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S-R COMPATIBILITY: CORRESPONDENCE AMONG PAIRED ELEMENTS WITHIN STIMULUS AND RESPONSE CODES[1]

PAUL M. FITTS AND RICHARD L. DEININGER

The Ohio State University

The present paper is the second dealing with the usefulness of the concept of S-R compatibility for behavior theory. This concept concerns the effects of a class of variables that influence task difficulty in experiments in which learning, complexity (amount of information), and discriminability are controlled. Compatibility effects are conceived as resulting from hypothetical information transformation processes (encoding and/or decoding) that intervene between receptor and effector activity. The rate of processing information is assumed to be maximum when these recoding processes are at a minimum.

The objective of the study of compatibility effects is to discover conditions under which these effects occur, and to establish principles that will permit specification of the nature and difficulty of perceptual-motor tasks in terms of (hypothetical) intervening information transformation processes. Such processes must be inferred, just as do constructs such as habit strength, from measures of performance obtained in appropriate experiments. The type of experiment of greatest interest for the present purpose is one in which it is possible to measure the rate of information transfer as a function of (*a*) the choice of stimulus sets, (*b*) the choice of response sets, and (*c*) the method of combining the elements of stimulus and response sets to form S-R ensembles, and in particular to evaluate the interactions among these three variables.

The concept of intervening information transformation processes permits a reformulation of numerous problems that have stimulated a good deal of previous research. Among these are the problems of control-display relationships (**1, 5, 7, 9, 12, 13, 14, 15, 16**), the effects of stimulus-response reversals (**2, 6, 11**), and certain aspects of such classical problems as similarity and discriminability.

The results of the previous study in this series (**4**) supported the conclusion that the rate at which the perceptual-motor system can process information is a function, not so much of the characteristics of a particular set of stimuli or of a particular set of responses, but rather of the degree to which the sets of stimuli and responses form a congruent match. In the earlier study all stimuli and all responses were spatial in character, and all stimulus-response pairings were made to agree as closely as possible with population stereotypes. In the present study another S-R coding variable is investigated, the degree of congruence in the pairings of the elements within stimulus and response sets.

Specifically, the present experiment was planned to test the hypothesis that one of the conditions necessary for

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maximum S-R compatibility (i.e., for maximum rate of information processing) is that the pairings of stimulus and response elements agree with a strong population stereotype. Clearly, the concept of population stereotype is related to that of S-R compatibility. However, the two concepts are defined by independent operations—population stereotypes by determination of the relative frequency with which each permissible response is made to each stimulus in a situation in which *E* gives no indication of what is considered an appropriate response (**3**, p. 1306), and compatibility effects by determination of the relative rates of gain of information when *S*s must conform to particular stimulus and response coding conditions. In the present experiment three arbitrary levels of agreement with population stereotypes—maximum, mirrored, and random S-R pairings—were employed in forming S-R ensembles.

The present study was also designed to permit a further test of the compatibility effect examined in the previous study (**4**), namely, variation in the degree of compatibility as a function of correspondence of the dimensions employed in forming stimulus sets and response sets. Two types of stimuli, spatial (lights) and symbolic (numbers and letters), were matched with a single set of (spatial) responses, and it was hypothesized in this case that greater compatibility could be achieved by the use of spatial than by the use of symbolic stimuli. The response set employed in the present study was identical with one of the response coding sets employed previously and the results from the use of symbolic vs. spatial stimuli in the present instance are considered chiefly in relation to the earlier findings. The present design, using several stimulus sets, also permits an evaluation of a third compatibility effect, the interaction of stimulus sets per se with the method of assigning specific stimuli to specific responses.

METHOD

Apparatus.—A schematic drawing of the apparatus is shown in Fig. 1. At the start of each trial *S* placed a stylus, which he held in his preferred hand, in contact with a ⅛-in.–diameter metal button located at the intersection of eight pathways that radiated from this point like the spokes of a wheel. The angle between each pair of adjacent paths was 45°. At a signal *S* moved the stylus quickly in one of the eight directions. Reaction (decision) time was measured by a 1/100-sec. timer which started at the onset of the stimulus and stopped as soon as the stylus had been moved far enough to break contact with the metal button.

Four different sets of eight stimuli were matched with this single set of eight spatial responses. Figure 2 illustrates the four stimulus sets, and the various ways in which the elements of each set were paired with the responses to form S-R ensembles. Stimulus sets were selected to vary in their degree of physical and/or learned spatial correspondence with the response set.

The first stimulus set was composed of eight lights arranged in an octagon pattern around the periphery of an 8-in.–diameter circle. Each stimulus element corresponded spatially to the termination of one of the elements of the response set. This set of stimuli will be referred to as a

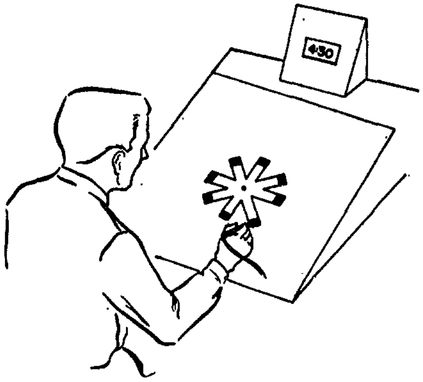

FIG. 1. Schematic drawing of the apparatus. The example shows a stimulus from the symbolic set and a response, down and to the right, which represents maximum S-R correspondence for this stimulus. (The stimulus numeral is not drawn to scale.)

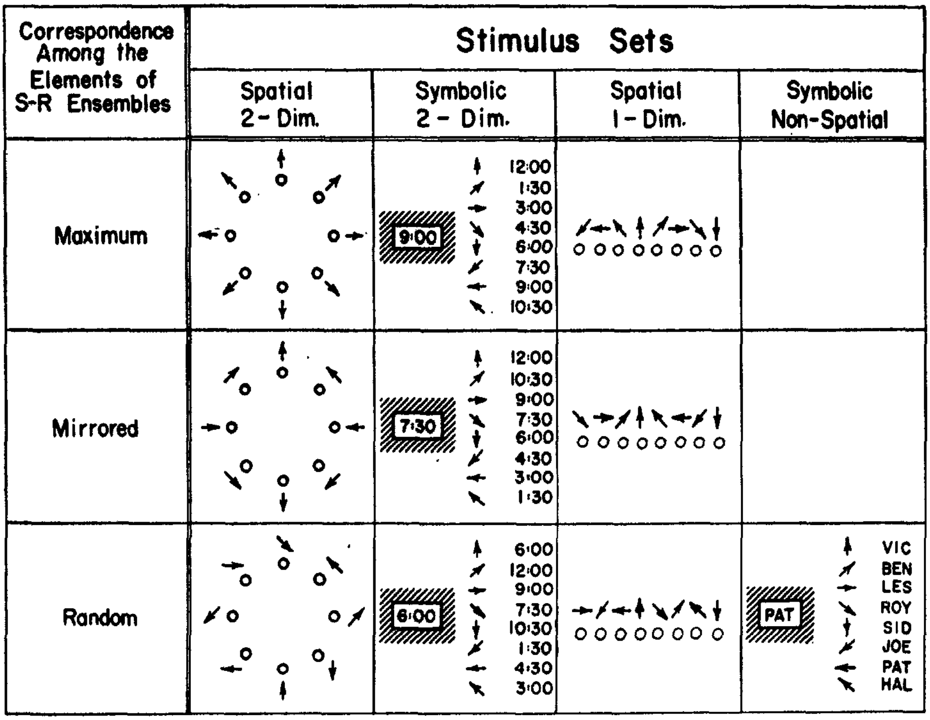

FIG. 2. The ten S-R ensembles investigated. The arrows indicate the directions of response movement designated by each stimulus. Response directions were different for each *S* in the case of random S-R pairing.

spatial two-dimensional set. It might also be called a pictorial stimulus set.

The second stimulus set, which had a learned correspondence to the response set, consisted of eight three- and four-digit numbers which were chosen to symbolize eight equally-spaced points around a clock face (1:30, 3:00, . . . 12:00). This will be referred to as a symbolic two-dimensional stimulus set.

The third stimulus set consisted of a horizontal row of eight lights spaced 1 in. apart. It will be referred to as a spatial one-dimensional stimulus set.

The fourth stimulus set consisted of eight three-letter first names. Familiar first names were used in preference to less meaningful stimuli in order to minimize stimulus differentiation learning. The set of names will be referred to as a symbolic nonspatial stimulus set since its elements are not ordered along a spatial dimension. Care was taken to make the elements of the third and fourth stimulus sets adequately legible, i.e., to minimize problems of discriminability.

In order to determine the effect of different S-R pairings (given the stimulus sets and the response set) the first three sets of stimuli were assigned to the response set in three different ways, as shown in Fig. 2. The first method of S-R mating maximized agreement with population stereotypes. Maximum correspondence of S-R pairs is unequivocal for the spatial and for the symbolic two-dimensional codes. However, in the case of the one-dimensional spatial code there is no strong population stereotype as to which two-dimensional response corresponds to each of the elements in the row of stimulus lights. On the basis of data from a preliminary investigation the procedure adopted was to assign responses in a clockwise order letting the light at the left end of the row signify a response in the 7:30 o'clock direction.

The second method of S-R mating consisted of reversing the left-right relations in the maximum correspondence ensemble while retaining the relations in the vertical dimension. This condition will be referred to as mirrored correspondence among S-R pairs.

The third method of S-R mating was random assignment of stimuli to responses. Different sets of eight randomly-matched pairs were used with each *S*.

Since first names are not ordered along any spatial dimension they were also assigned to responses at random, the order being different for each *S*. Random assignment was the only method of mating studied with this stimulus set.

Light stimuli were presented to *S* by means of switches at *E*'s console. The other stimuli (numbers and names) were presented by opening a shutter behind a 1-in. aperture in the panel facing *S*. The selection of a stimulus to appear in the aperture, and the opening of the shutter, was accomplished by remote control from *E*'s console. Reaction time was measured from either the onset of the light or the opening of the shutter.

The stimulus panel was located 28 in. away from and 15° below *S*'s eyes, and perpendicular to his line of sight. The response panel was located on the tilted surface of a table in a comfortable position in front of *S*. A movement of the stylus toward *S* was the appropriate response to a stimulus in the 6 o'clock position. Such a movement agrees with the population stereotype for this situation.

Subjects.—One hundred volunteer college students served as *S*s. They were scheduled in pairs of the same sex, and were assigned to one of the ten experimental groups by means of a table of random numbers, the only restrictions being that each group contain ten *S*s and the same proportion of men and women.

Procedure.—The nature of the task was explained briefly. Each *S* was then allowed to study a diagram indicating how stimuli had been assigned to responses in his learning task. After 1 min. the diagram was removed and *S* was asked to indicate the appropriate responses to each stimulus by drawing arrows on an answer sheet. One-minute study periods interspersed with test periods were continued until each *S* met a criterion of two successive errorless performances. Learning of the spatial and of the symbolic two-dimensional codes, with either optimum or mirrored S-R correspondence, seldom required extra sessions beyond the two necessary to meet the criterion. However, the randomly-assigned spatial one- and two-dimensional codes required 70% and 75% more trials, respectively, than the minimum number possible. The randomly-assigned symbolic codes (numbers and names) required only 30% and 15% more trials, respectively, than the minimum necessary to meet the criterion.

After the familiarization procedure was completed, appropriate instructions were read to each pair of *S*s. The instructions for the spatial two-dimensional stimuli are typical and were as follows:

"Hold the stylus in your preferred hand. When I say 'ready' place the point on this button and hold it there. Two to four seconds after I say 'ready' one of these eight lights will come on. Slide the stylus as quickly as you can along one of the paths in the direction indicated by the light. If you move to the wrong position the light will remain on, and you should correct your mistake as quickly as possible. When you have completed a correct response I shall turn out the stimulus light."

The *S*s were further instructed to emphasize accuracy rather than speed and to limit their errors to approximately 1 in 16 responses.

The *E* sat where he could observe *S*'s hand movements and recorded the direction of the initial movement and of any subsequent correction movements. Errors are defined as movements which were sufficiently large in amplitude to enter a wrong pathway (see Fig. 1). Since *S*s were trying to complete their responses as quickly as possible nearly all movements that were started in the wrong direction were of relatively large amplitude and were easily detected.

Each *S* served for two 1-hr. sessions on different days and was tested under one of ten experimental conditions. During each session he received 64 trials, 8 to each stimulus, or a total of 128 trials during the two days. Each *S* also observed his partner for an equal number of additional trials. Trials were given in blocks of 16 responses, the pair of *S*s alternating between observing and responding. At the end of each of these sequences *S* was told the number of errors and the accumulated reaction time for the 16 responses. All *S*s appeared to be well motivated.

Note that in all experimental groups amount of information per stimulus was held constant at 3 bits per stimulus event.

RESULTS

Reaction time and errors.—The means and *SD*'s of the pooled reaction time measures and the mean and median percentage of errors for each group are given in Table 1. Results for each of the two days as well as the combined data are included.

On both days the fastest mean reaction time and the fewest errors were recorded for the group using spatial two-dimensional stimuli (lights arranged in a circular pattern) mated with responses in such a way as to provide maximum agreement with population stereotypes. This is the only coding condition that maximizes both of the factors hypothesized to determine the degree of compatibility. The most errors, and the second slow-

TABLE 1

Summary of Reaction Time and Error Data
(Groups contained 10 *Ss*, each of whom made 64 responses per day for two days)

Condition	Reaction Time (Seconds)						Errors (Per Cent)					
	Day 1		Day 2		Combined		Day 1		Day 2		Combined	
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	Mdn.	Mean	Mdn.	Mean	Mdn.
Spatial 2-dim.												
Maximum corresp.	.421	.052	.354	.033	.387	.035	2.2	.8	1.6	.8	1.9	.8
Mirrored corresp.	.572	.085	.510	.081	.541	.069	5.5	5.6	3.3	2.8	4.4	3.9
Random corresp.	1.263	.186	.960	.120	1.111	.146	20.5	20.3	10.3	10.9	15.1	13.7
Symbolic 2-dim.												
Maximum corresp.	.707	.118	.644	.158	.675	.134	5.9	5.5	4.2	4.2	5.0	4.8
Mirrored corresp.	.844	.109	.709	.111	.777	.106	10.0	9.4	4.4	4.7	7.2	6.6
Random corresp.	.996	.337	.774	.121	.885	.218	12.1	10.9	7.8	7.8	10.0	8.6
Spatial 1-dim.												
Maximum corresp.	.853	.127	.733	.114	.793	.108	15.0	11.7	9.8	8.6	12.4	10.2
Mirrored corresp.	.928	.168	.748	.118	.838	.137	19.5	18.7	11.4	7.8	15.5	13.3
Random corresp.	1.339	.212	1.146	.311	1.242	.236	18.9	20.3	8.6	7.8	13.8	9.7
Symbolic nonspatial												
Random corresp.	.900	.150	.743	.134	.821	.129	14.2	12.5	9.7	10.1	11.9	9.4

est time, were recorded for the same two-dimensional spatial stimulus set, when random S-R pairing was employed. With this particular stimulus set mean reaction time was approximately three times as long and errors were approximately eight times as frequent for random as for maximum S-R pairing.

The symbolic two-dimensional stimulus code (clock numbers) with maximum S-R correspondence resulted in much slower reaction time and more errors than did the two-dimensional spatial code with either optimum or mirrored S-R correspondence. However, these relations were reversed for random S-R pairing of the latter stimulus set.

Improvement in reaction time from the first to the second day was small, but improvement in accuracy was rather large. For any given block of training trials, however, these two criteria agree closely in the rankings given to the ten coding conditions. For example, when all data are pooled over the two days the product-moment correlation between mean error scores and mean reaction time for the ten coding conditions was .84, which is significant at the $p < .01$ level of confidence. Since the reaction time measures are the more reliable, an analysis of variance was carried out on these scores for nine of the experimental conditions. The tenth condition, the symbolic nonspatial stimulus set with random S-R pairing, was not included in this analysis since it is not possible to achieve maximum or mirrored S-R correspondence with this set.

For the analysis of variance the conventional logarithmic transformation of the reaction time scores was made after the scores had been properly coded to avoid negative logarithms. Bartlett's test on the log scores supported the assumption of homogeneity. The results of the analysis are summarized in Table 2. The design employed for the analysis has been discussed elsewhere (**10**). Comparisons between experimental conditions are based on different groups of *S*s, but the test for learning is based on the same *S*s.

Although the effect of days was highly significant ($p < .01$) the absolute amount of improvement in speed from Day 1 to Day 2 was relatively small and there was no significant interaction between either experimental variable and days. The results therefore support the conclusion that compatibility effects do not change significantly with practice over two days. It should be noted that any transient learning effects that might have occurred during the first few trials on the first day are obscured by combining all the data for a given day.

An important finding with respect to the two main experimental variables was their highly significant interaction. This interaction apparently arises from the fact that the degree of compatibility of some S-R ensembles (those employing stimuli exhibiting a weak population stereotype) is affected only slightly by the method of assigning stimuli to responses, whereas the degree of compatibility characterizing other S-R ensembles (those exhibiting a strong population stereotype) is markedly affected by the method of forming S-R pairs. The latter, of course, are the stimulus coding sets for which maximum positive transfer or maximum interference effects would be expected. When tested using the interaction term, the method of pairing stimuli and responses was significant only at the .05 level of confidence. Since neither of the experimental conditions was introduced as a random variable, the latter finding cannot be generalized without reservation. In other words, random pairing of stimuli and responses in itself does not necessarily lead to poor performance—the effect depends on the strength of the population stereotype for a given stimulus coding set.

TABLE 2

SUMMARY OF ANALYSIS OF VARIANCE OF LOG REACTION TIME DATA FOR NINE OF THE EXPERIMENTAL CONDITIONS

Source	Sum of Squares	*df*	*F*†
Stimulus sets (C)	.981	2	2.75
S-R pairings (P)	1.988	2	5.57*
C×P Interaction	.714	4	16.38**
Residual (net between *S*s)	.882	81	
Learning (L)	.267	1	133.50**
C×L Interaction	.001	2	—
P×L Interaction	.009	2	2.25
C×P×L Interaction	.011	4	1.40
Residual (net within *S*s)	.078	81	
Total		179	

† The main effects (C and P) are tested using the C × P interaction term; the C × P interaction is tested using the residual (net between *S*s) term.

* $.05 > p > .01$.

** $p < .01$.

The preceding results are based on the mean reaction time for all eight elements in an S-R ensemble pooled. Mean reaction times were also computed for each S-R pair in each ensemble. There was somewhat less variability among the eight responses of the more compatible S-R ensembles than among those of the less compatible ones. The results agree with those of Garvey and Knowles (7). Among the ten experimental groups variability was greatest among the S-R pairs forming the one-dimensional spatial code. Reaction time for the two end elements of this set was consistently faster than for the centrally located elements under all three methods of S-R pairing. In terms of the present theoretical formulation this finding suggests that additional information transformation processes were involved in responding to the center lights.

Information analysis.—An analysis was made of the average amount of information transmitted per stimulus

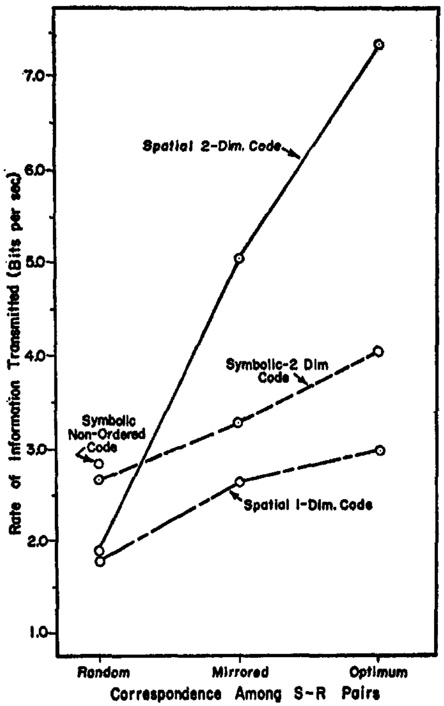

FIG. 3. Average rate of gain of information in bits per second for the ten experimental conditions, calculated from discrete reaction time and error data, pooled for all *Ss* in a group

by each of the ten experimental groups. The computations were made from frequency tables in which the errors for all *Ss* in a particular group were pooled. These tables were set up in a conventional manner for optimum and for mirrored pairings of the elements within S-R ensembles. However, in the case of the four groups using random S-R pairings (groups in which pairings were different for each *S*) the pooling of data obviously could not be made on the basis of identical stimuli. Instead, error frequencies were tabulated on the basis of the response that was designated by each stimulus. Thus, if one *S* had been trained to give a 12 o'clock response to the word *Vic*, and another *S* had been trained to give the same response to the word *Ben*, then these two stimulus words were considered equivalent.

After the pooled information transmitted per stimulus had been computed for each of the ten groups, these estimates were divided by the mean reaction time per response for that experimental group to obtain an estimate of the average rate of gain of information per stimulus for the different types of S-R ensembles. The results, shown graphically in Fig. 3, illustrate the magnitude of the interaction between coding dimension and method of pairing stimuli and responses. It should be noted that the present procedure may give a somewhat different estimate of the rate of information processing than that obtained from a serial task in which one stimulus follows another in rapid succession. However, computation of the rate of gain of information (8) is a useful way of combining speed and error data obtained in discrete response tasks.[2]

The lowest rate of gain of information, about 1.8 bits per second, occurred for the two sets of spatial stimuli with random S-R pairing. Random S-R pairings within the two symbolic stimulus sets (clock numbers and first names) gave considerably higher rate of gain of information than did random pairings within the two spatial stimulus sets. Unfortunately, no theoretical sampling distribution for these pooled estimates of information processing is available for testing directly the significance of the latter differences. However, an indirect test was made. Individual *t* tests were computed between the mean reaction times for the four groups. The results are shown in Table 3. The means for the two spatial (pic-

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[2] Following Hick's convention the term "rate of gain of information" is used when speed and error data from discrete responses are combined; the term "rate of transmission of information" is reserved for the serial or continuous response case.

torial) codes did not differ significantly from each other, and the means for the two symbolic codes did not differ significantly from each other. However, all comparisons between a symbolic and a spatial code were significantly different in favor of the former. The proportion of errors was also smaller for each of the symbolic than for either of the spatial codes. Since information rate is a function of these two variables (errors and time), it is reasonable to assume that the variation in rate of gain of information among the four groups is also significant. It can be stated with some confidence, therefore, that the interaction between coding sets and methods of forming S-R pairs, which appears as a reversal in the rate of gain of information for the pictorial and the symbolic two-dimensional codes when the method of S-R pairing is shifted from optimum to random, is a significant effect.

It is of interest to note that the differences between the symbolic and spatial codes, with random S-R pairing, were all in the same direction for the 1-min. preliminary learning trials as for the experiment proper.

The spatial one-dimensional code consistently led to a low rate of information transfer. As noted earlier, there is no strong population stereotype on which to base S-R pairings in this case.

TABLE 3

Summary of *t* Tests Between the Mean Log Reaction Times for the S-R Ensembles Composed of Randomly Mated S-R Pairs

Condition	Symbolic	Spatial	
	Nonspatial	2-Dim.	1-Dim.
Symbolic			
2-dimensional	.58	2.83*	3.61**
Nonspatial		4.60**	5.15**
Spatial			
2-dimensional			1.37

* .01 < *p* < .05, 18 *df.*
** *p* < .01, 18 *df.*

In the three instances studied mirrored S-R correspondence was intermediate in efficiency between the optimum and the random correspondence condition.

Discussion

The results of the present experiment support the assertion that the degree of S-R compatibility characterizing a perceptual-motor task depends not so much upon the particular set of stimuli nor upon the particular set of responses involved in the task as upon (*a*) the selection of congruent stimulus and response sets, and (*b*) the generation of congruent pairings of these stimulus and response elements in the formation of an S-R ensemble, i.e., the use of pairings that conform to population stereotypes. The finding of a significant interaction between these two variables provides evidence for a third compatibility effect, namely, that the greater the spatial correspondence of stimulus and response sets, the more detrimental the effect of noncongruent S-R pairings.

In regard to compatibility effects that result from the selection of stimulus and response sets, it must be kept in mind that the present experiment employed only one set of responses. It could therefore be argued that the variations in performance found for different stimulus sets could represent stimulus differences per se. Since the stimuli were sufficiently above threshold to be adequately visible and legible, however, such an argument is hardly tenable in view of the results of the previous study where it was shown that the best set of stimuli for one set of responses could become the worst set of stimuli with another set of responses. As an illustration, consider the row of eight lights, which was the worst of the sets of stimuli used in the present study. It can be argued that if the task had been to point to the light that was on, to push a key located under the light, or to move a joy stick to the right by an amount proportional to the distance from some reference point to the light, then this particular set of stimuli would have been superior to, say, the set of symbolic stimuli composed of first names. Although the data of the present experiment admittedly do not directly substantiate this argument, the authors prefer to make the theoretical interpretation that the difficulty met in responding to the row of lights in the present experiment was not due to lack of discriminability among the lights, in the conventional usage of that term (the lights were 1 in. apart and easily visible), but to some additional information transformation process (such as counting) that intervened between the occurrence of the stimulus and the appropriate response.

Compatibility effects are relatively large in magnitude when compared with either short-term learning effects or with the effects of variations in the amount of information per stimulus. For example, depending on the method of S-R pairing employed, the amount of information that was gained per second with the two-dimensional spatial code varied from a value (1.8 bits per second) which is slightly less than required to designate 1 from among 4 equally likely alternatives per second to a value (7.3 bits per second) equivalent to the designation of 1 from among about 160 alternatives per second. The differences attributable to changes in S-R pairing in the present experiment are comparable in magnitude to those found by Morin and Grant (13) when they introduced slight departures from direct spatial correspondence in assigning a row of stimulus lights to a row of response keys.

The authors would like to suggest that the concept of S-R compatibility might well replace such older concepts as meaningfulness and belongingness in specifying the conditions of motor learning. It may also prove useful in sharpening the definition of similarity (6). In studies of transfer effects, for example, it may be important to specify that the task to be learned is one for which there is no strong population stereotype, as was true of the task studied by Duncan (2). It may be even more important to specify that transfer is from a relatively compatible to a relatively incompatible task (as was true of the learning tasks studied by Morin and Grant [13] and by Lewis [11]), from one incompatible task to another, etc.

Compatibility effects also should be considered in measuring individual differences in perceptual-motor ability. Mitchell and Vince, for example, have suggested that "when performance is affected by a nonpreferred relationship, the task becomes one where the cognitive element plays a large part . . ." (12, p. 34). Although some widely-used psychomotor tests, such as the Two-Hand Coordination Test, employ incompatible S-R relations (14), the relation of this task characteristic to the abilities measured by such tests has not been stressed.

There are many obvious applications of the concept of compatibility to the design of tasks for most efficient learning and performance. In the present study, for example, the marked superiority of an optimal pictorial code over an optimal symbolic code for use with a set of spatial responses is of considerable practical and theoretical significance for human engineering.

Previous studies (4, 13) have shown that the efficiency of information processing varies among different S-R ensembles even after extensive training. The present experiment adds to this evidence the findings that results were stable over two days, and that a particular two-dimensional spatial stimulus was superior to a particular symbolic stimulus. The latter result is important because the difference occurs in spite of many years of experience and a strong population stereotype in interpreting the symbolic stimulus in spatial terms.

SUMMARY

An experiment was conducted to test the hypothesis that S-R compatibility is maximum when the pairings of stimulus and response elements in the formation of an S-R ensemble insure maximum agreement with population stereotypes. The experiment permitted a further test of the previously examined hypothesis that maximum S-R compatibility requires correspondence of stimulus sets and response sets in respect to the dimensions along which stimulus and response categories are selected, and also an evaluation of the interaction of the choice of stimulus sets with the method of S-R pairing.

Compatibility effects are conceived as arising

from an intervening information transformation process which is indicated by the statistical interactions of stimulus sets, response sets, and S-R mating procedures. The hypothesis was tested by analyzing the reaction times and errors of *S*s in a series of different experimental situations.

Ten groups, each containing ten randomly-assigned *S*s, were studied. Two spatial stimulus sets, a circle and a row of lights, and two symbolic stimulus sets, clock numbers and first names, were employed in forming S-R ensembles. Each of the stimulus sets contained eight alternatives. A single response set, composed of eight directional motor responses, was used for all groups. Stimuli were paired with responses in three ways, so as to provide maximum, mirrored, and random S-R correspondence (only random assignment was used with the set of first names).

The chief finding with regard to the two main experimental variables (choice of stimulus coding set and mating of S-R pairs) was their highly significant interaction. This finding and subsequent *t* tests support the original hypothesis. With either optimum or mirrored mating of S-R pairs the spatial two-dimensional ensemble was superior to all other groups. Performance was generally poor with random S-R mating, but significantly better performance was achieved in this case with the two symbolic coding sets than with either of the two spatial coding sets.

All groups were tested over two days. Improvement in reaction time between days was highly significant but of relatively small absolute magnitude, and there was no significant interaction between days and any of the experimental (compatibility) effects. Considered in relation to the performance differences between different coding procedures, and in the light of the finding from the previous study in this series, these results indicate that compatibility effects in perceptual-motor tasks are relatively large in comparison with effects produced by short-term learning or by changes in the number of alternatives (amount of information) relevant to each successive choice. The effects also appear to be relatively permanent.

Implications of the concept of compatibility for studies of transfer of training and individual differences are discussed.

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