DOCUMENT RESUME

ED 133 696 CS 003 137

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TITLE Linguistic and Conceptual Processes in the Comprehension of Spatial Antonyms.
PUB DATE Sep 76
NOTE 16p.; Paper presented at the Annual Meeting of the American Psychological Association (84th, Washington, D.C., September 1976)

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS *Cognitive Processes; Higher Education; *Language Research; Models; Reaction Time; *Reading Comprehension; *Semantics
IDENTIFIERS *Antonyms

ABSTRACT

Three pairs of spatial antonyms (higher than/lower than, above/below, and rising away from/falling away from) were used in a task in which subjects judged whether a sentence accurately described a previously presented pictorial relationship. Subjects' reaction times were used as the dependent measure. Since all three word pairs were used synonymously to describe the same pictures (either a plus over a star or a star over a plus), significant differences between the pairs must reflect differences in ability to apply them to this task. Reaction-time differences indicated that, within each pair of antonyms, the member referring to "upness" was easier to comprehend and that the three pairs differed in the size of intra-pair differences, in overall comprehensibility, and in correspondence to a model of picture/sentence matching developed by Clark and Chase (1972) to describe the use of "above/below" in this task. (Author/AA)

Linguistic and Conceptual Processes in the Comprehension of Spatial Antonyms

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Paper presented at the 84th annual meeting of the American Psychological Association, Washington, D.C., September, 1976.

In all natural languages, there are synonyms. There are different ways of describing the same situation. Furthermore, synonyms are not used with equal frequency by adults, or learned with equal ease by young children. When a fluent speaker chooses to use one description over another, the choice is often determined by pragmatic concerns. One example might be a speaker's concern with the hearer's focus in the situation being described. While a balloon floating over the treetops may be above the trees, it may be more appropriate to describe the balloon as rising away from the trees. Here, we are faced with a description type difference based on whether movement in the relationship is important to comprehension. If the speaker had chosen above, the hearer might not have been able to locate the balloon. Above and rising away from are not simple synonyms; above may be used to describe static or moving relationships, but rising away from is typically only used for moving relationships. By choosing above to describe the position of the balloon, the speaker would be imprecise, and the hearer could have directed his gaze merely to the top of the trees rather than the open sky itself.

Another type of pragmatic concern with which speakers must deal is the level of fluency of their hearers. To describe the location of a static object, a speaker could choose between above and higher than. The fact that higher than is used more often by adults than above implies that there are differences between even these simple synonyms. Coupled with developmental research, which indicates that higher than is learned before above (Friedenberg & Olson, in press) this difference may reflect how simply and explicitly vertical relationships are encoded by these items. Higher

than is the most explicit description, presenting explicit reference to the dimension, high, and morphemic cues to the comparison, -er than. Above presents implicit reference to both of these features. Rising away from, which is learned by children after above, has an explicit signal of the comparison, away from, but lacks dimensional reference and adds the concept of motion relative to a reference point. While the choice between higher than or above on one hand and rising away from on the other may be motivated by the importance of motion in the relationship, the choice between higher than and above reflects a difference between explicit and implicit descriptions. This way of assessing differences between synonyms uses semantics as the explanation, rather than relying on a symtactic contrast like grammatical class. For this reason, it may be closer to the way young children react to synonyms, learning the most explicit description first as opposed to learning the "adjectives" first, since young children have no concept of part-of-speech.

Higher than, above and rising away from are each a member of a pair of antonyms: higher than-lower than, above-below, and rising away from-falling away from. There has been much research on the comprehension of spatial antonyms, though largely confined to studying static descriptors. The bulk of this research indicates that one pair member is more frequent in adult speech (see frequency counts, Thorndike & Lorge, 1952) easier for adults to comprehend (e.g., H. Clark & Chase, 1972) and acquired earlier by young children (e.g., E. Clark, 1972, 1973). For antonyms referring to the vertical dimension, "up" words like above, higher, and rising are the simpler members. Explanations of this phenomenon center on differences in the semantic structures of pair members. Briefly, words implying an upward

perspective contain a positive polarity feature, since "up" appears to be the normative direction for this dimension. Words of a downward perspective, like below, lower, and falling, are negative polarity, and are therefore linguistically and conceptually more complex (see discussion in H. Clark, 1973).

In contrast to the wealth of research on pairs of antonyms, little attention has been devoted to comparing pairs of "synonymous antonyms"--different descriptions of the same space. My purpose in this study was to compare these three pairs, higher than-lower than, above-below, and rising away from-falling away from, in a picture-sentence matching task. There is already data illustrating how frequent each of these pairs is in adult speech (see frequency counts, Thorndike & Lorge) and developmental data regarding their order of acquisition (Friedenberg & Olson, in press). This study would fill the gap by providing information on their ease of comprehension.

A picture like * + could be described as: The star is above the plus, the star is higher than the plus, or with the right instructions and some imagination, the star is rising away from the plus. Alternatively, the relationship can be described from the reference point of the star, by saying: The plus is below the star, the plus is lower than the star, or the plus is falling away from the star. Subjects viewed a series of slide pairs, the first always a picture of a plus over a star, or a star over a plus, the second a sentence using one of the phrases in Table 1. The subjects were told to respond "true" if the sentence accurately described the preceeding picture, and "false" if it did not. Reaction time was used as the dependent measure. Besides the variables of description type and

polarity, the sentences varied in other ways. First, each of the six target phrases was used in both affirmative and negative structures, such as is higher than and is not higher than. Second, each of these affirmative and negative structures was presented four times with the plus as the sentence subject, and four times with the star as the sentence subject. These four presentations of each sentence were further divided into two "true" presentations, where the sentence accurately described the preceeding picture, and two "false" presentations, where the description was inaccurate. The design may be summarized as: 3 description types x 2 types of polarity x sentence negation x 2 sentence subjects x true/false, with replication.

Forty-six undergraduates were tested. Very few errors were made, under 4% on the average. The one significant effect in the error data was for sentence negation ($F\ [1,45] = 49.1$, $p < .001$), as subjects made more errors on negative than affirmative sentences. This finding parallels well documented research on the complexity of sentence negation. The remainder of the analysis used average reaction times for correct responses in the different conditions. Preliminary analysis indicated no differences between identical conditions in which the star or the plus was the sentence subject. This variable was ignored in subsequent analyses. Therefore, up to four reaction times, depending on the subject's errors, were averaged to obtain mean reaction time in each condition.

A combined analysis of variance, including description type as a variable, and a set of separate ANOVAs on each pair were performed. The graphs in Figure 1 represent the average latencies for correct responses in seconds. The solid lines indicate the obtained data, the broken lines the data predicted by a comprehension model to be discussed shortly.

Note that the vertical scales for the three pairs are not equal: The scale for above-below goes from 1.4-2.1 secs, for higher-lower from 1.3-2.3 secs, for rising-falling from 1.6-2.3 secs. The horizontal axes and notations within the graphs represent anchor points for the eight conditions applied to each pair. The "true" and "false" headings refer to matching conditions, in which the sentence description was either accurate or inaccurate. The positive/negative headings refer to the polarity of pair members, with above, higher and rising being the positive members, below, lower and falling the negative members. The affirmative and negative notations within the graphs refer to the presence or absence of the particle "not" in the sentence.

The results of the combined ANOVA indicated that reaction times for negative sentences were significantly longer than those for affirmative sentences in identical conditions ($F [2,90] = 71.41$, $p < .001$). This is clearly seen by the distance between the lines labelled negative and affirmative in each graph. There was a significant effect of polarity ($F [1,45] = 73.32$, $p < .001$) with shorter mean reaction times to positive items than to negative items. This is best seen by comparing, for example, the affirmative-true-positive polarity data points with their negative polarity counterparts. However, there was also a significant interaction of polarity and description type ($F [2,90] = 5.44$, $p < .05$) indicating that the size of the intra-pair difference varied according to type. Higher-lower showed the largest intra-pair difference, 240 msec, with above-below and rising-falling having about equal smaller differences, 138 and 134 msec respectively. Finally, there was a significant main effect of description type ($F [2,90] = 71.41$, $p < .001$) indicating that these three pairs were not equally complex in the overall task. Rising-falling showed the longest mean reaction time,

2065 msec, followed by above-below and higher-lower, whose means were 1794 and 1819 msec respectively. (This main effect may not be obvious from the graphs) Since the intra-pair difference for higher-lower is so much larger than that of above-below, as illustrated by the interaction of polarity and description type, it is useful to determine separate means for the pair members to determine ease of comprehension. The mean for higher was 1699 msec, for above 1725 msec, for lower 1939 msec, for below 1863 msec. We see that higher is easier than above, but lower is more difficult than below. This pattern of ease of comprehension is identical with the one determined in developmental research (Friedenberg & Olson, in press).

So far, we have been concerned only with the solid lines in the graphs, the obtained reaction times. The broken lines are reaction times predicted by an additive factors model of picture-sentence matching. This model was developed by Clark & Chase (1972) to describe their data on above-below in an almost identical task, and obviously best fits the current data on above-below. Deviations from the model's predictions occur for higher-lower and rising-falling. Coupled with the significant effect of description type, the implication is that structural differences in type of description affect the comprehension processes in this task. Without discussing this model in great detail, certain major features will be described to aid in assessing the deviations of higher-lower and rising-falling data. (The model is presented schematically in Figure 2.)

The above-below model predicts reaction time in each condition by deriving time estimates for each variable involved in that condition. These estimates are independent, so that their sum can represent the

closest possible predicted reaction time for that condition. This will produce longer reaction times for more complex conditions. One factor that can increase task complexity is sentence negation, as seen by its main effect in the ANOVA. Negation is represented in the model as "b+d". Another factor increasing complexity is the use of a negative polarity item, such as below, and this polarity factor is factor "a". Two additional parameters are used to describe the time taken by subjects to change response preferences from true to false, "e" and "f". Thus, the model predicts a significant main effect for negation and polarity, reflecting parameters "b+d" and "a", and two significant interactions reflecting parameters "e" and "f". (For an analysis of the source of these interactions, see Clark & Chase, 1972.)

A set of three separate ANOVAs were performed on the three description types. The above-below analysis revealed only the predicted significant main effects and interactions. This was supported by a least squares analysis to determine the duration of each parameter. The RMSD, a measure of the deviation of the predicted reaction times from the obtained times, was only 9 msec for above-below. The higher-lower analysis revealed two deviations from the model's predictions: A significant effect of true/false ($F\ [1.45] = 8.22$, $p < .05$) and the lack of a significant interaction reflecting parameter "e". This was also reflected in the higher-lower least squares analysis. The RMSD in this case was 51 msec. Rising-falling contained one deviation from the model's predictions, a significant interaction of negation and polarity ($F\ [1,45] = 5.44$, $p < .05$). In the rising-falling least squares analysis, the RMSD was 39 msec.

Thus, we see that the differences between these synonymous descriptions are reflected in specific ways in picture-sentence matching. The pairs are not equally easy to process, and the intra-pair difference is modified by description type. It is interesting to note that the above-below model actually shows a poorer fit to the higher-lower data than to the rising-falling data. Even though above-below and higher-lower are more synonymous than above-below and rising-falling, they differ more in picture-sentence matching processes.

These results indicate that the pair members of spatial antonyms referring to the vertical dimension are not created equal, and that pairs of "synonymous antonyms" for this dimension are also not equal. The very existence of antonyms and synonyms raises a psychological question regarding their presence. Why does language provide so much redundancy, so many ways of describing the same situation?

For the fluent speaker, who already knows the meaning of all of these phrases, the choice of a particular pair and a member within that pair is primarily determined by linguistic concerns. To draw attention to the lower of two objects, the negative polarity item is chosen. This is because in a sentence like: The plus is below the star., the "star" serves as the reference point for locating the desired object, the "plus". To draw attention to the upper of two objects, the positive polarity item is chosen. In a sentence like: The plus is above the star., the desired object, the "plus" is located above its reference object, the "star". This choice of pair member is motivated by linguistic concerns because English is constructed such that the object of the sentence is the reference point, the subject of the sentence the focal concern. However, we must

reconcile the fact that upward terms are more frequently used by adult speakers than downward words. Does this imply we more often refer to the upper of two objects, or that we tend to use upward terms to describe other situations also? It seems more reasonable that this asymmetrical distribution in usage reflects a bias to use positive terms for either attention to upper objects or for a neutral description of two object relationships, that is, for situations in which the speaker does not attach importance to the hearer's reference point. Thus, fluent speakers are provided with antonym pairs to allow for shifts in perspective.

What is the function of having several pairs of antonyms to describe a given relationship? Here, the fluent speaker makes choices based on other types of linguistic concerns. Higher-lower or above-below may be used to describe static relationships, and either of these pairs or rising-falling may be chosen for moving relationships. Thus, the choice of rising-falling implies that movement in the relationship is important, the choice of higher-lower or above-below that movement is unimportant. However, higher-lower are used more frequently by adults than above-below, even though they are applicable to the same situations. It is possible that the preference for higher-lower indicates a desire to be explicit, since higher-lower present explicit reference to features implicit in the meaning of above-below. Thus, fluent speakers are provided with pairs of antonyms to allow for different levels of detail and explicitness in their descriptions.

For the language learner, especially the young child, usage is based more on conceptual than linguistic concerns. The availability of two pair members has different consequences. Developmental research has shown that

young children typically learn to use and understand the upward items before the downward items. Upward items are linguistically less complex, containing a positive polarity direction feature, but this linguistic simplicity derives from a broader conceptual simplicity. With the ground being such a salient reference plane for the vertical dimension, "up" may be the normative direction, and the source of the positive/negative polarity difference in pair members. It is this conceptual simplicity that enables young children to first learn the positive pair member.

The presence of several pairs of antonymous descriptions also has conceptual implications for the language learner. For the vertical dimension, higher-lower is the most explicit pair, containing morphemic cues to the meaning of pair members. Developmental research has illustrated that this pair is acquired prior to above-below, the implicit descriptors for this dimension. Children can more easily determine what higher than means that what above means, just as the adults in this experiment could more quickly solve picture-sentence matches with higher than. Once children understand what higher and above mean, this information can provide the basis for conceptualizing similar relationships when objects are moving via a pair like rising-falling.

The preceding analysis has dealt exclusively with descriptors of vertical relationships. There is presently some data on other spatial pairs for this and other dimensions, providing information about frequency of usage, ease of comprehension, and acquisition order. However, an analysis of all three types of data for other pairs of synonymous antonyms is lacking. To demonstrate the generalizability of the linguistic and conceptual processes outlined in this paper, additional studies to fill in the gaps are needed.

Table 1

		above		
		below		
The star/	is (not)	higher than	the plus./	
The plus		lower than	the star.	
		rising away from		
		falling away from		

Figure 1

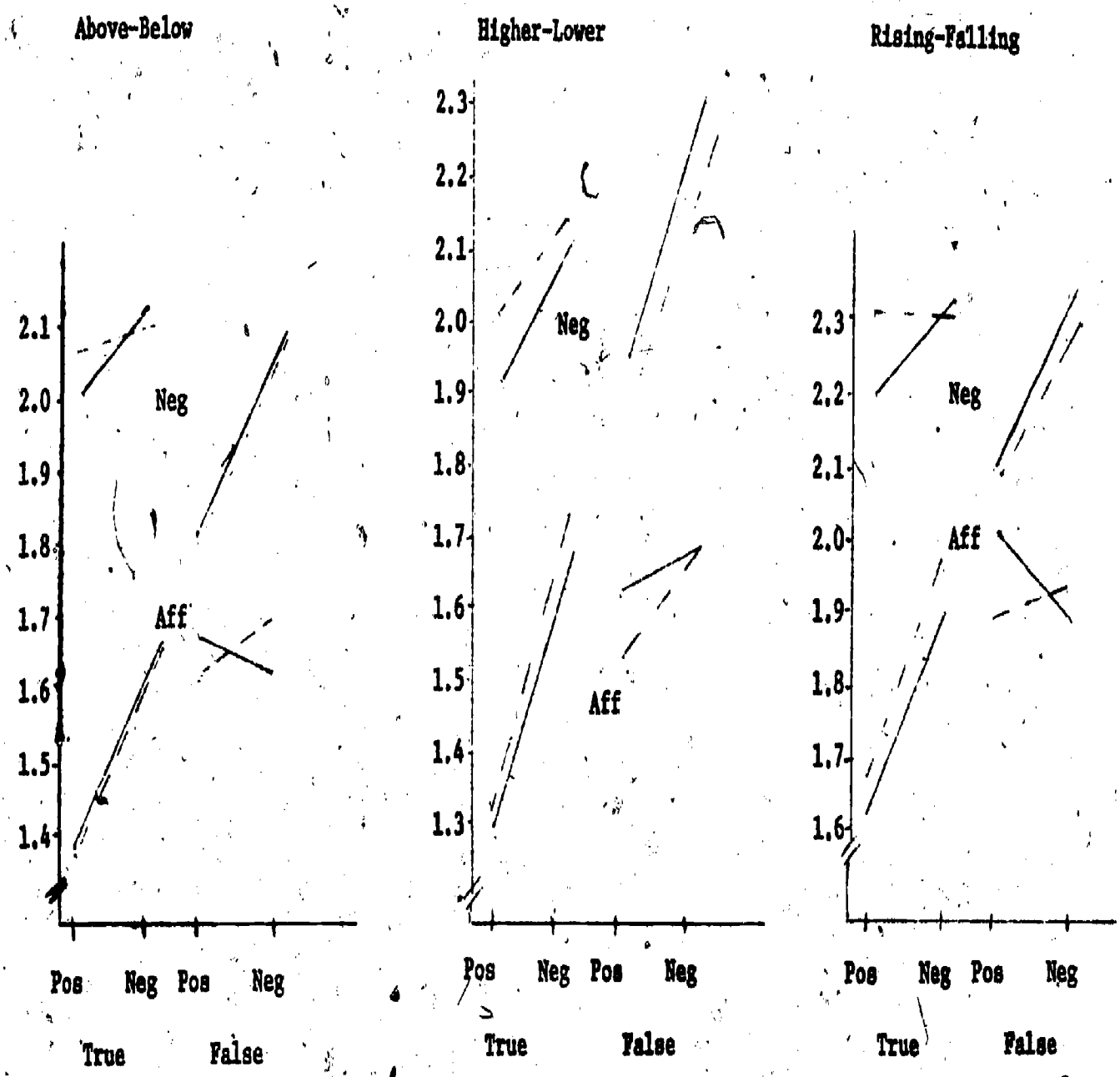
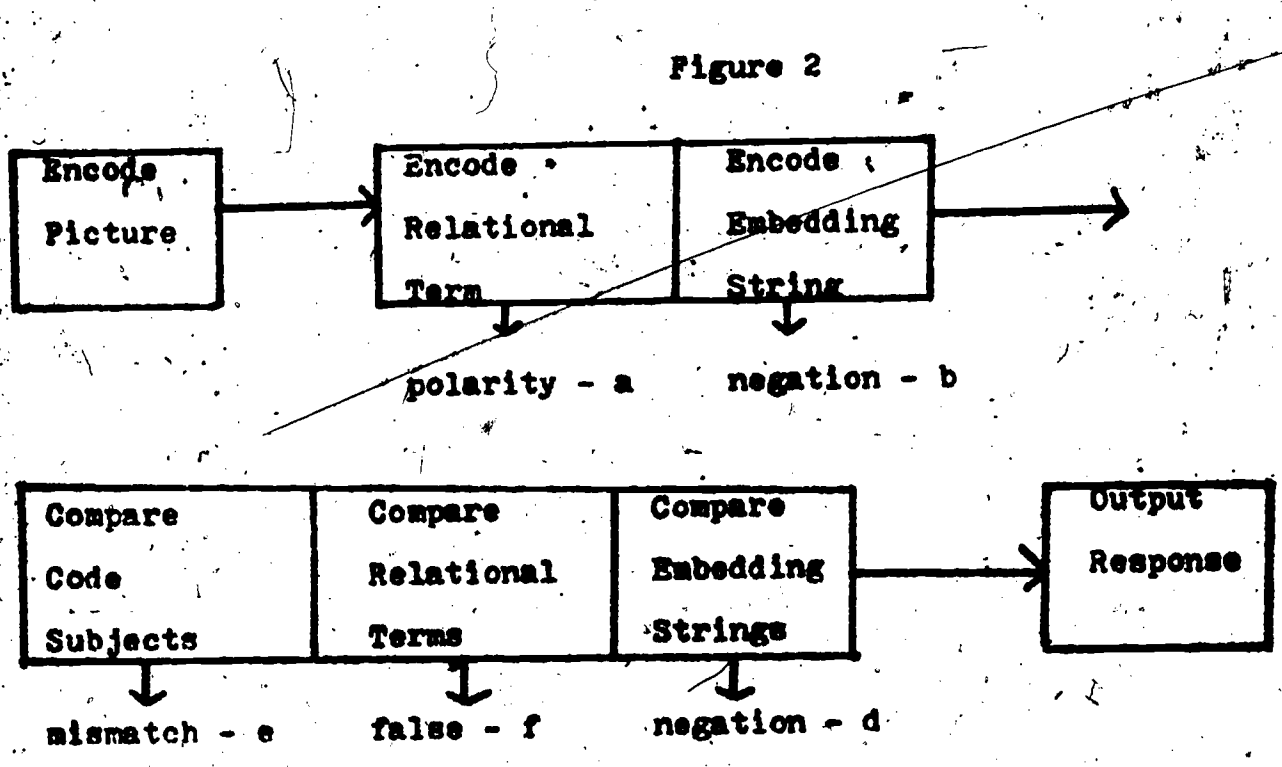

Above-Below
Higher-Lower
Rising-Falling
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
Neg
Aff
Pos
Neg
Pos
Neg
True
False

Figure 2


Encode Picture
Encode Relational Term
Encode Embedding String
polarity - a
negation - b
Compare Code Subjects
Compare Relational Terms
Compare Embedding Strings
Output Response
mismatch - e
false - f
negation - d