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EFFECTS OF FIRST STAGE VARIATIONS OF STIMULUS MEANINGFULNESS
AND RESPONSE MEANINGFULNESS IN THE A-B, B-C, A-C PARADIGM

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Molander, B., and Garvill, J. Effects of first stage variations of stimulus meaningfulness and response meaningfulness in the A-B, B-C, A-C paradigm. Umeå Psychological Reports, No. 85, 1975. - With CVC-syllables as low meaningfulness material and common nouns as high meaningfulness material, two levels of stimulus meaningfulness and two levels of response meaningfulness were combined to form the four first stage conditions HH, LH, HL and LL in the A-B, B-C, A-C paradigm. The results of the experiment, which was performed according to standard PA learning procedures, indicated that stimulus meaningfulness as well as response meaningfulness contributed to the mediation effects in stage three. The mediation effects, however, seemed to be directly related to first stage performance rather than to meaningfulness per se. The results also suggested that intra-pair and intralist similarity may be important acquisition variables in studies on mediation.

Within the context of verbal mediation research studies of the effects of meaningfulness (M) have mainly been concerned with mediator M. In general it has been found that the mediation effect increases with increased M of the mediator (Horton, 1964; Kausler, 1966). This finding is consistent with results showing high M material to be more effective in producing mediation than low M material (Peterson, Colavita, Sheahan, III, & Blattner, 1964; Peterson, 1965; Popp & Voss, 1967). These studies give little information to what extent M of other items than the mediator contributes to the mediation effect. Two exceptions to this interest in mediator M can be seen in studies by Cooke, III and Blount (1969) and Richardson and Brown (1966). In the former study

association values of word pairs were varied in each of the three stages in the A-B, B-C, A-C paradigm and in the latter study stimulus M was varied in a A-B, A-D paradigm where B-C-D chains were selected from the Russell and Storms norms. However, no systematic variation of both stimulus M and mediator M was carried out in any of these studies.

On the other hand, in research on PA learning and transfer, the importance of both stimulus and response M has long been recognized (Cieutat, Stockwell & Noble, 1958; Kothurkar, 1963; Weaver, McCann & Wehr, 1970; Read & Scarlett, 1973) and recent formulations by Martin (1968, 1971) emphasize stimulus aspects even more than response aspects. Read and Scarlett (1973), for example, found that in a A-B, A-C paradigm the effect of stimulus M interacted with response M. An increase of stimulus M had no effect on transfer when low-M responses were used but yielded negative transfer when high-M responses were used. Since stimulus M evidently contributes to the transfer effect in the A-B, A-C case it should be of interest to know what the effect of this variable is in a mediation paradigm, especially in the simple chaining paradigm which is similar to the A-B, A-C paradigm except for the second stage.

The purpose of the present investigation, then, is to study the effects of stimulus M and response M on mediation in a A-B, B-C, A-C paradigm. Two levels of stimulus M (high and low) and two levels of response M (high and low) were combined to form the four condition HH, HL, LH and LL where the first letter designates A-terms and the second letter designates B-terms. A variation of response M is, of course, also a variation of mediator M. At the present time there are no precise theoretical formulations on verbal mediation from which the effects of stimulus M and response M in the different stages could be inferred. However, on the basis of the associative probability theory (Underwood & Schulz, 1960) some gross predictions can be made. According to this theory it would be expected that an increase of M of A or B, or both, increases the probability of there being already existing associations between those items. High M material should thus be learned faster than low M material. This reasoning does not differentiate between HL and LH conditions, but on empirical grounds it is expected that LH should be superior to HL

(Cieutat et al., 1958; Kothurkar, 1963). These results suggest that the meaningfulness of response terms are more important than the meaningfulness of stimulus terms in PA learning. In the first stage then, it is predicted that acquisition should occur in the order HH, LH, HL and LL.

In the present experiment A-B, B-C, A-C performance is compared with A-B, D-C, A-C performance. In the second stage it is thus expected that B-C groups should be inferior to D-C groups due to the possibility of interference of backward associations from the first stage (Jenkins & Foss, 1965; Horton & Kjeldergaard, 1961). Some recent experiments (Battig, 1966; Jung, 1963; Merikle & Battig, 1963) suggest that the magnitude of interference is related to the degree of meaningfulness. In general, interference will decrease when the meaningfulness of the material is decreased. Since those results refer to the A-B, A-C paradigm where forward associations are the source of interference, a similar although weaker trend is expected in the present case where backward associations interfere in the second stage.

As was pointed out above, several investigators have shown that mediation effects increase with increased meaningfulness of the material and with the meaningfulness of the mediator. The increased meaningfulness presumably strengthens the A-B-C chain, thus facilitating third stage performance. If A-terms in stage three tend to elicit B-terms implicitly as is suggested by recent experiments (Schulz, Liston & Weaver, 1968; Horton & Wiley, 1967) it seems reasonable to assume that the relative importance of the meaningfulness of the implicit B responses over the meaningfulness of the A stimuli is the same as in stage one. Thus, it is predicted that the mediation effects will decrease in the order HH, LH, HL and LL. In summary, the present considerations suggest that there is an inverse relation between stage one and stage two performance and a direct relation between stage one and stage three performance.

Method

Subjects. The subjects were 128 students from the university of Umeå. Fifty-two of these were students from introductory courses in psychology and served as subjects to fulfill a course requirement. The other subjects

were paid for their participation. None of the subjects had prior experience of this type of verbal experiment. The subjects were randomly assigned to eight conditions with the restriction that after every eighth subject all conditions had been assigned one subject. Since it was suspected that the psychology students were less naive visavi psychological experiments, those subjects were run as the last 52 subjects and according to the assignment procedure all conditions had about equal number of psychology students.

Design. In the simple chaining paradigm A-B, B-C, A-C, A-terms and B-terms were varied with respect to M. Two levels of stimulus M (low and high) and two levels of response M (low and high) were combined to produce the four different conditions HH, HL, LH and LL. The same four conditions were also produced for the control groups which followed the A-B, D-C, A-C paradigm. The eight conditions thus constituted a 2 (experimental groups vs. control groups) x 2 (high vs. low stimulus M) x 2 (high vs. low response M) factorial design. The eight groups consisted of 16 subjects each.

Materials. Common Swedish nouns constituted the high M materials. Due to a lack of Swedish M norms the nouns were obtained from a Swedish word frequency dictionary (Allén, 1970). From the word frequency range of 100 or more in a million words 18 nouns were selected with a frequency range of 132-304 and a mean of 185. Low association value CVC-syllables were selected as low M materials. The syllables were obtained from Epstein (1967) ranging 16% - 48% and with a mean of 31%. From the nouns and syllables thus selected A, B and D-terms were chosen in such a way that they were similar in range and means. It could be argued that this procedure does not assure a selection of items reasonably differing in levels of M and that high M and low M items are quantified by different operations. However, it seems highly unlikely that low association value CVC-syllables and high frequency nouns had shown similar values if such a common quantification had existed. Furthermore, in order to assess that differences between high M and low M materials really had been accomplished a free learning experiment was performed where two groups of subjects learned the two materials. There were 12 subjects in each group and the material was learned by the study and recall method for 12 trials. The results of this experiment showed that the nouns were significantly

easier to learn ($p < .05$) and that there were no significant differences between A, B and D-terms in either material. As C-terms the digits 1-6 were selected. All lists were thus made up of six stimulus-response pairs and for every list there were two different combinations of stimuli and responses. Half of the subjects received each combination.

Procedure. All subjects were tested individually and in all stages the PA anticipation procedure was used. The subjects were seated in front of a semitransparent screen on which the verbal material was projected by means of a carousel slide projector. The presentation times, controlled by a timer, were 2:2 and with an intertrial interval of 4 seconds. The same presentation times were used for all lists. Before the start of the experiment there was a training task in order to acquaint the subjects with the experimental situation. After information of the anticipation procedure the subjects learned to associate six adjective - adjective pairs for six trials. An one-way analysis of variance on the performance of this training task showed no significant differences among the eight groups.

After completion of the training task the subject was told that his task was to learn three different lists of verbal material and that each list consisted of six different pairs. He was also told that learning would go on to a criterion of two consecutive trials correct. No information was given on the relations between the lists. After completion of the first list the subjects was told that in learning the second list he was supposed to associate words to digits and that the digits were 1-6. However, anticipation of correct responses, that is digits, should be done from the very first trial. In other words, the subject was told to guess and if he made a wrong guess he was instructed to remember the correct response. In all other respects second list training was similar to first list training. Before learning the third list the subjects was told that this list too would consist of word-digit pairs and that he from the very first trial should try to give the correct responses. Training on the third list proceeded to a criterion of two trials correct with the restriction that at least ten trials should be given each subject. In all lists the presentation order of the paired associates was varied from

trial to trial. Whenever two groups learned the same list the presentation orders of the pairs were identical. The subject spent approximately one hour in the laboratory to accomplish the learning tasks.

Results

First-list learning. A three-way analysis of variance (ANOVA) applied to number of trials to criterion showed no difference between experimental and control groups within each condition, a significant effect of response M, $F(1, 120) = 6.72$, $p < .05$, and a significant stimulus M x response M interaction, $F(1, 120) = 23.03$, $p < .01$. When results were combined for experimental and control groups within each condition, the mean number of trials for LH, HL, HH and LL were 12.9, 15.6, 18.7 and 23.9 respectively. The ANOVA was also applied to the total number of correct responses during the first five trials. This analysis gave essentially the same results, e.g., no difference between experimental and control conditions, a significant effect of response M, $F(1, 120) = 57.33$, $p < .01$, and a significant stimulus M x response M interaction, $F(1, 120) = 23.03$, $p < .01$. With experimental and control groups combined the means for LH, HH, HL and LL were 13.4, 10.3, 8.2 and 4.1 respectively where HH and HL occurred in the reversed order compared to the trials to criterion measure. A Newman-Keuls test (Kirk, 1968) on both types of data showed that LH was significantly superior to HH, HL and LL and that LL was significantly inferior to HH and HL.

In Figure 1, where the mean number correct responses for combined experimental and control groups has been plotted against trials 1-5, it can be seen that there is a strong effect of response M, and as the stimulus M x response M interaction indicates, this effect is strongest in those conditions where stimulus M is low. Furthermore, stimulus M seems to have a positive effect when response M is low but a negative effect when response M is high. It was expected that the performance in stage one should occur in the order HH, LH, HL and LL and that the meaningfulness of the response terms should be more important than the stimulus terms. The present data confirm the expectation of strong response M influence and in addition it is shown that stimulus M interacts with

response M. These results thus replicate earlier findings (Cieutat, et al., 1958). However, the order in which the different learning material were acquired is not in agreement with the expectation and earlier reported results. Reasons for this deviation from general findings will be discussed later.

Fig. 1. Mean correct responses for combined experimental and control groups on trials 1-5 during first-list learning.

Second-list learning. In stage two the ANOVA performed on the trials to criterion measure showed a significant effect of response M, $F(1, 120) = 9.38, p < .01$. When B and D-terms are low M learning is faster than when these terms are high M. The usual finding of superior performance in D-C conditions versus B-C conditions was not replicated. When the ANOVA was applied to number of correct responses on the first five trials, the same pattern was found.

Since the two dependent measures seemed to be somewhat insensitive to second-list learning, performance on the second list relative the first list was calculated for each subject according to the formula $(FL - SL / SL + FL) \times 100$ where FL is first-list performance and SL second-list performance. The formula was applied to both number of correct

responses on the first five trials and the trials to criterion measure. The ANOVA was then applied to each of those two measures. Since the analyses yielded the same pattern, the results presented are restricted to number of correct responses. As in the analysis presented above, there was a significant effect of response M, $F(1, 120) = 61.87$, $p < .01$. This effect means that if response M is low in the first list, second-list learning is faster than if response M is high. The interaction between the experimental vs. control factor and stimulus M factor was found to be significant, $F(1, 120) = 4.37$, $p < .05$. This result indicates superior performance in control groups vs. experimental groups for those conditions where stimulus M is high in the first list and superior performance in experimental groups vs. control groups for those conditions where stimulus M is low in the first list. There was also a significant stimulus M $\times$ response M interaction, $F(1, 120) = 12.13$, $p < .01$, showing stimulus M to have an effect on second-list performance when response M is low. Specifically, low stimulus M is more effective than high stimulus M for low M responses. When response M is high, on the other hand, there is no significant effect of stimulus M. In Figure 2 the mean percent improvement of the second list for the different conditions are plotted.

Fig. 2. Mean percent improvement from first to second list separately calculated for experimental and control groups. The values are based on total correct responses on trials 1-5.

As can be seen from this figure the second list is learned faster than the first list in all conditions. This is of course not surprising since there should be general transfer effects and the second-list material is presumably easier initially than the first-list material. It should be noticed, however, that this second-list facilitation is an inverse function of first-list performance. It can also be seen that if the differences between experimental and control groups are examined, negative transfer is obtained in conditions HH and HL and positive transfer in conditions LH and LL. Calculated amount of transfer in percent yielded -9.9%, -9.7%, +4.8% and +11.9% for HH, HL, LH and LL respectively. Although the present results fail to support the expectation of inferior B-C performance in all conditions, they are in line with the expectation of a direct relationship between meaningfulness and interference. It is also evident from these results that the meaningfulness of first-list stimuli is an important contributor to the transfer effects in stage two.

Mediation. Third stage performance was analysed by application of a three-way ANOVA, where the three factors refer to first stage conditions. Analysis of the trials to criterion measure failed to show mediation effects or main effects of stimulus M or response M. However, a significant stimulus M x response M interaction was obtained, $F(1, 120) = 4.12, p < .05$. This interaction indicates that groups with high stimulus M and high response M in the first stage are inferior to groups with low stimulus M and high response M, and that groups with high stimulus M and low response M in the first stage are superior to groups with low stimulus M and low response M. Thus, the interaction is identical to the one found in first stage performance. Since trials to criterion is a rather insensitive measure of mediation effects, the ANOVA was also performed on two other dependent measures: number of correct responses on the first five trials and number of correct responses on the first two trials. For the first measure the analysis showed a significant effect of mediation, $F(1, 120) = 8.27, p < .01$, and a significant stimulus M x response M interaction, $F(1, 120) = 14.82, p < .01$. This interaction had the same pattern as the interaction obtained on the trials to criterion measure. The means and standard deviations on the first five trials for the eight groups are presented in Table 1.

Table 1. Mean total correct responses and standard deviations on trials 1-5 in stage three.

First stage condition	E		C		E-C	$\frac{E-C}{E+C} \times 100$
	M	s	M	s		
LH	21.3	2.21	18.0	4.40	3.3	8.4 %
HL	20.2	4.56	17.9	3.23	2.3	6.0 %
HH	18.0	3.48	16.0	4.10	2.0	5.9 %
LL	16.6	3.88	16.4	4.19	0.2	0.1 %

As can be seen in Table 1 the strongest mediation effect is obtained in the LH condition, the weakest effect in the LL condition and with HL and HH on an intermediate level. The performance in stage three thus seems to reflect the performance in stage one.

The analysis of number of correct responses on the first two trials yielded essentially the same results as well as a significant triple interaction, $F(1, 120) = 5.22$, $p < .05$. See Figure 3. A closer inspection of this interaction showed that the stimulus M x response M interaction was significant for experimental groups but nonsignificant for control groups although the pattern was the same.

Fig. 3. Mean total correct responses on trials 1-2 in stage three for experimental and control groups. Abbreviations in the figure refer to first-stage conditions.

Discussion

As the present results show, the meaningfulness of response terms is more important than the meaningfulness of stimulus terms in stage one performance. This result is in accordance with earlier findings and so is the obtained stimulus M x response M interaction. However, the order in which the different learning materials were acquired deviates from the predicted order and from what is generally found. A probable reason to this deviation is that low M items and high M items were selected from different classes of verbal material. Intrapair and intralist interference would thus be minimized in LH and HL conditions and to some extent interact with level of meaningfulness. The trials to criterion measure gives some support to this reasoning since it yielded the order LH, HL, HH and LL. It should also be noticed that in most investigations where the order HH, LH, HL and LL has been obtained, variations in levels of meaningfulness are based on the same

class of material. Cieutat, et al., (1958) and Kothurkar (1963) for example used dissyllables and L'Abate (1959) used CVC-syllables. In contrast, Kimble and Dufort (1955) who used dissyllables as stimuli and words as responses, reported LH to be superior to HH.

In stage two, analysis of the trials to criterion measure showed that when stimuli in the second list have low M, learning is faster than when stimuli have high M. The digits used as C-terms are presumably high M material and second-list learning would thus seem to follow the same pattern as first-list learning. When stimuli and responses are based on items from different classes of verbal material, learning is faster than when these items are based on similar classes of verbal material. As evident from inspection of Figure 2 the second list was learned faster than the first list in all conditions and this general facilitation is inversely related to first-list performance. This inverse relation could in part be explained by the above reasoning since LH and HH groups in stage two learn H-H material and HL and LL groups learn L-H material.

It is also well-known that stimulus learning and response learning are more important for low M material. Transfer from the first to the second list should thus be greater for low M conditions. The significant main effect of response M is consistent with this reasoning and so is the stimulus M x response M interaction. This interaction means that if stimuli in the first list are low M and responses low M then there is more transfer than if stimuli are high M and responses low M. When responses are high M there is no effect of stimulus M. It should be noticed that in the stimulus M x response M interaction obtained in first-list learning the effect of stimulus M was the opposite, that is to say, high M stimuli were more effective than low M stimuli when response M was low. It was expected that B-C groups should be inferior to D-C groups in stage two. This was also the case in those conditions where stimuli are high M in the first list, but in those conditions where stimuli are low M in the first list B-C groups were superior to D-C groups. These results are partly explained by differential interference from B-A backward associations. Under the assumption that C-terms can be considered high M material, there should be more interference when the implicit A-terms are high M

than when those terms are low M. This does not explain why there is a trend towards positive transfer in LH and LL conditions but it should be pointed out that this result is not entirely unique. Battig (1966) has reported data from an experiment by Merikle where it was shown that in the A-B, A-C paradigm HL and LL conditions produced positive transfer in the second list. It was also expected that the transfer effects in the second list should be a function of the meaningfulness of the material. As the calculated differences in percent transfer between experimental and control groups show this is the case and it may be suggested that although first-list performance is not directly dependent on degree of meaningfulness interference in the second-list is.

As expected mediation effects were obtained in stage three. As in earlier findings the present data show that mediation effects are stronger in conditions with high M material. It can be seen in Table 1 that the LL condition sharply deviates from the other conditions where stimuli and/or responses are high M. However, contrary to expectations, the mediation effects were not directly related to meaningfulness. Instead the effects seem to reflect first stage performance, and the obtained stimulus M x response M interaction shows the same pattern as the one obtained in the first stage. When stimuli are low M there is an effect of response M but when stimuli are high M there is no effect of response M. Similarly, there is an effect of stimulus M when response M is low but no effect when response M is high. Thus it seems that the mediation effects are more strongly related to first stage performance than to meaningfulness per se. To the extent that meaningfulness contributes to level of performance in the first stage it also contributes to the magnitude of the mediation effect. In contrast to recent research on verbal mediation, where the meaningfulness of the mediator has been emphasized, the present data point to the importance of stimulus meaningfulness. That stimulus meaningfulness as well as response meaningfulness are important contributors to the mediation effect is further supported by the obtained triple interaction which showed that the stimulus M x response M interaction was more pronounced for the experimental groups. It may also be pointed out, that there are surprisingly few studies where

the effects on mediation of acquisition variables other than meaningfulness have been investigated. The present results suggest that intra-pair and intralist similarity in the first list may be important variables.

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