Effect of Verbal Response Class on Shift in the Preschool Child's Judgment of Length in Response to an Anchor Stimulus *

Suzanne Salzinger  Kurt Salzinger  Jean Patenaude
Biometrics Research  Biometrics Research  Biometrics Research
Polytechnic Institute of Brooklyn

Abstract

Two types of verbal response classes were used by 68 preschool children (3 - 6 yrs.) in rendering their judgments of length under unanchored and anchored conditions. One of the response classes was that of number (ordinal scale) and the other was color (nominal scale). Results showed that the use of the ordinal scale better enabled the children to resist the anchor than the nominal scale. There is some indication that the acquisition of number concepts in the older children gave rise to this difference. The results are interpreted as being a function of the difference between the mediating responses induced by the use of the ordinal scale and the nominal scale.

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The development of the child's judgment of the physical properties of objects in the world around him is not only a function of perceptual learning, i.e., discrimination training, but is affected also by his acquisition of verbal responses used in connection with making such judgments (Weir, M. W., & Stevenson, H. W., 1959). This formulation implies a mediation process. The Kenders in their review of vertical and horizontal processes in problem solving (1962, p. 11) have suggested that "with age an increase occurs in interaction among chains of different vertical levels." It is this interaction with which we are concerned. The present study is an attempt to measure the effect of two different types of verbalization (the use of a nominal response class and an ordinal response class) on the child's ability to maintain stable judgments of the physical attribute of length.

Although the significance of the topography of the stimulus in perception and discrimination has been urgently pointed up by a number of investigators (Gibson, J. J., & Gibson, E. J., 1955; Wolhwill, J. F., 1958; Tighe, L. S., & Tighe, T. J., 1966), others, such as Kuenne, have stressed the relationship between the stimulus and response. In her paper on transposition with young children (Kuenne, N., 1946, p. 488), she put forth the hypothesis "that the child's responses in the discrimination-learning situation become keyed to words relating to the cue aspect of the stimuli." Subsequent work, emphasizing the response, first by Lyckoff (1952) and later by Zeaman and House (1963) has introduced the concept of the observing response. This may be defined as a response by S which directs his attention to a relevant dimension, or critical aspect of the stimulus, thereby enabling him to discriminate among cues or values of the stimulus. Among the factors which can be considered to control the emission of observing responses are the use of verbal responses by the subject himself.

In the present study, the physical stimuli are identical for both groups. Only the observing responses, produced by the S's own verbal responses differ, thereby producing differences in judgment of the identical stimuli for the two groups. Since we take the view that the response (verbal, in this case) utilized determines, in part, the child's judgment of physical stimuli we would expect that as the child develops language, predictable changes in judgment will occur, as a result, with age.

The two verbal response classes which were selected, (nominal and ordinal) differed with respect to the interrelationship among their members (Salzinger, K., 1967), as well as the relationship between the response classes and the physical stimuli. Thus, while John, Jim, and George are all names of people and therefore
members of the same response class, they need not bear any special relationship to each other or to the stimuli, other than that each name is emitted in the presence of a different stimulus. On the other hand, if three different people were respectively designated short, medium, and tall, then the three verbal responses would not only share membership in the same response class, but would imply a certain relationship among each other (order), and furthermore, a certain relationship between the verbal response and a dimension of the stimulus which is not implied by the names of John, Jim and George.

Given that, outside the laboratory, the child is never required to make judgments of the length of a stimulus in the absence of other physical stimuli, we felt it useful to choose a judgment task in which the child is subjected to the influence of an extraneous stimulus, in this case a long anchor stimulus, the effect of which can be predicted to result in underestimation of the scale values. The dependent variable, therefore, was actually the child's capability for developing constancy in judgment. The classical psychophysical technique of absolute judgment (single stimuli) was adapted for use with the children. The use of one of the classical methods, particularly with children, assured us of more stringent control than might be achieved using some freer method (Gibson, E. J., & Olum, V., 1960).

Preschool children were trained to give either of two types of verbal responses in rendering their judgments of length. One of these was based on an underlying nominal scale (i.e., color names) and the other on an ordinal scale (i.e., numbers).

A number of hypotheses was tested. The first was that the ability to resist shifting judgment when subjected to an anchor stimulus would improve with age. This hypothesis is suggested by the fact that studies of size constancy show an increase in constancy within this age range (Wohlwill, J. F., 1960).

The second was that the two types of verbal responses the children were forced to use in making their judgments of length would produce differences in their ability to resist the anchor. Two alternative hypotheses suggested themselves with regard to this difference: One was that a nominal scale would produce more stable judgments, since the color responses the children were required to use were distinctly different from one another and would not easily allow for generalization among the responses, whereas the ordinal scale would enhance shifting, since the modification of use of any of the responses necessarily implies change of use of others in the same direction, i.e., the children might more easily generalize from one response to the other. The alternative hypothesis was that resistance to shift would be enhanced by the use of that scale which is most customarily used in making judgments of length, namely numbers, since their use promotes an observing response (mediation response) of the appropriate dimension (relative size) for making the proper discriminative responses. The nominal scale (i.e., color names), on the other hand, would not enable the stimuli to gain sufficient discriminative control over the judgment behavior to allow the children to resist the anchor resulting in judgments which reflect the interaction between the physical values of the scaled stimuli and the anchor stimulus.
The third main hypothesis was that the nominal response scale (i.e., color names) would not change the children's judgment behavior considerably within the age range selected (3 - 6 years) since the color labels which were selected for use were highly distinct from each other and, in this population, frequently used by the children even at the lowest age level, whereas the ordinal response scale (i.e., numbers) would change the children's judgment behavior considerably in this age range since number concepts are in the process of being acquired. If children were trained to acquire numbers as an ordinal scale from the beginning, one would expect a smooth acquisition with age. However, if children are first trained to use numbers as labels (i.e., as a nominal scale) and only later as an ordinal scale, one might expect a somewhat discontinuous function with age, the number labels affecting judgment behavior in a similar fashion to the color labels initially, and only subsequently functioning differently (in this case to reduce shift) from the color labels.

Method

Subjects. Ss consisted of 68 preschool children ranging in age from 3 years 11 months to 6 years who attended a private day nursery and kindergarten. The group can be characterized as urban white Jewish middle class children coming from business, professional, and semi-professional homes.

Procedure. The procedure consisted of five steps: The first (stimulus familiarization) was to familiarize the children with the stimuli, namely, rods of the lengths which were later used in the judgment task. The second (verbal response training) was a response training procedure to train half the children to emit the verbal number-responses 1, 2, 3, and 4 and half the children the color-responses, red, yellow, green, and blue. Third (labeling the stimuli), the children were trained to label the four rods of various lengths by using either colors or numbers. Fourth (unanchored condition), the children's judgments under conditions which did not involve the use of an anchor stimulus were tested, and fifth (anchored condition), a comparable test of their judgment under conditions which did make use of an anchor stimulus was undertaken.

1. Stimulus familiarization.

The children were seated at a table the surface of which was covered by dark brown posterboard. The sides and rear were screened by the same dark brown posterboard. In front of the screen was a papier-maché clown (Happy, by name) with a white 7½ watt light bulb nose which could be lighted by $E$ and used to administer reinforcements (Salzinger, S. et al., 1962). A cup for holding trinkets was also placed next to the clown. In front of the clown, close to the child, was a stimulus display board showing a picture map of four locations, each marked by a signpost (i.e., the four stimuli), with a connecting path between them showing the way Happy must travel in order to find his way home to the circus tent. Happy was
represented by a small pipestem-cleaner puppet which could be moved by E along the
path. The signposts were standard size Cuisenaire rods, 4, 6, 8, and 10 cms. long.
For half the children one set of posts, all painted white, had inscribed on them
the number 1, 2, 3, or 4 in order of increasing size, and a corresponding number of
dots; for the other half, the rods were painted green, blue, red, and yellow in
order of increasing size.

A tape recording of Happy's voice told the children either one of two versions
of a story about himself which was illustrated on the display board. The two ver-
sions differed from one another only in that for half the children, the rods (label-
ed by number) were described in terms of number and in the other, the rods (labeled
by color) were described in terms of color. The signposts were made significant
elements in the story.

The story related how Happy found his way home from the "other side of the
world" where he had gotten lost. He was helped in his endeavor by the "Great and
Good Cugelhupf" who told him that he had to travel through the world until he pass-
ed four signposts in four different places. After he reached the last one he would
find his way home. Happy found the first signpost on an island in the middle of
the ocean, the second in a dark jungle, the third in a dragon's cave, and the fourth on
top of the highest mountain in the world. The puppet was moved by E along the
board from post to post as Happy told the story.

2. Verbal response training.

The display board was then removed and the child was trained to emit the four
colors (or numbers) in the absence of any physical stimuli, using a short progra-
med learning sequence. This was done to ensure that the child had all the respons-
es easily available in his verbal repertoire.

The learning program involved having the child supply verbally the missing
color(s) [number(s)] in response to a series of incomplete verbal listings of the
four colors [numbers], to have him repeat all four colors [numbers] after E listed
them, and to emit all four colors [numbers] when none of the stimuli were given by
E. The sequence consisted of nine stimulus presentations, each spoken by E. Addi-
tional prompts were used only when necessary. The children were induced to perform
this part of the task by asking them to help Happy remember the four signposts in
order to prevent him from getting lost again. The nose light on Happy was turned
on and a trinket was delivered as positive reinforcement after each correct response
emission.

3. Labeling the stimuli.

E then instructed the children as follows:

"Now let's play Happy's favorite game. I'm going to show
you the signposts one at a time. But someone forgot to
paint the colors (numbers) on them so when I show you a
signpost I'll tell you what color (number) it should have. You try to remember which signpost should have the color green, the color blue, the color red, and the color yellow (the number 1, the number 2, the number 3, and the number 4) because later on, I'll ask you to tell me. Now look right in front of you on the table and listen very carefully and I'll show you the signposts."

E then, using a set of 4 white signposts, displayed the stimuli one by one in a prearranged programmed sequence which allowed for some repetition depending on the child's responses, in order to teach the children to correctly assign the colors or numbers to the rods. Modeling, correction, and positive verbal reinforcement were used. At the beginning of the programmed sequence only two of the rods were shown to the child while E labeled them. Then E asked the children to label the same two stimuli on five successive trials. After each correct response E verbally reinforced the child. If a response was not correct E informed the child of the correct response, had the child emit it, and then reinforced him. A third stimulus was then displayed by E who labeled it for the child. The child was then asked to label each of the three stimuli during the next eight trials, correction and reinforcement again being administered when appropriate. Finally, the fourth rod was modeled by E and the child was asked to label all the stimuli during the next six trials, correction and reinforcement again being administered when appropriate.

Following this, eight trials were given, with each of the stimuli represented twice in randomized blocks of four during which E refrained from all verbalization, merely presenting each stimulus until the child responded and then going on to the next. Some leeway was allowed for repetition of prior blocks of the stimulus sequence just before the introduction of a new stimulus when it was clear that the child was not labeling correctly. Although this lengthened the sequence for some of the children, most of them were able to master the labeling procedure in the standard 31 stimulus presentations. The procedure was continued until all the children were correctly labeling at least 6 out of 8 stimuli, i.e., out of two complete sets of stimulus presentations.

4. Unanchored condition.

At this point, giving no indication to the child that the learning phase was over and a new condition begun, the unanchored condition was initiated by presenting all the children with the identical sequence of 16 stimulus rods, the 4 different rods first being randomly arranged and then rotated through 4 different orders. E presented each stimulus for approximately 3-5 secs., making no response whatever to the children's responses.

5. Anchored condition.

E then instructed the children as follows:

"One day Happy found another huge signpost." (E shows the
anchor rod, 20 cms. long). "It looked like the others but it was very big. And just for fun Happy would like you to look at it. O.K.? He wants you to look at it each time, just before I show you Happy's real signposts, and just before you have to tell me the names of the real signposts."

The sequence of stimulus presentations in the anchored condition was identical to that of the unanchored condition except for the fact that the anchor rod (white, like the other stimuli) was placed in front of the child for a period of 3-5 secs. just prior to each stimulus presentation.

Results

The age groups were arrived at by rank ordering all the children in the "color" group and all the children in the "number" group and then dividing each group into four equal consecutive groups. Two children who had initially been tested were discarded from the number group, one based upon the fact that he was the only child in the sample who showed extreme variability in the unanchored condition (i.e., 20 cms. whereas the highest variability shown by any other child was 3 cms.) and the other discarded at random in order to preserve the proportionality of the N's for purposes of analysis.

The children's performance was gauged in terms of the amount of shift they displayed upon introduction of a long anchor stimulus (see Table 1). Shift was computed in the following way: The difference between the length of a stimulus, in cms., to which a particular judgment made reference and the length of the stimulus to which it should have referred (i.e., the length it was trained to represent) was taken. These differences were summed separately for all judgments which were attributed to rods longer and all judgments which were attributed to rods shorter than the ones to which they should have been attributed. The "shorter" judgments (i.e., those referring to stimuli shorter than those to which they should have referred) were then subtracted from the "longer" judgments, yielding separate 'bias' scores for the unanchored condition and the anchored condition. Shift was finally computed by subtracting the unanchored 'bias' score from the anchored 'bias' score for each child.²

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Insert Table 1 about here

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In the unanchored condition only 20 of the 68 children showed any deviations from the correct judgments (see Table 2). Eleven of these 20 children deviated by only 2 cms., 5 by 4 cms., 2 by 6 cms., and 2 by 8 cms. Eleven of the children who deviated were trained on color verbalizations and nine on number verbalizations. There was no uniform direction characteristic of these total deviations.
Insert Table 2 about here

To test for differences in shift among the four age groups as well as the effects of the two verbalization conditions on the children's judgment, an analysis of variance using a mixed model was performed on the data (Scheffé, H., 1959). The mean shift scores, in cms., for the four age groups in increasing order of age were 14.12, 3.12, 12.47, and 6.82. The difference among the means was found to be statistically significant ($F = 2.893, p < .05$). The mean shift scores for the color condition and the number condition were 13.7 and 6.56 respectively ($F = 12.472, p < .001$). The interaction between the two variables was not statistically significant ($F = 2.297, .05 < p < .10$). The direction of the difference between the means for color and number lends support to our second alternative, namely, that the use of number responses induces an appropriate observing response thereby making it more useful for the child than the color response.

Although the difference in favor of the number condition is quite clear, the age effect is not. There appears to be a relationship such that judgment becomes more resistant to shift with age; however, the function is certainly not a smooth one. A look at a scattergram of all the children's performances is suggestive. It appears that for the very young children there is no difference between the performances of children who used color and children who used number responses. How-

Insert Fig. 1 about here

ever, after this initial stage the number group appears to drop to a lower level of shift which is maintained throughout the age range whereas the color group continues shifting throughout the age range at a somewhat higher level. Despite the fact that the interaction term was not statistically significant ($.05 < p < .10$), we felt that the trend warranted further analysis.

Consequently, the means for all the subgroups were tabulated (see Table 3) and t-tests were performed between these groups.
The following pattern of results emerged: 1) no significant differences were found between any pair of age groups for the color response children; 2) significant differences were found between the number response children in age groups I and II ($\mu_{I} = 14.5$, $\mu_{II} = .5$, $p < .005$) and groups I and IV ($\mu_{I} = 14.5$, $\mu_{IV} = 3.0$, $p < .01$); 3) significant differences were found between color and number for age group II ($\mu_{\text{color}} = 14.9$, $\mu_{\text{number}} = .5$, $p < .005$) and for age group IV ($\mu_{\text{color}} = 10.2$, $\mu_{\text{number}} = 3.0$, $p < .01$). For a number of reasons, among which is the fact that the initial F-ratio for the interaction was not significant and that the variability was quite high for these small subgroups, we suspected that we might be producing a Type I error, namely, rejecting the null hypothesis when in fact we should have accepted it. Therefore, we also performed the same comparisons using a non-parametric test, the Mann-Whitney U test, which, although less powerful, does not require the data to meet the same assumptions, and found the results to be identical to those revealed by the t-tests.

The pattern of results is generally consistent with our hypothesis concerning a difference between the effect of the use of numbers and colors with age, except for one group of children, assigned to a number-response group, the mean age of which was 5 years. The mean shift for this group was higher than we predicted (8.3 cm.). A look at the scattergram (Fig. 1) reveals that this increase in the mean shift was brought about by the performance of only two children in the group who were shifting considerably more than the others in the group and more like the rate of the children in the comparable age color-response group.

In general then, we concluded that there were distinct differences, within this age range, between children who were made to emit responses of a nominal scale as opposed to an ordinal scale in their ability to make accurate judgments of length in the presence of an anchor stimulus. The use of an ordinal scale generally increased the children's ability to resist shift increasingly with age, although the function was not a smooth function.

Discussion

The increase in invariance of judgment of physical size with age, as has also been noted in past studies (Wohlwill, J. F., 1960), is subject to the influence of other variables. In the present study, these variables are the two verbal response classes which form a significant aspect of the judgment process, and in this case, undergo a different pattern of change with age.

The interaction of the two verbal response classes with the children's ability to resist the anchor proved to be fairly complicated. Although both the color names and the numbers were easily available in the repertoire of the children and although the children in both groups were equally able, as indicated by their performance in the unanchored condition, to make accurate judgments of the size of the four stimuli, the use of the color response class did not enable the children
to develop an increase in resistance to shift within the age range studied. The use of the number response class, on the other hand, enabled most of the children, other than the youngest, to increase their resistance to shift within the age range studied.

In order to understand this, let us speculate about the young child's history of the acquisition of each of the verbal response classes, color and number. What is learned in each case? When is it learned? And in what circumstances, i.e., in the presence of which discriminative stimuli, is it reinforced?

For color, each response is reinforced in the presence of a class of stimuli, wavelengths, the order of which need not be taken account of for reinforcement to be forthcoming. In addition, with the increased emphasis by middle class parents on the development of cognitive skills the four colors used in the present study would in all likelihood have been learned by the age of four years. For number, it is possible that, for many children, learning takes place in two stages. During the initial period of conditioning, number names may be reinforced in the presence of small groups of one or more objects, or even in the presence of no physical discriminative stimuli, with no attempt made to explicate relationship among the stimuli. The second stage would provide reinforcement for those number responses which take account of the ordinal relationship among the stimuli. The age at which the second (i.e., relational) stage comes about may well vary from child to child. Indeed, depending upon the way in which the individual child was taught number concepts before he entered school, he may have skipped the first stage entirely, or, once in school, given the flexibility of the typical middle class preschool program with regard to teaching cognitive skills, and a concomitant concern for individual development, some children may not acquire ordinal number responses during this entire period.

Such a developmental sequence would account for the fact that in the present study, the color response class does not modify performance with age, whereas the number response class improves performance for most of the older children. Those older children for whom it does not improve performance may still be using numbers as labels and not as relational terms. However, since age has been used as an indicator of the learning of both color and number concepts, a conclusive result must await a further study in which learning of the two concepts is experimentally controlled and measured directly.

In attempting to account for the fact that number responses aided the older children in resisting the anchor effect, whereas color responses did not, we can consider the fact that the number response scale when utilized as an ordinal concept by the children, better describes the relationship among the stimuli. The number responses gave the older children more information about the stimulus dimension than the color responses in two ways. First, because of their past acquisition history they produced an observing response (i.e., an attentional response) for relative size, and second, the use of any one of the numbers, produced mediating responses for the other numbers.
Those investigators using mediation theory (Hendler, H. H., & Hendler, T. S., 1962), and we include among them those using selective attention (Zeaman, D., & House, B. S., 1963) and observing responses (Wyckoff, L. B., 1953), introduce an important point, namely, that the response used actually modifies the critical stimulus. However, at this point it is not enough to merely demonstrate the existence of mediating responses. It is necessary to examine the extent to which, and the manner in which, different response classes -- particularly verbal responses, since the changes in language are so rapid during the preschool years -- allow children to make use of the mediation postulated.
REFERENCES


FOOTNOTES

1 Grateful acknowledgment is made to Mrs. Regina Gilbert, the director of the school, Rabbi Edward Klein of the Stephen Wise Free Synagogue, and the teachers for their cooperation in enabling us to carry out this study.

2 This procedure in some cases produces a negative shift score. Such scores were given by 6 children, all in the 3 older number groups. The scores were treated as if they lay along the same continuum and were therefore considered to be extreme cases of resistance to shift. In an attempt to check on this, we reran our analysis assigning such children shift scores of 0 (i.e., no shift) and found no difference in the results.

A more detailed description of the scoring procedure as well as the rationale for its use in preference to other possible scoring procedures is presented by K. Salzinger (1956).
Table 1
Example of Shift Computation

<table>
<thead>
<tr>
<th>Rod length (cms.)</th>
<th>Unanchored Condition</th>
<th>Anchored Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Green</td>
<td>Blue</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

Unanchored Computation

'longer' bias score = 10-red: 1 (2 cms.) = 2 cms.
'shorter' bias score = 6-red: 2 (2 cms.) = 4 cms.

'longer' minus 'shorter' = -2 cms.

Anchored Computation

'longer' bias score = 6-green: 1 (2 cms.) + 8-green: 1 (4 cms.)
+ 3-blue: 1 (2 cms.) + 10-red: 3 (2 cms.) = 14 cms.

'shorter' bias score = 0 cms.

'longer' minus 'shorter' = 14 cms.

Shift = 14 cms. -(-2 cms.) = 16 cms.

* Entries above the diagonal represent judgments referring to stimuli shorter than those to which they should have referred; below the diagonal they refer to stimuli longer than the ones to which they should have referred; along the diagonal are the correct assignments of judgments to stimuli.

** or One, Two, Three, Four
Table 2
Distribution of the Sum of the Deviations of each Child from Correct Judgments in the Unanchored Condition

<table>
<thead>
<tr>
<th>Deviations (in cms.)</th>
<th>Age I</th>
<th>Age II</th>
<th>Age III</th>
<th>Age IV</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Color Number</td>
<td>Color Number</td>
<td>Color Number</td>
<td>Color Number</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>5 2</td>
<td>6 8</td>
<td>6 7</td>
<td>8 6</td>
<td>48</td>
</tr>
<tr>
<td>2</td>
<td>1 2</td>
<td>2</td>
<td>2 1</td>
<td>1 2</td>
<td>11</td>
</tr>
<tr>
<td>4</td>
<td>3 2</td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td>1 1</td>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>
Table 4

Analysis of Variance of Mean Shift for the
Two Types of Verbal Responses and the Four Age Groups

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>d.f.</th>
<th>Hi Sq.</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (color or number)</td>
<td>881.962</td>
<td>1</td>
<td>881.962</td>
<td>12.472</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td>B (age)</td>
<td>613.824</td>
<td>3</td>
<td>204.606</td>
<td>2.893</td>
<td>p &lt; .05</td>
</tr>
<tr>
<td>C (children)</td>
<td>4243.056</td>
<td>60</td>
<td>70.718</td>
<td>2.297</td>
<td>.05 &lt; p &lt; .10</td>
</tr>
<tr>
<td>AB</td>
<td>487.217</td>
<td>3</td>
<td>162.406</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>6226.059</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Fig. 1. The relationship between shift and age for children using color and number responses.