DOCUMENT RESUME

ED 262 567 FL 015 208

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TITLE	When "Big" Does Not Refer to Overall Size: Dimensional Adjectives in Context.
PUB DATE	Aug 85
NOTE	9p.
PUB TYPE	Reports - Research/Technical (143) -- Journal Articles (080)
JOURNAL CIT	Papers and Reports on Child Language Development; v24 p62-69 Aug 1985
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	*Adjectives; Adults; *Age Differences; Area; Child Language; College Students; *Concept Formation; English; Error Patterns; Language Acquisition; Language Research; *Language Usage; *Semantics; *Visual Perception
IDENTIFIERS	*Size Estimation

ABSTRACT

Two experiments examining adults' use of dimensional adjectives focused specifically on the distinction made between height and overall size as determiners of "bigness." The subjects in both experiments were college students. In the first, the hypothesis that the meaning of "big" shifts as a function of the object being described was tested. The subjects were asked to judge the size of symmetrical and tall rectangles and line drawings of people. It was predicted that they would be more likely to emphasize height in people but area in rectangles. The results were clear and in accord with the prediction. In the second experiment, subjects were asked to judge either the bigness or the area of figures of people. It was predicted that, if height bias in the first experiment was due to a perceptual problem, the subjects would answer alike in the two conditions ("big" and "area"). However, if "big" does not refer to area, the subjects would show more of a height bias when judging bigness than when judging area. The results again suggested that the adjective "big" as applied to figures does not refer to overall area. Theories of semantic development must deal with the variability of meanings across contexts. (MSE)

PRCLD 24 (1985)

WHEN "BIG" DOES NOT REFER TO OVERALL SIZE: DIMENSIONAL ADJECTIVES IN CONTEXT

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For researchers in semantic development, the appeal of dimensional adjectives, such as *big, tall,* and *wide,* is the possibility that they can be ranked according to linguistic complexity. Several investigators (see Clark, 1983; de Villiers & de Villiers, 1978) have suggested that children learn linguistically simpler terms before those that are more complex. Among dimensional adjectives, *big* and *little* are commonly assumed to be the simplest (e.g., Bierwisch, 1967), and are assumed to be learned correctly at an early age (Carey, 1978, 1982; Clark, 1972). Although a great deal of research seems to support this notion (Blewitt, 1982), more recent studies point to difficulties.

Maratsos (1973, 1974), for example, found that children's understanding of *big* seemed to decrease with age. While 3-year-olds apparently agreed with adult usage, 5-year-olds responded as if *big* meant tall. These results were surprising because they implied that children abandon a correct rule in favor of an incorrect rule.

Ravn and Gelman (1984) conducted an experiment to clarify what meanings children assign to *big* and *little*. Our experiment went beyond Maratsos' in its methodology. Maratsos tested just two rules at a time, pitting the correct rule against only one incorrect rule. Every time children did not respond according to the height rule, they were counted as using the area rule, and vice versa. But there are rules other than height or area that children could have been using (see Bausano & Jeffrey, 1975).

Ravn and Gelman tried to avoid this problem by testing five possible rules at once, including the height and area rules proposed by Maratsos, as well as other rules that researchers in the field have found plausible.

The children viewed cardboard rectangles, two at a time, and were asked to point to the big (or little) one of each pair. In order to be counted as using one of the rules, children had to answer consistently, following the particular rule on at least 8 out of 10 questions. Otherwise, they were counted as not using any rule at all. See Ravn & Gelman (1984) for further details of the method and results.

Most children consistently followed a rule, for both *big* and *little*. At every age, the height rule was the rule most commonly used. The area rule was rarely used. Only 5% of the 3-year-olds used it, only 15% of the older children. This result contradicts Maratsos' claim that 3-year-olds prefer the area rule.

We confirmed Maratsos' finding that percent correct decreased with age on certain rectangle pairs. But when we examined the rule usage of individual subjects across rectangle pairs, a different pattern emerged: older children were more apt to use the correct rule. It may seem paradoxical that percent correct decreased with age, while the number of correct rule-users increased. The paradox was resolved when we examined consistency of performance. Older children were significantly more consistent in their rule use, on several measures. For example, 80% of the 5-year-olds relied on a rule (usually an incorrect one), compared to only about half of the 3-year-olds. In other words, 5-year-olds were making systematic, rule-governed errors, whereas 3-year-olds ended up giving more correct answers just by chance -- precisely because they were not as tightly bound to the wrong rule.

To summarize these findings, young children often believe that *big* means tall (see also Maratsos, 1973, 1974). Contrary to past claims, children do not start out with an overall size rule: at age 3 they are more likely to pay attention to height or to the most salient dimension. The major developmental difference between ages 3 and 5 is that older children are more consistent rule-users. 5-year-olds are more likely to use a rule and stick by that rule than are

3-year-olds.

These results leave us with the question of why height is so salient for young children. Children's errors seem surprising: children actually get *more* bound to the height rule with age. Shouldn't the adult input be working against such an error? We believe the answer lies, in part, with a closer analysis of the adult meaning of *big*. It is often assumed that *big* (for adults) refers to overall size. Linguists have characterized big as "clearly synonymous" with large (Teller, 1969, p. 205), and as meaning "greater in size" (Katz, 1967, p. 187) where size is contrasted with height among other dimensions. Similarly, developmental psychologists have characterized *big* as referring to "general spatial extension" (Maratsos, 1973).

However, *big* may have somewhat different meanings, depending on the category it describes. Bierwisch (1967) noted that *big* can refer to one, two, or three dimensions, depending on the object being described. A big needle is big in one dimension (length), a big window is big in two dimensions (height and width), and a big apple is big in all three dimensions. These particular examples need not contradict the claim that *big* means "overall size." It could simply be that the unattended dimensions are usually unobservable (the thickness of a window) or unvarying and therefore non-informative (the width of a needle).

Yet for some uses adults may actually judge *big* to be in conflict with overall size. For example, consider two doors: one is 3 feet high, 2 feet wide, and 1-1/2 feet thick; the other is 10 feet high, 4 feet wide, and 2 inches thick. Which door is considered "bigger": the first, whose overall volume is larger, or the second, whose height x width is larger? The bigger door may be the taller, wider door with smaller volume. Or consider the bigness of people. Bierwisch claims that the German word *gross* (a near synonym for *big*), when applied to people, maps onto height. Overall, height probably correlates quite highly with overall size. The test case of interest is when height and volume conflict (a tall, thin person as compared to a shorter, fatter person). If the taller person is still considered "bigger," then the term does not mean "overall size." Rather, it would sometimes entail computing and attending to separate dimensions, and ignoring one or more.

This is a crucial point for understanding the semantics of dimensional adjectives: if *big* does not always refer to overall size, then its meaning can be considered at least as complex as, say, *tall* or *wide*. Yet this analysis has typically been overlooked. At this point Bierwisch's linguistic insight needs to be empirically tested and more fully specified. For example, there is no empirical evidence that *big* ever conflicts with overall size. Furthermore, we do not know whether the use of *big* is governed by purely perceptual phenomena: for example, do we ignore a given dimension only when we cannot see it or integrate it? Or do people suppress one or more available dimensions? Is the meaning of *big* a function of the general proportions of the object involved, or more closely tied to the category itself? In other words, can two categories with the same general proportions have different rules for *big*?

Experiments 1 and 2 examine these issues in more detail. In the discussion we return to the issue of acquisition, and explore the consequences of this analysis for how children learn *big*.

EXPERIMENT 1

In this experiment we test the hypothesis that the meaning of *big* shifts as a function of the object being described[1]. Adults were asked to judge how big rectangles or line drawings of people were. The prediction is that adults will be more apt to emphasize height when judging bigness of people, but will use an area rule for rectangles. Tall rectangles (approximately the same proportions as the people) were also included, to discover whether a height bias in judging people (if found) is due to the category being judged, or rather to the general overall proportions of the object.

Method

Subjects were asked to judge bigness in a way that permitted a more precise analysis than was possible with preschoolers.

Subjects. Subjects were 41 Stanford University undergraduates fulfilling a course requirement. Each was assigned to one of three conditions: figures (line drawings of people in profile) (n=15), symmetric rectangles (n=13), and tall rectangles (n=13).

Materials. Subjects in the figure condition were given a series of fourteen problems (one per page) of the following type: For each problem, subjects saw a row of seven figures (termed a *scale*) increasing from left to right in area, by varying along height alone, width alone, or some combination of the two. Preceding the scale on the left was a *target* figure, set off by a vertical line. The subjects' task was to indicate where along the scale the target figure belonged, in terms of its bigness. There were two target figures each combined with seven scales, giving a total of fourteen problems. The problems for subjects in the two rectangle conditions were constructed analogously. Examples of all three scale types are shown in Figure 1.

Each of the seven seven-step scales was drawn from a corresponding ten-step *prototypical scale*. A prototypical scale was constructed by choosing an initial item (figure or rectangle), designated as step 0 of the scale. For symmetric rectangles the initial item was a square (0.51 x 0.51 inches)[2]. Each of the seven prototypical scales was specified by choosing a rate of increase of height (denoted h, the height multiplier) and width (denoted w, the width multiplier) along the scale. To generate step 1 on the prototypical scale, we increased the height of the prototypical item by a factor of h and increased its width by a factor of w. Step 2 was h^2 times taller and w^2 times wider than step 0; step 3 was h^3 times taller and w^3 times wider than step 0, and so forth. If $h=1$, the items on the scale varied only in width. If $w=1$, the items on the scale varied only in height. There were ten steps on each prototypical scale, numbered 0 to 9.

Note that the area of each successive item was hw times bigger than that of its predecessor. For all scales, the values h and w were chosen so that $hw = C$, a constant. All the scales for a particular kind of item were generated from a single common prototype, the 0th element on all scales. Consequently, all the items on the first step of each scale had area C times bigger than the prototype, on the second step, C^2 times bigger, etc. The value of C was chosen so that the area of the last item (step 9) was double that of the prototypical item. The multipliers h and w used for the seven prototypical scales are given in Table 1:

Table 1

	h	w	
Scale 1	1.000	1.080	"width only"
2	1.016	1.063	
3	1.029	1.050	
4	1.039	1.039	
5	1.050	1.029	
6	1.063	1.016	
7	1.080	1.000	"height only"

All stimulus materials were generated, randomized, and scored using programs written in PASCAL on a VAX 11/780.

Subjects never saw the full ten-step prototypical scales. Rather, the scales they viewed were seven-step scales beginning on step 1, 2 or 3 of the corresponding prototypical scale. Underneath the seven scale items were 15 small boxes that subjects could check to indicate

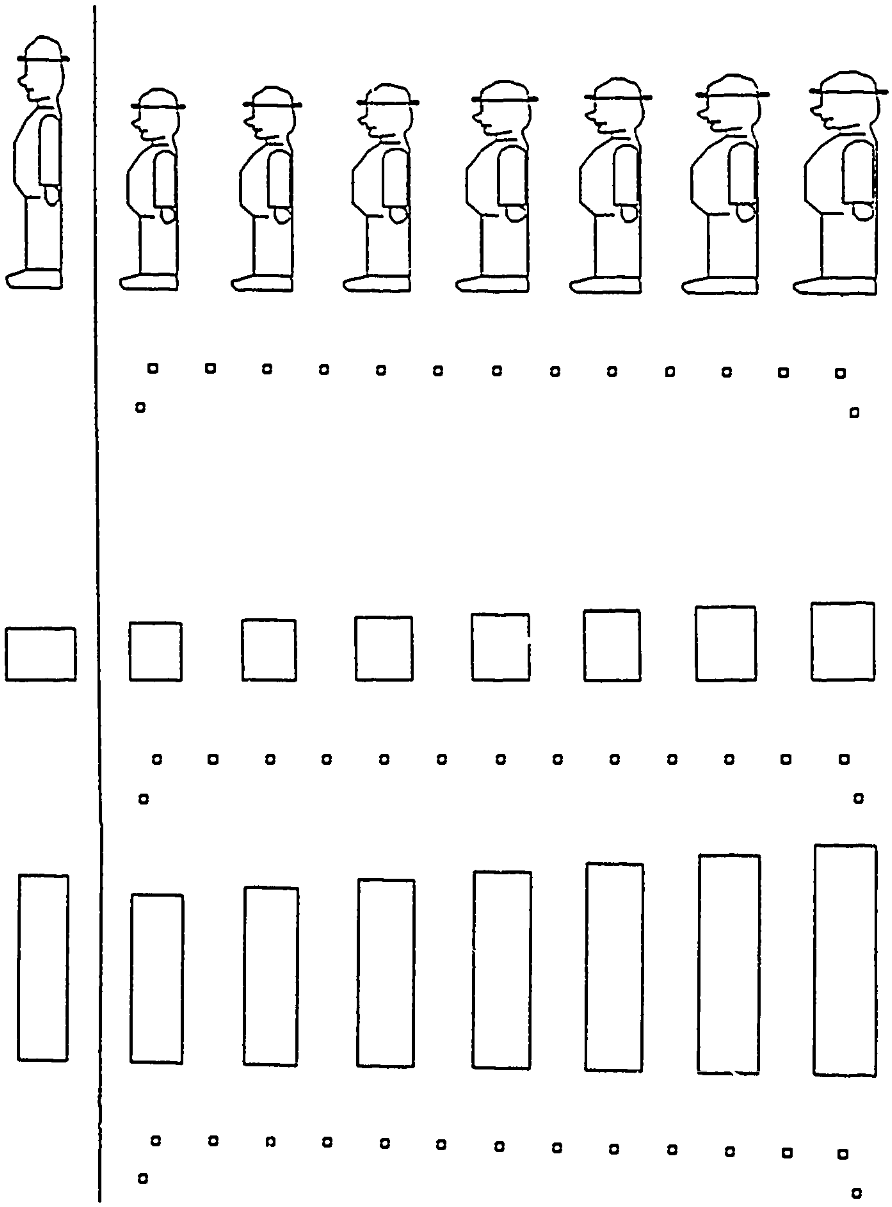

Figure 1: Examples of target items and scales for figures, symmetric rectangles, and tall rectangles.

where, in bigness, the target would fall (seven boxes under the seven pictures, six intermediate between pictures, and two at either end of the scale used to indicate that the target item did not fall within the range of the scale). The starting step (1, 2, or 3) for each of the seven scales was chosen at random. Consequently a subject checking equal-area items (all of which would fall on the same step of the prototypical scales) would not find herself repeatedly choosing the same scale step. The order of presentation of the 14 target/scale combinations was randomized.

As mentioned before, step 0 for the symmetric rectangles was .51 x .51 inches; step 0 for the figures was 2.10 x .69 inches; step 0 for the tall rectangles was 1.53 x .51 inches (figures and tall rectangles have approximately the same proportions, height three times the width). In going from steps 0 to 9, the picture was always exactly doubled in area. The fourteen problems subjects received corresponded to two sets each of the seven prototype scales. Each set (henceforth referred to as A and B) included one target picture, with dimensions (in inches) as follows: 0.54 x 0.75 (Set A) and 0.65 x 0.53 (Set B) for the symmetric rectangles; 1.62 x 0.75 (Set A) and 1.96 x 0.53 (Set B) for the tall rectangles; and 2.22 x 1.00 (Set A) and 2.69 x .71 (Set B) for figures.

Procedure. Subjects were tested in groups. They were instructed to judge how big the target pictures were relative to the scales. We took care to stress, in the figure condition, that they would be seeing drawings of people, and should judge them as if they were people. Subjects went through booklets at their own pace and were debriefed afterwards.

Results

Our hypothesis is that height will be weighted more heavily when subjects are judging figures of people than when judging rectangles. Tall rectangles were included as a comparison. If subjects treat tall rectangles and symmetric rectangles alike, and as distinct from figures, then their judgments are based on the category of objects being judged. If instead subjects treat tall rectangles and figures alike, and as distinct from symmetric rectangles, then their rules are dependent on the general proportions of the objects being judged.

Scoring. Subjects' scores were converted back to the prototype 10-point scale (see Methods). For each of the fourteen scales, we calculated a band of answers that would be accepted for each of three rules: a height rule, a width rule, and an area rule. Each response was judged consistent with a height rule if it fell within approximately one scale step[3] of the actual height of the item, and similarly for the other rules. These scores are measures of the relative weight subjects placed upon height and width in making their judgments. A high score on the height measure implies that a subject places more emphasis on height than width in her judgments, not that the subject must be using precisely a height rule, completely ignoring width. A high score on the area measure implies subjects are taking both height and width into account with approximately equal weight.

For each subject and for each of Sets A and B, we computed height, width and area measures. Each of these numbers could range from 0 to 7. An initial analysis indicated that only one subject scored highly on the width measure, so the width measure is not considered further here. The primary score used in all the remaining analyses was a difference score of the height measure minus the area measure, for each subject and each set. This number (which could range between -7 and 7) measured the degree to which a subject emphasized height over area, on each set.

The results were very clear and in accord with our predictions. A one-way analysis of variance was computed on the three sets of difference scores (height measure minus area measure) for Set A. The means were significantly different ($F(2,38) = 11.32$; $p < 0.01$). We used Dunnett's test (Roscoe, 1975) to compare first the figure condition and then the tall rectangle condition to the symmetric rectangle condition. Tall rectangles were treated no differently than symmetric rectangles, Dunnett's $t\,(38) = -0.07$, $p > 0.05$, but difference scores for figures were shifted toward the height rule in comparison with symmetric rectangles, Dunnett's $t\,(38) = 4.03$, $p < 0.01$. These findings also held for Set B, as indicated in a one-way ANOVA, $F(2,38) = 4.54$; $p < 0.05$. Difference scores for figures were greater than those for symmetric rectangles, Dunnett's $t\,(38) = 2.75$, $p < 0.01$, but difference scores for the two sets of rectangles did not differ significantly, Dunnett's $t\,(38) = 0.37$, $p > 0.05$.

Two subjects in the figure condition scored the maximum possible (7) on the height measure for both target items. Two other subjects in the figure condition scored the maximum possible on the height measure for figure A alone and figure B alone respectively. No subjects scored the maximum on the height measure for either target item in either of the rectangle conditions. There were in contrast five maximum scores on the area measure for one or the other target item in the two rectangle conditions but no perfect scores for the area measure in the figure condition.

Discussion

Adults shift their interpretation of *big* depending on the category being described. When judging bigness of figures, they tend to emphasize height more than when judging bigness of rectangles, at least over the range of stimuli employed here. In other words, the weight that subjects assigned to width in the figure condition is smaller than that assigned in the rectangle conditions. Furthermore, these results are true even with rectangles having approximately the same overall proportions as the figures (the tall rectangle condition). The category of the object seems more important than the general proportions of the object for interpreting the word *big*.

The question arises as to whether subjects' height bias in the figure condition is a perceptual problem, or whether a height bias for judging people is actually part of the meaning of the word *big*. That is, are subjects unable to estimate the area of figures of people accurately, or do they actually suppress the width dimension? Experiment 2 addresses this question by examining whether subjects can take width into account when asked to judge area rather than bigness.

EXPERIMENT 2

In this experiment subjects were asked to judge either the bigness or the area of figures of people. If the height bias in Experiment 1 was due to a perceptual problem, then subjects should answer alike in the two conditions (big and area). If instead *big* does not refer to the area of figures, then subjects should show more of a height bias when judging bigness than area.

Method

Subjects. Subjects were 25 Stanford University undergraduates fulfilling a course requirement. Each was assigned to one of two conditions: big (n=13) and area (n=12).

Materials. Subjects were asked to judge bigness or area on scales that were generated as described in Experiment 1. The dimensions of the target stimuli in this experiment were (height x width) in inches: 2.31 x 0.92 (Set A) and 2.62 x 0.75 (Set B)[2].

Procedure. The procedure was identical to that of Experiment 1, except that subjects in the area condition were instructed to judge area rather than bigness.

Results and Discussion

The results indicate again that *big* as applied to figures does not refer to overall area. Furthermore, when specifically asked to judge the area of the figures, subjects were significantly more successful, as shown by a comparison of performance in the two conditions (see Results section of Experiment 1 for details on the scoring method), Target A: $t(23) = 4.51$, $p < 0.001$ and Target B: $t(23) = 6.05$, $p < 0.001$.

GENERAL DISCUSSION

Big is often dismissed as a very simple, general term that should be easy for children to acquire. However, Bierwisch's (1967) analysis points to a very important problem: the number of dimensions implied by this word is left unspecified by the adjective itself. Instead, the number of dimensions that *big* refers to is determined by the particular object being described.

The present experiments supported and extended Bierwisch's linguistic insight. The interpretation of *big* does vary as a function of the object being described. Subjects gave less weight to the width dimension when judging figures than when judging rectangles. We have also shown that this is not purely a perceptual problem: subjects *did* judge the area of figures more accurately when directly asked. Finally, the biases were specific to the category being described, and were not simply a function of the proportions of the object. Two objects with approximately the same overall proportions (such as the figures and the tall rectangles) did not yield the same bias.

What are the implications for development? We suggest that children, like adults, may attend to the meaning of *big* that is associated with the particular category. For example, children (like the adults in our experiment) may have a height-biased rule for judging the bigness of people. But, when forced to consider the bigness of rectangles, children may not yet have learned a specific rule for that category. In that case, they might fall back on some other familiar rule, such as their height rule for people. Our claim is a specific test case for a theory proposed by Carey (1978) and extended by Keil and Carroll (1980). They suggested that children's early word-meanings may at first be based on knowledge about specific examples rather than reflecting a more general definition. Our claim emphasizes the context-dependency of adults' word-meanings, as well.

We cannot assume that children have a general height rule unless we have demonstrated it across a range of categories. To do so would be analogous to concluding that adults have a height-biased rule, based only on their responses to figures of people in Experiment 1.

In sum, we would like to make two points: the first is a methodological one, that we need to be careful in specifying how words are used by children and adults. Much can be learned by studying consistency in rule use, and by studying word meaning across contexts. The second point is that theories of semantic development have to deal with the problem of how meanings vary across contexts. Katz (1964) has demonstrated this with the word *good*: a good knife and a good wine are good in very different ways. Although there may be some abstract representation in common to all uses of the word *good*, one still cannot know the extension of the term without detailed knowledge about the objects being described. For dimensional adjectives, too, we cannot assume that each word has just one interpretation.

FOOTNOTES

This work was supported in part by the University of Michigan.

1. By "meaning" we are referring to the apparent rule subjects use to interpret a word.
2. The figures were specified to the plotting device in arbitrary units. Step 0 for symmetric rectangles was, for example, 375 by 375 arbitrary units. The relative sizes of plotted figures are exact to within an arbitrary unit. The absolute dimensions of the stimuli, however, were estimated by hand from the output and are accurate to no more than 1/32 inch. The height and width of the figures were taken to be the dimensions of the rectangle that would just enclose the figure, a somewhat arbitrary choice.
3. The value 1.05 scale step was used in the actual scoring to avoid rounding problems in computation.

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