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# The Sentence-Verification Paradigm: A Case Study of Two Conflicting Approaches to Individual Differences*

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The contrasting approaches of differential psychology and cognitive psychology to the same individual differences data are outlined. Using illustrative data from the Clark and Chase (1972) sentence-picture verification task, four loci of conflict between these two disciplines are identified. These areas of conflict center around issues of (1) theory versus measurement, (2) meaningfulness versus reliability, (3) linearity of relationships, and (4) discontinuities in performance. We conclude on the basis of observed incompatabilities that a simple derivation of differential psychology from cognitive psychology is not likely, but separate development of complementary theories may be possible.

Differential psychology deals with the description of relative individual performance. By adopting a pragmatic attitude toward theory development, differential psychologists have constructed an impressive array of useful measurement instruments. There has, however, been relatively little progress in our understanding of the processes by which individuals achieve the scores that they do. Cognitive psychology, on the other hand, deals with the process of human information handling. Quite sophisticated models have been developed for the analysis of performance in limited laboratory situations, said to represent prototypical cognitive acts. While this work has considerably advanced our understanding of the thinking process, it has not had great impact upon applied psychology. Indeed, Cronbach (1957) has decried the existence of the two disciplines of scientific psychology and has urged that they be reunited.

Within the last few years a number of people, including ourselves, have tried to respond to Cronbach's call. These efforts have taken two forms. We and other experimental psychologists have tried to apply the statistical procedures of the psychometrician to data gathered in laboratory situations, while psychometricians have tried to interpret their measures in terms of the theories of cognitive psychology (Carroll, 1976). Intermediate procedures have also been used

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(Sternberg, 1977). Such steps toward the reunification of the disciplines can be applauded as attempts to establish the basic unity of scientific psychology. Reunification would also be desirable for the practical reason that it would aid in establishing a scientific justification for gathering data that is often influential in important social and personal decision making.

The reunification movement implicitly assumes that there is a conceptual unity underlying the way that cognitive and differential psychologists approach the study of human thought processes. Any surface discrepancies in their procedures or their conclusions are believed to be due to an unfortunate historical divergence in their procedures for data collection, rather than any basic conceptual incompatability in their thinking about psychological data in general or about cognition in particular. Is it possible that this assumption is wrong? We have begun to suspect that it is. Hunt, MacLeod, and Lansman (1978) raised four issues that seem to indicate deep underlying conceptual differences between the differential and cognitive psychology approaches to thought. In this paper we shall illustrate the issues raised by Hunt et al. through the use of a detailed case study of how a single experimental paradigm from cognitive psychology has been applied to the study of individual differences.

## THE PARADIGM

Clark and Chase (1972) introduced the *sentence-verification task* as a procedure for studying comprehension, which is certainly a basic cognitive skill. In this task the subject is to verify or deny that simple sentences are descriptions of simple pictures. The sentences are of the form PLUS IS ABOVE STAR, STAR IS NOT ABOVE PLUS, etc. The pictures are simply pictures of a plus above a star ($\overset{+}{*}$) or a star above a plus ($\overset{*}{+}$). There are three versions of the paradigm. In the *sentence-first* procedure, the sentence is shown, read, and then replaced by the picture. The sequence of events is shown in Fig. 1. The dependent variable is the time required for the subject to examine the picture and verify that the sentence does indeed describe it. In the *picture-first* variation of the paradigm, the order of the picture and the sentence is reversed. In the *simultaneous* condition both picture and sentence are presented at the same time. The simultaneous condition is of interest to psychometricians because it can be used in "paper and pencil" testing, whereas the other procedures require individually timed presentations of stimuli and recording of responses. In the paper and pencil version of the simultaneous condition, the number of trials completed in a fixed time may be used to derive an estimate of the time per trial.

Clark and Chase justified the study of sentence verification on the grounds that the coordination of linguistic descriptions and nonlinguistic reality is a basic step in verbal cognition. One can hardly disagree. In addition, the task has several valuable features. From a methodological standpoint, one can focus upon a single dependent variable, reaction time, as a measure of linguistic information

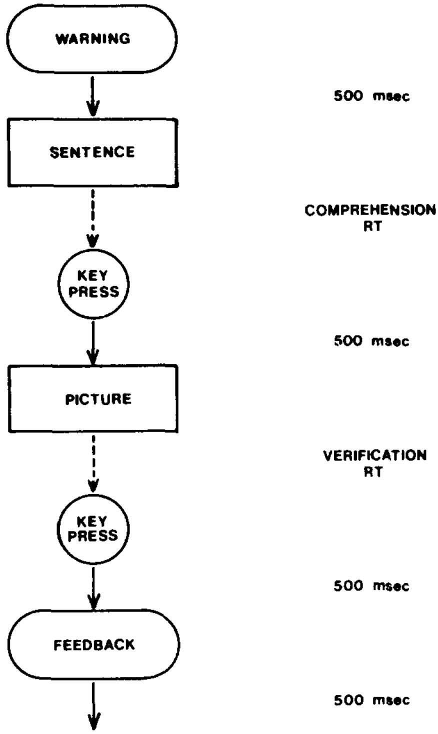


FIG. 1 The sequence of events in the sentence-first version of the sentence-picture verification task.

processing, for errors are seldom made. Moreover, the paradigm is reliable and the phenomenon it taps is robust. Since Clark and Chase's original study, many other investigators have found that reaction time does vary systematically with the linguistic complexity of the sentence (cf. the review in Carpenter & Just, 1975). Consequently, this task can be used to relate psychological complexity, as determined by reaction time, to linguistic complexity, as determined by a linguistic analysis of the sentence structure.

In an earlier related study, Baddeley (1968) found that the time required to verify sentences had a substantial correlation with performance on a much longer verbal aptitude test. We have verified his observation, using procedures more closely approximating the now standard sentence-verification task. We have found correlations ranging from .35 to .70 between sentence verification and verbal aptitude measures, even within the restricted range of talent found in a university student body (Lansman, 1978; Lansman & Hunt, 1978). Such results are of interest in differential psychology because the task is easy to administer and does not require any specialized knowledge beyond the ability to read very simple sentences. Thus, it is a face-valid candidate for culture fair testing of some aspects of verbal cognition for all high school graduates in an English speaking country.

Having completed this optimistic description of the task, let us turn to a less sanguine analysis of the conceptual and methodological issues raised when sentence verification is used as a tool in differential psychology. First, however, we want to stress that the sentence-verification task is only one of several paradigms that we could have chosen to make our points. In fact, we debated our choice of illustration at the outset of preparation of this paper. It is rather arbitrary that the issues we raise shall be demonstrated using sentence verification and verbal aptitude. We believe that the issues are relevant to the development of any experimental paradigm as a tool for any sort of differential psychology.

## INCOMPATIBILITY ISSUES

Two of the issues posed by Hunt et al. (1978) deal with the measurement and analysis of data. In our case study we shall deal with these issues first. We shall then deal with two issues that Hunt et al. concluded arose from differences about the concept of cognition and its distribution over individuals. In discussing each issue we shall use the same format for presentation. First, we will present an illustrative problem using the sentence-verification procedure, and then we shall make some comments intended to generalize the example.

### *Issue 1. Theoretical Specificity of Measurements*

By conventional standards of writing and conversation, none of the sentences used in a verification paradigm is difficult. It is hard to say anything very complicated about a picture of a plus above a star. Still, the various types of sentences do vary in their complexity. Figure 2 shows a propositional analysis of four types of sentence–picture combinations. Note that there are two sources of complexity in the comparison; whether or not the sentence is true and whether or not the sentence contains a negation. Only the latter source of variation is a strictly linguistic variable. It is well-known that sentence-verification time increases as the propositional complexity of the task increases. Several models of linguistic information processing have been proposed to account for this relation.

The most detailed linguistic model is the *constituent comparison* model due to Carpenter and Just (1975). Carpenter and Just assumed that the subject derives propositions from both the sentence and the picture, and then compares them to determine whether or not they are logically equivalent. The propositional form of the picture is presumed to be constant, whereas the propositional form of the sentence will vary with its linguistic structure, as shown in Fig. 2. The model is essentially an algorithm for comparing propositional representation in a particular manner, based upon the notion that each comparison requires a scan through the contents of short-term memory. The more complex the picture–sentence

| Trial Type | Number of Constituent Comparisons | Sentence | Picture | Sentence Representation | Picture Representation |
|---|---|---|---|---|---|
| TRUE AFFIRMATIVE (TA) | K | PLUS IS ABOVE STAR<br>STAR IS BELOW PLUS | +<br>* | [Aff,(PLUS,Top)] | (PLUS,Top) |
| FALSE AFFIRMATIVE (FA) | K+1 | STAR IS ABOVE PLUS<br>PLUS IS BELOW STAR | | [Aff,(STAR,Top)] | |
| TRUE NEGATIVE (TN) | K+5 | STAR IS NOT ABOVE PLUS<br>PLUS IS NOT BELOW STAR | | {Neg,[Aff,(STAR,Top)]} | |
| FALSE NEGATIVE (FN) | K+4 | PLUS IS NOT ABOVE STAR<br>STAR IS NOT BELOW PLUS | | {Neg,[Aff,(PLUS,Top)]} | |

FIG. 2 The sentence–picture stimulus pairs as a function of trial type, hypothetical representation, and number of constituent comparisons.

comparison, the more scans are required. If one accepts this model, it is possible to analyze the relationship between verification reaction times to the four different types of sentence–picture comparison (True Affirmative, False Affirmative, True Negative, False Negative) in order to derive a single parameter said to represent the time required to complete a single scan. Virtually any theory of language and thought would have to regard such a measure as a measure of an elementary process. Hence, measurement of scan time on an individual basis should tell us a great deal about a person's capacity for rapid verbal comprehension. On the other hand, as Carpenter and Just point out, other algorithms for scanning and comparing propositions are possible, and other algorithms would dictate other procedures for parameter estimation given the same data.

To apply sentence-verification data to the study of individual differences, then, one must take one of two approaches. One way to proceed is to regard sentence verification itself as primitive, and to study the correlation between some summary statistic describing sentence verification, such as the mean reaction time over trials, and other measures of psychological traits. This is the approach taken by Baddeley (1968) and Lansman (1978). This approach has the advantage of relying upon well-understood statistical procedures and of not depending upon the truth of any particular theory. It has the disadvantage of being limited to regarding sentence verification as a primitive to be accepted rather than to be described. The analysis of averages discards any information contained in the relations between subsets of the data, in this case, in the differences between individual reaction times as a function of sentence complexity. As we have indicated in discussing the constituent comparison model, it is possible to use this information to infer measures of the efficiency of short-term memory during linguistic comprehension.

MacLeod, Hunt, and Mathews (1978) took the more theoretical approach of using the constituent comparison model to make such an inference. They found a correlation of −.33 between verbal aptitude, as measured by an omnibus scholastic aptitude battery, and the scanning parameter of the Carpenter and Just model. One could use this information to draw the conclusion that there was a relation between "high verbal ability" and speed of information processing in short-term memory, which is an intuitively more interesting conclusion than the simple statement that people with high verbal aptitude are more rapid in sentence comprehension and verification. But this approach has its complementary pitfall. The conclusion is tied to acceptance of a particular theory. The constituent comparison model may be found wanting on the basis of research quite outside the individual differences field. (See, for instance, discussions by Tanenhaus, Carroll, and Bever, 1976; and by Catlin and Jones, 1976.) One is skating on thin ice when conclusions about differential psychology are drawn from correlational studies based upon model-specific parameters.

This is obviously a general problem. Given that one has observed performance on some cognitive task, one's most reliable summary is a statement about average performance. Such a statement sets a lower limit upon the primitiveness of one's conclusions about the task and its correlations with other measures. If one decides to go beyond a discussion of average performance by deriving parameters for a model of task performance, then one becomes committed to that model. If the model requires that more than one parameter be derived from the data, there is the additional technical problem that the same errors of measurement contaminate all parameter estimates. Conceptually, the problem is one of balancing between the value of obtaining a more basic explanation of a phenomenon and the risk of having an explanation that relies more heavily upon unproven assumptions. The idea of making such a tradeoff is certainly not a new one, but the assignment of numbers to the costs and benefits is not a simple task.

*Issue 2. Formal Meaningfulness and Statistical Reliability*

Suppes and Zinnes (1963) have observed that meaningful scientific statements must be invariant over equivalent ways of measuring one's results. To take a trivial example, the statement that dogs are heavier than cats should be true regardless of whether weight is to be stated in grams or pounds. It is equally important that statements be based upon reliable data. If two out of three physicians are said to prescribe brand X, we are interested in knowing whether the assertion is based on a sample of three or three hundred. Modern cognitive psychology has emphasized the importance of meaningfulness, whereas psychometrics has been concerned with reliability. Although these two goals are both valid, they may be in conflict.

To set the stage for an illustration of such a conflict, we describe part of a recently completed sentence-verification study in which we were interested in the use of a concurrent task as a measure of information-processing load (cf. Kahneman, 1973; Norman & Bobrow, 1975). The study used a sentence-first procedure, with the added feature that a tone was presented during some of the picture presentations. The exact sequence of events is shown in Fig. 3. The subject's task was to turn off the tone as soon as it sounded and then proceed with sentence verification.

As a preliminary to other analyses, we wished to know whether the processing of the tone resulted in interference with sentence–picture processing. Of course, we know that there will be some interference in responding, simply because the time to make a second response will typically be delayed by the making of a first response (Kantowitz, 1974). Is there also interference that is not related to response execution?

Following Anderson (1974), we have conducted a functional analysis of this situation. Let $I$(total) be the total information load in the situation, let $I$(comparison) be the information load imposed by the sentence–picture comparison, and

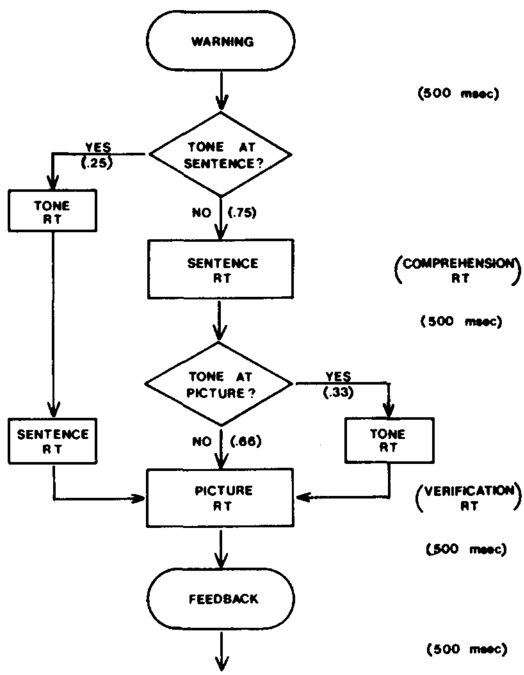


FIG. 3 The sequence of events in the version of the sentence–picture verification task using tones as a secondary task.

let $I$(tone) be the information load imposed by the tone. "Information load" is the psychological variable that we wish to study. If information loads from the two sources do not interact, then

$$I(\text{total}) = I(\text{comparison}) + I(\text{tone}). \tag{1}$$

Next consider the relationship between reaction time (which, unlike information load, is observable) and the experimental conditions. Applying Anderson's functional analysis technique, we conclude that if reaction time is a linear measure of information load, and if Eq. (1) is true, then there will be no interaction between comparison complexity and the presence or absence of a tone in determining reaction time. Note the conjunction in this statement; the scaling assumption is an inseparable part of the theory.

The top half of Table 1 presents the data, reaction times for the factorial experiment varying comparison complexity and tone present or absent. There is no interaction at all. This conclusion is based upon an analysis of variance of reaction times, which introduces a technical assumption that will become important later. The analysis of variance assumes that the underlying data are normally distributed within each condition of the experiment. However, reaction times are typically not normally distributed. In the particular application of the analysis of variance technique which we made, this was not of concern because, if anything, the result of deviations from the assumptions of normality and equality of variance is to increase the probability of a "statistically significant" $F$ test (Scheffé, 1959).

Now suppose that we wish to study the correlation between information load and some psychological trait, Y. Because the correlation coefficient is invariant

TABLE 1
Mean Verification Reaction Times and Verification Speeds for Trials with and without Tone Probes as a Function of Sentence-Picture Complexity

| Tone condition | Sentence complexity TA | FA | TN | FN |
|---|---|---|---|---|
| Reaction times | | | | |
| With | 931 | 1034 | 1254 | 1239 |
| Without | 591 | 718 | 858 | 915 |
| Difference | 340 | 316 | 396 | 324 |
| Speeds | | | | |
| With | 1.074 | .967 | .797 | .807 |
| Without | 1.692 | 1.392 | 1.166 | 1.093 |
| Difference | .618 | .425 | .369 | .286 |

over a linear transformation, it is clearly appropriate to consider the correlation between Y and verification reaction time. As Carroll (1978) has correctly pointed out, this raises a question about reliability, because the correlation coefficient is not a robust statistic when its distribution assumptions are relaxed. Indeed, it is unusually sensitive to the presence of outliers, and outliers frequently do occur in reaction time studies. The problem will be much worse if our eventual statement is to be about some derivative of the correlation matrix (e.g., a factor analysis), because the assumption of multivariate normal distributions for the basic variables will have been used quite strongly.

When this sort of problem appears in data analysis psychometricians generally recommend taking some nonlinear transformation of the original measures, in order to produce well-behaved distributions. In this case the obvious transformation to use is speed, the inverse of reaction time. Let us assume that this transformation does produce normally distributed data, so that correlation matrices based on speed can be regarded as reliable. We could then determine the linear components of the speed measure, in terms of some basic underlying traits derived from an analysis of the multivariate experiment.

But what would we have found the linear components of? The bottom half of Table 1 presents the transforms into speeds of those reaction times shown in the upper half of the table. The interaction is now significant, so either the two sources of information load do interact, or the speed measure is not a linear measure of information load, or both. We again suspect the correlation matrix, but this time because we cannot assign meaning to it even though we do not doubt its reliability.

Again we have a case of a specific example of a general problem. Suppose that we wish to study the covariation of two theoretical variables, $x$ and $y$. By appropriate experimental procedures, we justify two observable measures, $X$ and $Y$, that can be regarded as linear measures of $x$ and $y$. That is, we believe that

$$X = a + bx + e_x,$$
$$Y = c + dy + e_y, \qquad (2)$$

where $e_x$ and $e_y$ are errors of measurement. The correlation between the observables, $r(XY)$, establishes a lower bound upon the correlation of theoretical interest, $r(xy)$. There is no guarantee that $X$ and $Y$ will be bivariately normally distributed. Indeed, there is no guarantee that $e_x$ and $e_y$ will be normally distributed; whether they will or not depends upon the process model one assumes for generation of the overt measure. Therefore one cannot establish the reliability of $r(XY)$ or any linear transformation of it. On the other hand, one can assign meaning only to these measures.

We do not despair of ever seeing this problem solved. It should be possible to develop techniques to handle our simultaneous concerns for meaningfulness and reliability. Our point is simply that these techniques remain to be developed and widely used.

*Issue 3. Nonlinear Relationships*

The differential psychology view of cognition is that cognitive performance in any specific situation is due to an individual's position on some underlying trait. Thus, the probability of a person's choosing any of the possible responses to, say, a Raven Matrix test item, can be specified by stating that person's position on the trait that underlies performance on the item in question. The traits underlying specific performances are themselves considered to be derived from a set of basic traits. To continue the example, one might have a theory in which the trait underlying the Raven Matrix test was a linear combination of positions on more basic functions, such as spatial ability and logical reasoning. Letting $T_i$ be the position of person $i$ on the trait underlying the behavior observed, and letting $x_i$ and $y_i$ be that person's position on some basic traits $x$ and $y$, we have

$$T_i = ax_i + by_i. \quad (3)$$

Equation (3) implies that there is a complete tradeoff between talent on ability $x$ and talent on ability $y$, and deficiency in one can be compensated for by excess capacity on the other. This is foreign to a number of cognitive psychology models, which specify that some capacity must exist in a sufficient amount to ensure performance, but that once this capacity requirement has been met, excess capacity will exert no further effect on performance. It is also a consequence of Eq. (3) that the same relationship should exist between $T$ and $x$ (or $y$) throughout the range of $T$. (In practice, one would have to adjust for a drop in correlations due to restriction in the range of variation, but this is an easily handled technical problem.) A cognitive theory that depended upon the existence of minimum capacities would not make this assumption.

Hunt et al. (1978) refer to the assumption of Eq. (3) as the linearity assumption of differential psychology. We now illustrate its failure within a quite homogeneous and psychologically ubiquitous population—college students. Together with John Palmer, we have just completed a large study on the correlation between reading measures and information-processing measures in the college population. Our sample was carefully constructed to be a stratified sample of reading comprehension ability in the University of Washington student body. One of the tasks we used was sentence verification. Table 2 presents the correlation coefficients between mean sentence-verification reaction time and reading comprehension scores for the entire sample, and then for subjects who were either above or below the median in reading comprehension. If the linearity assumption holds, we would expect the correlations between sentence verification and reading comprehension to shrink slightly and uniformly as we moved from the large sample to the two subsets. Clearly, this is not what happens. One correlation shrinks and the other rises. Whatever the underlying traits for these measures are, the relation between them is different in the subsamples. Any correlation, and certainly any factor analysis, based upon the entire sample

TABLE 2
Correlations of WPC Reading Comprehension Scores with Mean Picture-Sentence Verification Times for All Subjects and for Two Subgroups, Good and Poor Readers

| Group | Number of subjects | Correlation ($r$) | Significance ($p$) |
|---|---|---|---|
| All | 91 | −.34 | <.001 |
| Good readers | 45 | −.52 | <.001 |
| Poor readers | 40 | −.05 | .37 |

would be misleading. Yet samples of university students are generally criticized for being too homogeneous to represent the real world.

Many, if not most, information-processing theories of cognitive processes regard performance as a nonlinear function of the primitive variables of the model. To the extent that such cognitive theories are correct, psychometric techniques and differential psychology theories that assume linearity are simply not relevant to the analysis of experimental data. This is not a technical problem in data analysis, as the meaningfulness–reliability paradox was. It represents a distinction between the two disciplines of scientific psychology in their concept of mental capacity itself.

*Issue 4. Discontinuities in Performance*

The nonlinearity issue deals with changes in the relations between variables that occur over the range of a particular behavior being studied. Hunt et al. observe that similar changes in relationships can occur because of qualitative changes in the way that different individuals approach cognitive tasks, or even because the same individual's approach may change from time to time. This effect can be demonstrated by considering the results of two experiments we have conducted in collaboration with Nancy Mathews.

These experiments used the sentence-verification paradigm described in Fig. 1. In the first study (MacLeod et al., 1978), we simply observed the strategies that people used to deal with the task. Two strategies were identified. The first was to read the sentence as it was presented, remember it in whatever form sentences are normally remembered, look at the picture, describe it, and compare the picture description to the sentence representation. We shall refer to this as the linguistic strategy. The second strategy was to read the sentence and, from this information, to form an image of the picture the sentence described. When the picture was presented it was compared directly to the subject's expectation. We shall call this the visual strategy.

We were able to identify subjects who had clear preferences for the one or the other strategy. (Some subjects are also capable of switching.) The best

TABLE 3
**Overall and Partial Correlations of Mean Sentence-Picture Verification Times with WPC Verbal and Spatial Ability Scores for the Subjects Who Were Well-Fit and Poorly-Fit by the Constituent Comparison Model**

| Group | WPC Verbal | WPC Spatial |
|---|---|---|
| Well-fit ($n = 43$) | −.52* | −.32 |
| Poorly-fit ($n = 16$) | −.33 | −.68* |
| | (Spatial partialed out) | (Verbal partialed out) |
| Well-fit | −.44* | .07 |
| Poorly-fit | −.05 | −.64* |

*Note:* Those correlations marked with an asterisk are significant beyond $p < .01$.

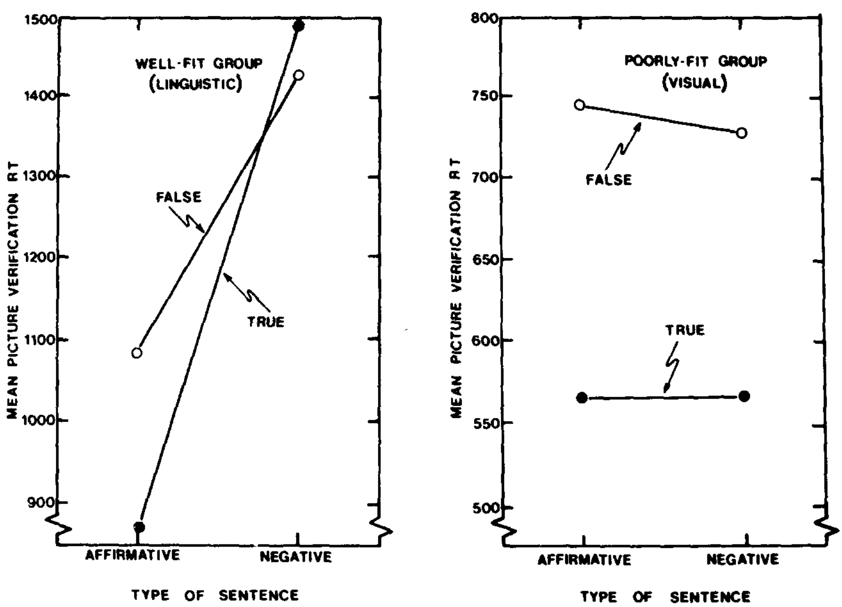


FIG. 4 Mean verification time as a function of the linguistic complexity of the sentence (affirmative vs. negative). The curve parameter is the truth value of the sentence–picture relationship (true vs. false). The left panel represents the Well-Fit group; the right panel represents the Poorly-Fit group.

psychometric predictor of verification reaction time for the subjects using the linguistic strategy was a measure of verbal aptitude, whereas the best psychometric predictor of performance for the visual strategy users was a spatial aptitude measure. The relevant correlations are shown in Table 3. We call attention especially to the partial correlations, as spatial and verbal aptitude are themselves correlated. Furthermore, our conclusions about different relations do not depend upon any assumption about the truth of a particular model of linguistic processing. To appreciate why this is true, consider Fig. 4, where verification reaction times are plotted as a function of group membership, the presence or absence of a linguistic variable (negation), and the presence or absence of a logical variable (truth value of the sentence as a description of the picture). The linguistic variable has an effect only for the users of the linguistic strategy.

A differential psychology theory might handle this data by asserting that choice of strategy is itself a trait that functions as a moderator variable. Strategy choice could then be entered into a linear model of behavior. Such a treatment could handle the MacLeod et al. (1978) results, but would have difficulty with our second experiment. In this study (not yet formally reported) subjects participated in six days of sentence-verification sessions. The first two days were replications of the first experiment, and were used to identify the subject's natural strategy choice. On the third and fourth day the subjects were instructed to use either the linguistic or visual strategies; on the fifth and sixth days they were instructed to change strategies. There was no extended training period; we simply described the strategies to the subjects and asked them to use the appropriate method. This proved remarkably easy to do. Figure 5 shows the data from a subject who initially chose the linguistic strategy, while Fig. 6 shows the corresponding data from a subject who initially preferred the visual strategy. The influence of linguistic complexity evidently appears to depend upon a rather casual choice of strategy.

According to an information-processing theory, performance on a cognitive task is the product of an interaction between knowledge possessed, elementary information-processing capacity, and one's choice of strategy for executing information-processing steps based upon knowledge. Some information-processing capacities may indeed be stable characteristics of an individual, others may be quite labile. The influence of a particular information-processing capacity upon task performance depends crucially upon the strategy used for task execution. Since strategy is a choice, there is no reason to assume that it is a stable characteristic of the individual. However, information-processing theories cannot be used to predict behavior unless task strategy can be specified.

## CONCLUDING COMMENTS

The sentence-verification paradigm has been used to illustrate four incompatabilities between the experimental and differential psychology approaches to

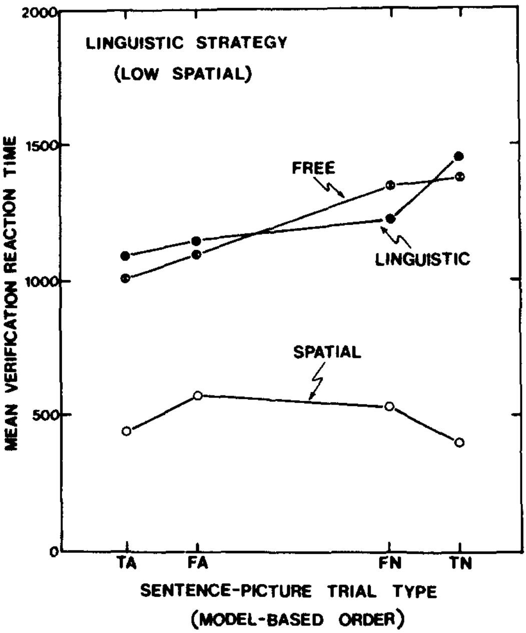


FIG. 5 Mean verification time as a function of sentence complexity for a subject using the linguistic strategy. The curve parameter represents the instructions given for each 2-day period.

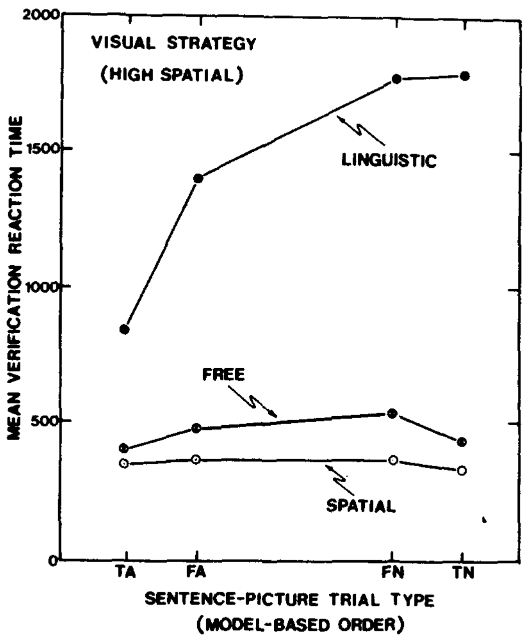


FIG. 6 Mean verification time as a function of sentence complexity for a subject using the visual strategy. The curve parameter represents the instructions given for each 2-day period.

the study of individual differences in cognition. We believe that these incompatabilities are basic ones. The differential psychologist seeks the underlying traits of intelligence. For the cognitive psychologist the concept of intelligence itself simply disappears, to be replaced by the specification of permanent and labile information-processing capacities and a library of available strategies.

Perhaps largely because of these differences in view about thought, the differential and cognitive psychologists have also developed different techniques for data analysis, and these techniques are bound to the theories that generated them. It is also obvious that the availability of particular data analysis procedures has had an effect upon theorizing, and this, too, has increased the incompatability between the disciplines of scientific psychology.

The fact that there are really two disciplines of scientific psychology does not mean that one of them is right and the other is wrong. Differential psychologists have dealt with the description and prediction of relative performance, a legitimate and important goal in both scientific and applied psychology. Certainly the concepts and techniques of differential psychology will continue to be useful in personnel selection procedures in education, government, and industry. They will also provide basic scientific constructs for use in theories aimed at a more global level of mental performance, e.g., in social psychology and anthropology. We also hope to see the development of a cognitive psychology of individual differences. Such a theory should be useful in relating mental performance to more reductionist scientific theories in such fields as physiology and genetics. Surely the variables studied in these sciences have their effect upon information-processing structures and processes rather than upon statistical abstractions such as traits.

In considering where one should use a differential or a cognitive approach, we would be inclined not to make a theoretical versus applied distinction. Instead, we would make a distinction between global versus reductionist views of mental performance, and the prediction of relative or absolute performance. Each of Cronbach's two disciplines seems to have its forte in different fields.

What, then, has happened to the reunification of the disciplines? The term "separate but equal" has been discredited in one field of human affairs. It is not wise to carry an analogy too far. Cultural pluralism may indeed be the appropriate course of action for the psychology of individual differences.

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