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SHORT NOTE

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NOTE ON THE ABSTRACTION OF LINGUISTIC IDEAS

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Tversky's (1977) feature matching theory of similarity is applied to the data of some experiments of Bransford and Franks (1971) to demonstrate that the concept of "wholistic semantic abstraction" is not necessary to explain the findings reported by these authors.

Bransford and Franks (1971) made a case for the abstraction of "wholistic linguistic ideas" from individual simple sentences. Their subjects were presented sets of sentences such as "the ants were in the kitchen", "the jelly was on the table", "the ants in the kitchen ate the jelly", "the ants ate the sweet jelly which was on the table", etc. Afterwards, recognition memory for old and new sentences was tested. In fact, the investigators used four simple sentences. From all possible combinations of these basic components, a subset was presented on acquisition.

The dependent variable was a combination of the recognition response (old or new) and the recognition confidence rated on a 5-point scale. The results were a. that this mean recognition score increased as a function of the number of components in the test sentence; and b. whether the test sentences were old or new had very little effect on the recognition ratings.

Bransford and Franks interprete this as evidence for the hypothesis that "Ss integrated the information communicated by sets of individual sentences to construct wholistic semantic ideas". (1971, p. 348).

This conclusion is controversial, as will be shown in the present note. Tversky's (1977) feature matching theory of similarity provides a useful frame of reference for this purpose. This theory proposes that objects consist of a number of features, and that similarity of two objects a and b, is an increasing function of the features common to a and b, and a decreasing function of the features that distinguish a from b and b from a. In the *contrast* model, similarity between a and b, $S(a,b)$, is defined by

$$S(a,b) = \theta f(A \cap B) - \alpha f(A - B) - \beta f(B - A), \quad (1)$$

where $f(x)$ is a function of the features contained in set x, A and B are the sets of features of stimuli a and b, and θ, α and β are constants greater or equal to zero. The *ratio* model defines the similarity by

$$S(a,b) = f(A \cap B)/[f(A \cap B) + \alpha f(A - B) + \beta f(B - A)], \quad (2)$$

where $\alpha, \beta \geq 0$.

In order to apply these models to the Bransford and Franks data, some additional assumptions are needed:

1. during the acquisition phase of the experiment, the sentences are stored in (episodic) memory;
2. each sentence is considered to be a collection of features. More specifically, it is assumed that the idea expressed in a simple sentence such as "the jelly was sweet" consists of one feature. More complex sentences contain several simple ideas, and are consequently composed of several features.
3. Recognition memory is based on the similarity between the test item and the memorized target, and the confidence rating is an increasing function of this similarity.
4. When a test item is similar to several stored targets, the probability of recognizing the test and the confidence rating increase. This is achieved by an additive combination of the similarities over the targets.

TAB. 1. MEAN RECOGNITION RATINGS OF BRANSFORD AND FRANKS (1971) DATA AND PREDICTIONS OF THE CONTRAST AND RATIO MODELS

	Bransford & Franks		Contrast model	Ratio model
	trial I	trial II	$\theta, \alpha, \beta = 1$	$\alpha, \beta = 1$
test items				
(c)	—2.73	—2.60	—8	1.16
(d)	0.20	—1.20	—8	1.33
(b d)	3.86	3.33	—6	2.08
(b, c)	—0.40	—1.06	—6	2.17
(c, d)	3.00	2.86	—6	2.25
(a, c, d)	3.86	3.40	—2	2.67
(a, b, c, d)	4.26	4.26	0	3.00

The contrast and the ratio models extended with these assumptions were applied to the recognition ratings of "idea set A" of the Bransford-Franks study—the only set for which detailed results were presented. In these experiments, the subjects ran through the recognition test twice. Table 1 displays the mean recognition ratings for all test patterns on both trials together with the predictions of the contrast and ratio model with $\theta = \alpha = \beta = 1$.

The product-moment correlations between both models and the data are shown in Table 2. All four correlations are significant at the .05 level. Table 1 shows that there is some variability within the 1- and 2-feature test sets. Therefore, the data were grouped into four categories according to the number of components in the test sentence. The correlations between these grouped data and the models are still higher, and all are significant at the .05 level.

The correlations of the ratio model with the data are consistently higher than those of the contrast model, but this difference fails to reach statistical significance.

These analyses demonstrate that the data obtained by Bransford and

Franks (1971) can easily be explained by a simple memory model, without invoking a rather vague concept, such as "wholistic semantic abstraction". Because of the detailed assumptions made in this note, the simplicity of the memory model is possibly not obvious. It should be noted that the only critical assumption is that recognition memory is a function of the similarity between test and memory trace. All other assumptions were simplifications. The proposition that a simple idea is

TAB. 2. PRODUCT-MOMENT CORRELATIONS BETWEEN MODELS AND DATA

	Contrast model			Ratio model		
	r	t	p<	r	t	p<
Individual data points						
trial I	.729	2.38	.05	.824	3.25	.025
trial II	.771	2.71	.025	.853	3.66	.025
Grouped data points						
trial I	.926	3.46	.05	.992	10.84	.005
trial II	.938	3.84	.05	.998	19.85	.005

Note. The statistical tests are one-tailed. The t-statistic has respectively 5 and 2 degrees of freedom in the upper and lower half of the table.

a feature might appear rather unrealistic. For the present application, this is irrelevant, because it could also be assumed that a simple idea consists of $n > 1$ features. The results would be perfectly identical, as the f-values in equations (1) and (2) would all increase with the same amount, having the same net effect on the relations between the similarities, and hence, on the predicted recognition ratings.

Other values of the parameters θ, α, and β would probably lead to somewhat different predictions. Yet, the essential point is that with very simple and perhaps trivial assumptions the Bransford and Franks data are explainable without the notion of abstraction.

In other stimulus domains, such as geometric figures (Franks and Bransford, 1971), and random dot patterns (Posner and Keele, 1968; 1970) the same pattern of findings has been reported, and interpreted in terms of schema abstraction. Applied to these domains, the similarity model predicts the same pattern of results. Consequently, the general concept of abstraction would seem superfluous. Medin and Schaffer (1978) and Medin and Smith (1981) have, in fact, reported evidence to show that their notion of interactive similarity between test and memorized instances can account for the abstraction findings. An interesting point is that in both cases, some notion of similarity plays an important role.

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