Cognitive Similarity

Attached is a paper I wrote many years ago--a condensation of my dissertation. I have only the vaguest feeling that it connects somehow with your thinking. If the first sentences below bore you, throw it away.

Suppose A, B, C, D, and E are stimuli (objects) that are perceived by two persons I_1 and I_2 as being characterized by various amounts of two properties, and suppose the two persons agree well enough on the proportions of the two properties characterizing each stimulus. Theh let the diagram (third page) show the placement of the five stimuli in a space spanned by the two properties.

Next, suppose the two persons have preferences among the five objects. Each person likes one object the most, another next most, and so on. Each person likes most the object that comes "closest" to his or her ideal object. Let I_1 and I_2 in the diagram mark the positions of the two ideal objects.

Now, to form a single rank order of preference, each person must "compose" the two-dimensional layout into a one-dimensional array. Suppose they both do that by putting a vector through the 2-space that represents the weighting each gives to the two properties. In the diagram, let the upper (steeper) vector be the "composition function" of I_1 and the lower (less steep) vector be that of I_2.

The rank order of preference for each person will be that of the rank order of <u>distances</u> from the projection of the ideal to the projections of the five objects. For I_1, the projection of A is closest to the projection of I_1, the projection of D is next closest, and so on to B, the projection

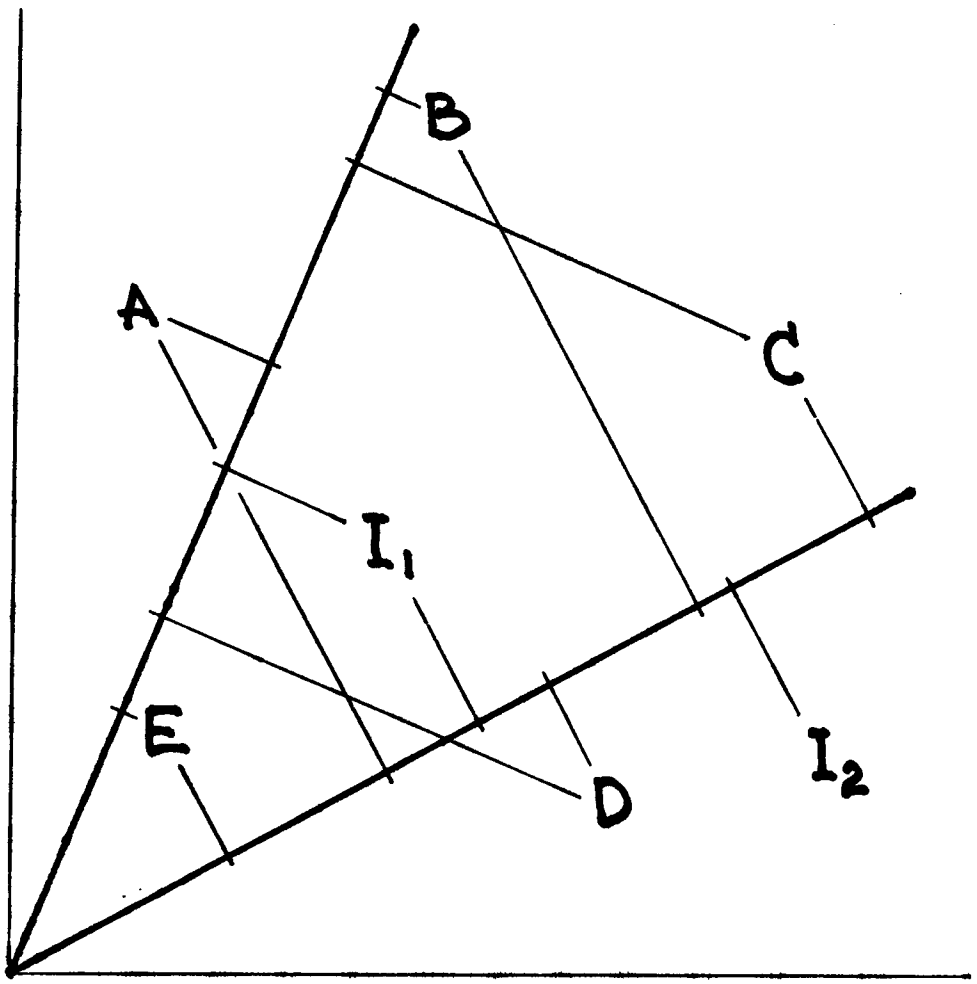
of which is farthest away from the ideal of I_1. The preference order of I_1 is ADECB. That is called a "folded" order, because you would find the projections in that order if you folded the paper along I_1's projection. Similarly, the rank order of preference for I_2 along the lower vector is BCDAE.

Now suppose you do not know the layout of the objects in the space. Suppose you have only the two preference orders. The question is: How can you tell whether those two folded orders might have been composed from the same composition function, or from two parallel (or almost parallel) composition functions? How can you tell whether it would be impossible for them to have come from parallel functions?

To illustrate and give a hint, I have also drawn the projections that would fall on the lower vector if I_1 were using <u>that</u> vector. Note that if I_1 is using the upper vector, the projection of C is closer to his ideal than the projection of B. But if I_1 is using the lower vector, it is the other way round: B is closer than C. Well, you can't have it both ways. So the diagram shows two functions that are not parallel (or co-linear, as I called it in 1956) in this sense. The unfolding theory of Coombs tells how to tell whether two rank orders will or will not "unfold" together.

The attached paper reports an application of unfolding.

At the time I wrote the paper, I neglected to look in the dictionary, where I would have discovered that what I called "co-linear" was properly spelled "collinear." Later, in his 1964 book, Coombs gave it a better label: "compatible."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Cognitive Similarity in Facilitating Communication[1]

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It has long been commonly observed that the meaning of any spoken phrase or any gesture depends upon the expectations within which it is embedded. Another way to say this is that the stimuli comprised by a communication impinge upon a set of potential responses belonging to the listener. This set of potential responses, being a limited selection of all human acts and being organized by a hierarchy of probabilities, must mediate every communicative process by presenting a framework, or mechanism, within which any communicated message will find its effect. It is this framework of potentialities upon which are engraved expectations of culture and role and the demands of the situation. In the terms of this framework any communication finds its resultant.

Clearly, an act of communication is itself a response. The possibilities of response are the possibilities of communication. The transmitter as well as the receiver of communication acts within a limiting framework. Using the term "cognitive field" to designate the possibilities of response, we may conceive the total communication process as an interaction between cognitive fields. The stimuli which impinge upon each field bring about alterations of response not only to the stimuli explicit in the situation but also to stimuli which are carried implicitly in the field; and further, the response which we see as communication arises not only from the stimuli offered by the other communicator, but also from the many stimuli implicitly associated in the cognitive field of the speaker and from the hierarchy of potential responses which organize them.

It follows from this view that communication cannot fruitfully be conceived as a sequence in which self-contained packets of information are exchanged. It is not a process in which one person merely adds to the belongings of another by "giving" him information. It is rather a kind of guessing game. Each person carries with him his cognitive field as a map of the world. He responds not to the world, but to the map. When he receives the stimulus of a communication, the meaning it has is the way it can be fitted into the map. When the communication fits readily, one's confidence in his map of the world is increased.

Since the effects of a communication depend on the manner in which

[1] This paper reports some of the findings of a dissertation (5) submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at the University of Michigan. Dr. T. M. Newcomb, particularly, is herewith thanked for his unflagging encouragement.

it "meshes" with an existing cognitive map, we might entertain the notion that these effects will take place more readily when the cognitive maps of the communicators are similar in structure. In fact, the general hypothesis of this paper is that *similarity of structure between two cognitive fields increases the efficacy of communication between them.* In its general form, this hypothesis is no doubt as old as communication. The contribution of this paper to the problems of communication lies not in the general terms of the problem chosen for study, but rather in the forms by means of which quantification has been applied to similarity of cognitive structure. In the present study, the particular index which furnishes operations for assessing similarity of cognitive structure is one which I have labeled "co-linearity" and which will be explained below.

THEORY

The theoretical framework supporting this investigation of the mediation of communication is a deliberate attempt to utilize in one consistent scheme Newcomb's (4) theory of communicative acts and some of the ideas of C. H. Coombs, particularly as the latter are represented in the monograph by Coombs and Kao (3). Because of space limitations, only those theoretical concepts necessary for explaining the experimental operations will be presented here.

We define an *orientation* toward a stimulus A as the set of all potential responses which the individual might at some moment make toward stimulus A or a set of stimuli containing stimulus A. There may at any moment be a number of possible respects in which the individual might respond to stimulus A. That is, there may be a number of *attributes* of stimulus A and the other stimuli in the situation which are relevant at that moment. These *relevant attributes* serve as reference vectors and define a multidimensional space within which the individual's potential responses to stimulus A are determined.

Although the space in which an orientation occurs may be multidimensional, the individual may simplify the interrelations of his judgments or potential responses by combining in some way the attributes of the objects to which he responds. By weighting or ordering the relevant attributes in some way, the individual can frequently put a number of stimuli into a simple (or linear) order. When an orientation involving a set of stimuli is so highly structured that the individual responds to the stimuli as if they were simply ordered, an important consequence is that *certain responses to the stimuli will be impossible* to him as long as he maintains the cognitive structure within which the simple order is defined. This assertion is not so complicated as it may sound, and illustrations are easy to find. Most men, for example, perceive the "fit" of clothing to correspond to the sizes

in which the clothing is manufactured. Suppose a man is trying on suits of sizes 36, 38, 40, 42, and 44. If he decides that size 42 fits him best, it would be impossible for him to report that the size 40 suit was a *worse* fit than the size 36.

But now the reader may object. "Is it inconceivable," he may ask, "that some man might be found who would give such an unusual opinion?" Let us put ourselves in the shoes of such an unusual fellow. We would feel, I believe, that he had found some characteristic or attribute of the suits which made it reasonable for him most to prefer the size 42, next the size 36, and least the size 40. Whatever this attribute might be, it would certainly be above and beyond the characteristics determining the usual order of the sizes. In other words, the response of our deviant would enable us no longer to interpret the preferences of individuals within the unidimensional space indicated by the simple ordering of sizes, but would require us to admit a multidimensional response space. This illustration points up the two parts of the assertion made earlier that the individual will find certain responses impossible *as long as he maintains a cognitive structure which puts a simple (unidimensional) order on the stimuli.*

Now let us suppose that person B is communicating with person A about a set of stimuli. Suppose that a clothing salesman is communicating with a customer about suits. "Try on this size 40," the salesman suggests. "Not quite right? Well, let's try a size 42. There, that looks just fine, doesn't it? You'd like to try a size 44? All right, here you are. Yes, I agree, this one is a little too large. The size 42 is just right for you."

Let us now ask the customer what the salesman would say about a size 38 or a size 36, or about a size 46 or a size 48. Obviously, the customer can predict very well what sizes the salesman would consider too small and too large. The point is that in providing the customer with an attribute in terms of which his judgments are being made, the salesman is giving the customer his opinions about stimuli which are not mentioned explicitly. From a sample of observed stimuli, the customer *gets information about other stimuli which can be judged according to the same attribute* as that underlying the judgments among the sampled stimuli. The important qualification here is that both communicators must be making their judgments, and interpreting the communication which occurs, according to the same attribute. If this is the case, each person can make correct predictions about responses the other would make to stimuli not yet communicated about explicitly.

But the customer might be purchasing a suit to wear to a fancy-dress ball, and the order of sizes might not be at all the order in which he judges how funny the suits are. If the customer with such a purpose does not let the salesman know what attribute is underlying his judgments, we can

only feel sorry for the salesman when we imagine the communication which might take place.

When two communicating individuals utilize the same underlying attribute in forming their judgments, we shall say that their orientations are *co-linear*. When they utilize attributes which would give at least some conflicting judgments, we shall say that their orientations are *non-co-linear*. These terms are chosen for their metaphorical reference to the unidimensional requirement and serve to suggest that the individuals are "on the same line" or "not on the same line," respectively.

CO-LINEARITY

The concepts so far presented have brought us to the point of being precise about a way of investigating the proposition that similarity of structure between two cognitive fields increases the efficacy of communication between them. If, in a multidimensional space, two individuals select the same attributes as relevant, they may then (or they may not) compose or weight these attributes so as to resolve their judgments into a simple order. If they do this, thus resolving a multidimensional space into a unidimensional, they may or may not do so similarly. The resulting simple orders, in brief, may or may not be co-linear. But if the two individuals do form orientations which are co-linear, then communication from one to the other transmits information about stimuli *in addition* to those stimuli which are explicitly mentioned in the communication as was illustrated earlier. We can now state our central hypothesis more precisely. We can assert that *communication about a sample of stimuli will convey more information about the stimuli from which the sample is drawn if the orientations of the communicators are co-linear, and less information if they are non-co-linear.*

The index of co-linearity used in the present research is built on the unfolding technique of Coombs (1, 2). In terms of the illustration of the customer looking for a suit, the preferences of most men in regard to fit would "unfold" into the order in which sizes fall. A man on the small side of size 42 might prefer five suits in the order of the sizes 42, 40, 44, 38, 36. And a man near size 36 might have the preference order 36, 38, 40, 42, 44. But we can call out both these orders because we are aware of the underlying attribute which organizes the preferences. There are some permutations of these five numbers which cannot be called off by standing in the shoes of a man of some one size and calling off the sizes in order of best fit to worst.

Orders of five stimuli which can unfold with A B C D E into *no* underlying order are given in Table 1. This table is used to compare the rank orders yielded by the responses of two subjects. Every rank order in the

TABLE 1

Co-linearity Table For Five Stimuli

Given two rank orders, re-label the stimuli of one order A B C D E, respectively. Then label each stimulus of the second order with the letter assigned to that stimulus in the first order. If the resulting second rank order appears below, the two given rank orders are *non-co-linear*.

A B E D C	C E D B A
A C E D B	D A C B E
A D C B E	D A C E B
A D C E B	D A E C B
A D E C B	D B C A E
A E B D C	D B C E A
A E C B D	D B E C A
A E C D B	D E A C B
A E D B C	D E B C A
A E D C B	E A B D C
B A E D C	E A C B D
B C E D A	E A C D B
B D C A E	E A D B C
B D C E A	E A D C B
B D E C A	E B A D C
B E A D C	E B C A D
B E C A D	E B C D A
B E C D A	E B D A C
B E D A C	E B D C A
B E D C A	E C A D B
C A E D B	E C B D A
C B E D A	E C D A B
C E A D B	E C D B A
C E B D A	E D A C B
C E D A B	E D B C A

table is non-co-linear with the rank order A B C D E. For five stimuli, there are fifty rank orders which are non-co-linear with any given order, and seventy which are co-linear.

PROCEDURES

Students in the introductory course in psychology at the University of Michigan were presented with five statements which could be seen as related to the content of the course but which were not assertions of the kind that would be made as a part of the material to be learned in the course or given as items on tests. The five statements used are these:

1. The conditions of living in the United States tend to narrow the range of things we are able to decide to do, think about, etc.

2. People who have a firm moral code are in general better adjusted than those who have not.

3. The biggest weakness of present-day psychology is that it is too theoretical.

4. Individuals could be changed in practically any way one might wish if the environment could be appropriately controlled.

5. The strongest influence in shaping a person into the kind of person he becomes, is his mother.

For reasons which will appear shortly, the Method of Rank Order was not used in collecting responses to these statements. The method used was the Method of Triads (2, p. 502). The statements were presented in groups of three, all ten of the possible combinations being used. The subject was instructed to mark, in each triad, the statement with which he *most* agreed and the statement with which he *least* agreed. Data were collected in this way from the classes of five teachers during the first week of the semester, and the identical procedure was repeated during the last week but one of the semester. The same questionnaire given to the students was also given to each of the five teachers. The preferences of teacher and student among the five statements were tallied, and a rank order inferred in each case where there was no evidence of a multidimensional response. Each teacher's rank order was then compared with the rank order given by each of his students by means of the co-linearity table, and the teacher-student pair was then categorized as co-linear or non-co-linear.

Since we have asserted that co-linear pairs of persons should exchange information more efficiently, and since quizzes on the course work can be taken as a measure of the degree to which the student has received the information which the teacher has given, we are ready to state hypotheses in operational terms. Since reliability or stability of a unidimensional orientation is one of the postulated requirements for a prediction based on co-linearity, two hypotheses will be advanced for testing, so that the results for each, when compared, will provide a check on the postulated effect of stability of the orientation.

Hypothesis 1: Among students who yield reliable rank orders of attitude items pertinent to the course, those who from pretest to posttest maintain rank orders co-linear with that of the instructor will receive higher grades on quizzes than those whose rank orders remain non-co-linear with that of the instructor.

Hypothesis 2: The difference in quiz grades predicted by Hypothesis 1 will be at least as pronounced when only those students are considered whose pretest and posttest rank orders are co-linear.

It is now appropriate to gather together a few loose threads; these will concern the selection of stimulus-statements for indexing co-linearity and the method of selecting stable and unidimensional responses from the responses obtained.

We have already mentioned that a direct sample of quiz material was

avoided in choosing the stimulus-statements for indexing co-linearity. Obviously, no elaborate theory would be required to predict quiz grades from a sample of quiz material. A further word, however, needs to be said about the way in which the stimulus-statements should be "related" to the content of the introductory psychology course. Briefly, the statements were chosen so as to "represent," in a special sense, the cognitive fields (or response spaces) which would mediate the communication between teacher and student. In order for a set of stimuli to be "representative," each statement should be multidimensional. That is, it should be possible for one subject to judge the statement on the basis of one attribute, and for another subject to judge the same statement on the basis of another attribute. With such stimuli, the order of preference given by the subject can reflect the attributes, and his weighting of them, which the subject brings to the stimulus situation.

To select a group of multidimensional statements, a long list of statements was first put together in which each statement, in the judgement of the experimenter, seemed interpretable from more than one viewpoint. These statements were then carried to a number of teachers of the introductory course in psychology, and each teacher was asked to state reasons which students might have for agreeing or disagreeing with the statements. The objective was to find a set of statements (a) which could be judged from a variety of reasons or viewpoints, and (b) could be discriminated from each other in regard to degree of agreement or disagreement with the statement. It will be seen that the search was for a highly heterogeneous set of items, rather than for a homogeneous set. The final selection rested on the judgments of the experimenter and the teachers. (A similar procedure was used in an earlier pilot study done with classes in zoology, which gave results substantially the same as those to be described here.) According to the theory, any set of stimulus-statements which was representative in the sense indicated, and discriminable, would have done as well as the set chosen.

We now turn to the method of selecting stable and unidimensional responses. The selection of subjects for whom co-linearity with the teacher was computed went through the following stages:

(1) Out of seven classes in introductory psychology (taught by five teachers), some students responded only to the pretest or only to the posttest. The number responding to both administrations of the questionnaire was 145.

(2) Of 145 subjects responding at both pretest and posttest, 15 gave responses at one time or the other which were intransitive, indicating that they were "unwilling" to compose the stimuli into a simple (or unidimensional) order. This left 130.

(3) The 130 transitive subjects gave responses which contained varying degrees of inconsistency. The Method of Triads presents each pair of stimuli to the subject three times when five stimuli are used. It is therefore possible for the subject to express a preference for stimulus A over stimulus B at one moment and for B over A at a later moment. If a subject is highly inconsistent, there is some ponderable possibility that the weight of his responses would have yielded an *intransitive* relation among the stimuli, had he responded a moment later than he did. In this sense, inconsistency may be interpreted as "uncertainty" on the part of the subject about putting a simple order on the stimuli. An arbitrary criterion was established at 70 per cent of the paired comparisons. Subjects who gave inconsistencies in 30 per cent or more of the pairs of stimuli were dropped from consideration. This removed 54 subjects, leaving 76. All five teachers gave transitive responses containing at least 80 per cent consistency.

(4) Hypothesis 1 makes explicit the next step in selection. Once the co-linearity index is applied to two rank orders, it provides in itself evidence for change of viewpoint between the two responses. (I shall frequently from here forward use the term "viewpoint" as a synonym for the cognitive structure underlying a rank ordering.) Subjects whose pretest responses were co-linear with the teacher's, but whose posttest responses were non-co-linear, or conversely, would have been exposed to one condition and then to the other in some unknown proportion and could not reliably be used to test the hypothesis. Using only those subjects who were co-linear with the teacher at both pretest and posttest, or non-co-linear at both, reduced the number of subjects by 34 of the 76, leaving 42. At this level of "purity," so to speak, I judged that the co-linearity index should be effective enough to separate sheep from goats.

(5) Hypothesis 2 specifies a further step in selection. If the co-linearity index is applied to the subject's own two responses, one at pretest and one at posttest, non-co-linearity "pre-to-post" would imply that the subject has changed his viewpoint in the interim, even though the viewpoints at both times are co-linear (or non-co-linear) with that of the teacher. Of the 42 students used in testing Hypothesis 1, 6 gave non-co-linear pre-to-post responses, leaving 36 subjects in the test of Hypothesis 2.

Quiz Grade z-Scores

Co-linearity, then, applied in the manner described, is the independent variable for Hypotheses 1 and 2. The dependent variable is the mean grade made by the subject on quizzes written and graded by his teacher. Within each of the seven classes, each quiz was given equal weight in the total score. In order to compare quiz grades across classes, z-scores were then

TABLE 2

Difference between Z-scores on Quizzes for Students Co-linear and Non-co-linear with the Instructor

	N	Z-scores		
		Mean	Range	S.D.
Co-linear with instructor	21	.51	−1.16 to 2.77	1.18
Non-co-linear with instructor	21	−.15	−2.56 to 1.74	1.18

TABLE 3

Difference between Z-scores on Quizzes for Students Co-linear and Non-co-linear with the Instructor, for Students Who Were Co-linear with Themselves from Pretest to Posttest

	N	Z-scores		
		Mean	Range	S.D.
Co-linear with instructor	17	.60	−1.16 to 2.77	1.38
Non-co-linear with instructor	19	−.25	−2.56 to 1.74	1.17

computed for each class. The z-scores were used as data in all further computations.

RESULTS FOR HYPOTHESIS 1

Dividing the 42 subjects used to test Hypothesis 1 into those co-linear with the instructor at both pretest and posttest (21 subjects) and those non-co-linear with the instructor at both tests (also 21 subjects) the finding is in the proper direction (t-test, satisfies $\alpha > .07$).[2] Statistics pertinent to this result are shown in Table 2.

Although this result would make acceptance of this hypothesis dubious by itself, it will be seen that this result is entirely consistent with the result of the test of Hypothesis 2, which reaches traditionally acceptable levels of significance.

RESULTS FOR HYPOTHESIS 2

Hypothesis 2 stated that the difference in quiz grades predicted by Hypothesis 1 will be at least as pronounced when only those students are considered whose pretest and posttest rank orders are co-linear.

In the test of Hypothesis 2, there were 17 subjects in the group co-linear with the instructor and 19 in the non-co-linear group. The t-test applied to the quiz scores of these two groups yields a significance level beyond .05. Statistics for this test are shown in Table 3.

[2] All probability figures in this paper are two-tailed probabilities.

It should be pointed out that the t-test is not entirely appropriate for testing these hypotheses. When the co-linearity index gives a value of non-co-linear, it may be said according to the theory that the subject could not, from any position on the attribute underlying his response, give a rank order of the stimuli which would unfold with that of the other person. But when the index gives a value of co-linear, the converse cannot be said. An index value of "co-linear" indicates only that it *cannot be said*, according to the theory, that the subject's viewpoint is *not* co-linear with that of the other person. It *may or may not* unfold with his. For this reason, a test of co-variation such as product-moment correlation, chi square, or the t-test demands more of the data than can be predicted.

For the reason that a test such as the t-test is treating the data more stringently than the prediction undertakes, the probability of .07 given by the t-test for Hypothesis 1 becomes more acceptable. As was suggested earlier, the result of Hypothesis 1, when compared to that for Hypothesis 2, argues for the correctness of the theoretical derivations, since it was expected on theoretical grounds that the criteria for the co-linearity index used in Hypothesis 2 would give better results than the less stringent criteria used in Hypothesis 1.

TESTS OF ALTERNATIVE HYPOTHESES

It will now be well to raise a few questions about the findings so far given. The first of these has to do with the effect of co-linearity, as contrasted with similar preferences among the stimuli on the part of teacher and student, in predicting mean grades.

Preferences among the Stimuli

It may occur to the reader to wonder whether it might be that the co-linearity index has picked out, among the data, co-linear rank orders which contain the same stimuli in preferred positions. That is, it might be that co-linear persons are those who agree that certain stimuli are *most preferable*. If this were the case, it might be argued that the theoretical derivations were unnecessary, and that agreement with the teacher on quiz answers was foreshadowed by agreement with the teacher on the choice of the most preferred among the five attitude statements.

The tau statistic, which measures rank order similarity, was used as a measure of the degree to which a student and his teacher chose the same stimulus-statements as best. Since the scatter-diagrams suggested that both the tau values and the quiz z-scores were distributed symmetrically, the product-moment correlation was computed between them. The correlation figure was .23 for 34 degrees of freedom, which is far short of a value at which the null hypothesis of no association could reasonably be rejected.

In short, the data fail to give evidence that quiz grades follow a preference for the same stimulus-statements preferred by the teacher. It is not agreement with the teacher on which statements are the best which makes the difference in quiz grades; rather it is judging the statements according to the *same underlying attribute*, regardless of whether the student agrees with the teacher about the most desirable point on the attribute.

Existence of an Attitude Norm

Another possibility which should be examined is that co-linearity with one's particular teacher is not the determining factor, but rather co-linearity with a *normative* ordering of the stimuli. That is, it might not be the interaction of cognitive fields of teacher and student which accounts for the difference in grade-achievement, but rather the sensitivity of the student to a more general "cultural" frame of reference which is merely mediated by the teacher. If this were the case, the data should show a tendency for mutual co-linearity among the responses of the teachers. That this is not the case is shown in Table 4. This table shows that while teachers 1 and 2 are co-linear, and teachers 3 and 4 are co-linear, neither 1 nor 2 is co-linear with either 3 or 4. This indicates that at least two incompatible viewpoints exist among the five teachers. A tendency toward a single viewpoint is not found.

Scholastic Aptitude

In any investigation where symbolic responses are being studied, the possibility can always be entertained that the performance of the subjects may be related to performance on some measure of symbolic skill such as a test of intelligence, scholastic aptitude, or scholastic achievement. If a relation were found between such an ability and the quiz z-score, the novelty of the present findings would be weakened to the extent that co-linearity with the instructor was not independent of the symbolic skill.

TABLE 4

Co-linearity of Viewpoint between Pairs of Teachers

Margins of the table show identification numbers of the teachers. Each cell shows whether the responses of the two indicated teachers are co-linear or non-co-linear.

2	3	4	5	
Co-lin.	Non-co.	Non-co.	Co-lin.	1
	Non-co.	Non-co.	Co-lin.	2
		Co-lin.	Non-co.	3
			Co-lin.	4

The American Council on Education test of scholastic aptitude seemed an appropriate measure with which to examine this possible relationship. A.C.E. scores were available for 100 of the subjects who responded both to pretest and posttest, including 26 of the 36 subjects used in testing Hypothesis 2.

A t-test was carried out to see whether the co-linearity index somehow selected groups which differed in A.C.E. scores. No difference was demonstrable between the group co-linear with the teacher and the group non-co-linear with the teacher in regard to mean A.C.E. score.

One would conclude from this result that members of the co-linear group were drawn from the same level of A.C.E. scores as members of the non-co-linear group. The difference in z-scores between the two groups can be attributed to the co-linearity condition and not to any difference in scholastic aptitude. To check whether scholastic aptitude could in any case have differentiated among quiz grades, A.C.E. scores for the 100 available cases were correlated with quiz grades, and a positive correlation of .42 was found, which is significant beyond the .05 level. The nonsignificant result of the t-test of the 26 cases in the co-linearity groups, nevertheless, argues that the co-linearity effect on quiz grades was not due to differential selection of scholastic ability.

In sum, it seems clear that the co-linearity index predicts a difference among quiz grades which is not attributable to the relation between A.C.E. scores and quiz grades, to response to an attribute norm, or to a preference for the stimulus-statements preferred by the teacher.

DISCUSSION

This research examines the relation between an interaction variable (co-linearity) and an individual variable (success in choosing "correct" answers in quizzes). It examines the effect on individual responses when a certain kind of "meshing" exists or does not exist between the viewpoints which shape the communicative acts of two or more persons.

In describing the intent and implications of this research it is important to make clear the structural difference between an interaction variable such as co-linearity (or deviation from a group norm, or certain kinds of power relations, to give other examples) and experimental variables which are constructed by comparing individuals on some specific attribute. Examples of the latter would be found in selecting pairs or groups of persons according to how they compared with each other on liking for dancing, years of education, authoritarianism, or some other particular attribute. A variable constructed in this fashion enables hypotheses to be made of this type: if individuals who are high (or low, or the same, or different) on attribute x are put in communication with each other, then these individuals will show certain behaviors rather than others.

An hypothesis concerning an interaction variable such as co-linearity has a different form: if individuals communicate on the basis of the same attribute x, regardless of what attribute it may be and regardless of whether the individuals are high, low, the same, or different on this attribute, then they will show certain behaviors rather than others.

In ascertaining co-linearity between pairs of persons in the present research no attempt was made to put a label on the attribute which two co-linear individuals used in common in organizing their responses to the stimuli. Nor was any attempt made to find out whether one co-linear teacher-pupil pair was responding according to the same attribute utilized by another co-linear teacher-pupil pair. The "content" of the attribute mediating the responses of any pair was unknown. Further, there was good evidence that some co-linear pairs must have been judging the stimuli on the basis of different attributes from other pairs, as indicated by Table 4. The predictions and analyses of this research were made with regard only to the *structural* similarity of orientations toward the stimuli as reflected in the co-linearity index, and without regard to the content character of the orientations, indeed without any knowledge of their content character.

Many investigations of social process require the study of communication, of the transmission of information, of the "understanding" of stimuli presented by some persons to others. The effects of this communication depend on the abilities of the individuals involved, and often upon the agreement or disagreement which exists between the communicators in regard to the content of the communication. But beyond these factors the present research argues that whatever the abilities of the individuals and whatever the extent of their agreement, the effects of the communication also depend on the structural similarity of the viewpoints which mediate "sending" and "receiving" in the communicative interaction.

SUMMARY

This paper has been concerned with the proposition that similarity of structure between two cognitive fields increases the efficacy of communication between them.

Communication or interaction between two persons is conceived as being mediated by the cognitive structure, or space of potential responses, associated with each individual. The response spaces, in turn, can be described in terms of the attributes which mediate the responses; that is, the attributes of the objects in respect to which the individual makes his responses. Further, an individual may combine the attributes mediating his responses into one composite attribute. This composite attribute is compounded in different ways by different individuals, and such a composite attribute underlying the responses of an individual permits some responses and precludes others. I have described criteria for deciding whether or not a com-

posite attribute can be inferred reliably to underlie the responses, and if so, whether or not the composite attributes being used by two communicating individuals might be permitting or precluding the same responses.

If responses of two individuals can be interpreted to be mediated by the same underlying attribute, the responses are termed "co-linear," and "non-co-linear" if they cannot. Computation of an index of co-linearity rests upon the "unfolding technique" of Coombs.

In these terms, we can index similarity of cognitive structure with the co-linearity index and put into more precise terms the proposition with which we began; namely, where changes in orientations occur as a result of communication, the changes will be more pronounced for co-linear communicating pairs and less pronounced for non-co-linear pairs.

This hypothesis was tested by presenting statements to teachers and students concerning the introductory course in psychology in which they interacted for the period of a semester. It was predicted that students co-linear with the teacher would get higher grades on quizzes than students non-co-linear with the teacher. This prediction was well supported by the results. Further examinations of the data provided evidence that the higher grades on the part of co-linear students could not be accounted for by differences in scholastic ability as measured by A.C.E. scores, nor by conformity to a common attitude norm, nor by a preference for the same attitude position as that held by the teacher.

The results of this research imply that differences in abilities between communicators and differences in agreement concerning the content of communication must fail to account for certain effects of communication which can be accounted for by similarity of cognitive structure between the communicators.

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