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A NOTE ON THE RELATION BETWEEN CROSS-MODAL TRANSFER OF
LEARNING AND CROSS-MODAL MATCHING

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Garvill, J., and Molander, B. A note on the relation between cross-modal transfer of learning and cross-modal matching. Umeå Psychological Reports No. 126, 1977. - Cross-modal transfer of learning was studied in a paradigm that closely parallels the one used for studying intra-modal and cross-modal matching. The hypotheses that (1) the asymmetric transfer effects found in studies of cross-modal transfer of learning and in studies of intra-modal and cross-modal matching are compatible and (2) that they can be explained in terms of differences in information processing capacity between the visual and the tactual modality were tested. The results supported the hypotheses. It was also found that the amount of cross-modal transfer as well as the asymmetry of transfer are affected by letting the subjects practice the transfer task on each trial.

This experiment is concerned with the question of asymmetric transfer between the visual and tactual modalities and the seemingly contradictory results obtained in experiments on cross-modal matching and on cross-modal transfer of learning.

In the majority of the experiments on cross-modal matching the VT condition (visual presentation of standard stimulus, tactual presentation of comparison stimulus) has been found to be superior, or equal, to the TV condition (tactual presentation of standard stimulus, visual presentation of comparison stimulus). Thus, there is an asymmetric effect and performance is better for the modality order vision to touch over touch to vision (e.g., Lobb, 1965, Chashdan, 1968, Garvill & Molander, 1969, 1973, 1975, 1977; Goodnow, 1971, Fico & Brodsky, 1972; Abravanel, 1973, Friedes, 1975). In the experiments on cross-modal transfer of learning, on the other

hand, transfer from touch to vision has usually been found to be superior, or no difference has been found (e.g., Gaydos, 1956; Björkman, Garvill & Molander, 1965; Walk, 1965; Eastman, 1967; Garvill & Molander, 1968, 1971; Clark, Warm & Schumsky, 1972, Molander & Garvill, 1977).

There are, however, differences between the cross-modal matching paradigm and the cross-modal transfer of learning paradigm that might very well account for the differences in results. In the matching paradigm the performance in the two cross-modal conditions VT and TV are directly compared. This way of comparing transfer from vision to touch and vice versa do not take account of differences in information processing capacity between the modalities per se. In the cross-modal transfer of learning paradigm the amount of transfer from one modality to the other is expressed as a proportion of what is learned in the first modality, thus controlling for differences in capacity between the modalities.

There are also other differences between experiments on cross-modal matching and cross-modal transfer of learning which might influence the transfer. In cross-modal matching tests for transfer are made on each trial and the subjects are fully aware of the cross-modal requirements from the beginning. This procedure, which means that the subjects practice transfer of information from one modality to another on each trial could possibly affect the selection of information from the stimuli or affect the coding of the information or both. In experiments on cross-modal transfer of learning the subjects are usually not aware of the forthcoming transfer test and the transfer is tested only once.

The present experiment can be seen as a transition experiment between cross-modal matching and cross-modal transfer of learning. It is designed to study cross-modal transfer of learning with a procedure that parallels the one used in intra-modal and cross-modal matching. This is accomplished by using an alternate study and recall method for learning instead of the anticipation method

usually employed. The alternate study and recall method makes it possible to present the stimuli together with their labels for inspection in one modality and test for learning in the same modality or test for transfer in the other modality on each trial. This gives four modality conditions VV (visual inspection, visual test), TT (tactual inspection, tactual test), VT (visual inspection, tactual test) and TV (tactual inspection, visual test) which are the same modality conditions as those studied in experiments on intra-modal and cross-modal matching. The performance in these conditions can be compared in the same way as is done in the matching experiments. It is also possible to calculate the relative amount of cross-modal transfer of learning in each condition in the same way as is done in the transfer experiments.

In connection with experiments on intra-modal and cross-modal matching (Garvill, et al., 1973, 1975, 1977) we have argued that most of the effects obtained can be explained in terms of differences in information processing capacity between vision and touch. We have hypothesized that the visual modality can process more information, and probably also more complex information, than the tactual modality. We have also hypothesized a common storage for visually and tactually acquired information about form. This means that the visual modality can utilize more of the information acquired tactually than the tactual modality can of the information acquired visually. These hypotheses predicts that in this experiment the VV condition should be superior to the other conditions, VT, TV, and TT. Furthermore the VT condition should be superior, or at least equal, to the TV and TT conditions. The hypotheses also predict a greater amount of relative transfer from touch to vision than from vision to touch.

In the VT and TV conditions where the subjects are aware of the transfer tests, and in fact practice transfer on each trial, we could expect a higher amount of relative transfer in both directions than in the VV and TT conditions. That it is possible to affect the amount of relative transfer by informing the subjects

of the transfer test before the training has been shown by Björkman, et al., (1965).

In this experiment we thus expect to find the same effects as in intra-modal and cross-modal matching as well as the same effects as in cross-modal transfer of learning.

METHOD

Subjects. Eighty undergraduate psychology students from the University of Umeå served as subjects to fulfill a course requirement. The subjects were randomly assigned to eight groups of ten subjects each.

Material. As stimuli, seven three-dimensional "nonsense" ceramic objects were used. The stimuli were of the same kind as those used by Gibson (1963). They were all white, had the same weight and differed only in form. A drawing of one of the stimuli as well as of the experimental situation is provided in Garvill, et al., (1971). To each of the seven objects a number from 1 to 7 was randomly assigned. These numbers served as labels and the subjects were required to associate these labels with the stimuli and use them as responses.

Apparatus. During the experiment the subject was seated in front of a screen. When an object was presented in the tactual modality the subject put his hands under the screen and could explore the object without seeing it. During the visual presentations the objects were placed in the middle of a rotating disc behind the screen and at the same level as the upper edge of the screen i.e., at eye-level. The rate of rotation was one turn per five sec. The numbers assigned to the stimuli were presented from a tape recorder.

Procedure. The learning method in this experiment was alternate study and recall. Each trial consisted of two parts, one inspection (study) part and one test (recall) part. In the inspection

part each stimulus and the number assigned was presented for 5 sec. in a randomized order. After all the stimuli and their labels had been presented the test part of the trial began. Each stimulus was presented again for 5 sec. in a new presentation order and the subjects were required to respond with the number presented together with each stimulus in the inspection part. The subjects were not told whether their responses were correct or not. This procedure was repeated for each trial. The intertrial interval was 5 sec.

There were four modality conditions VV (visual inspection, visual test), TT (tactual inspection, tactual test), VT (visual inspection, tactual test) and TV (tactual inspection, visual test). There were two groups for each modality condition. One of the groups for each condition was trained to a criterion of at least 4 correct responses on 2 consecutive trials. After the training there were tests for cross-modal transfer in the VV and TT conditions. The test procedure was the same as in the test part in the preceding trials with the exception that the stimuli were presented in the tactual modality in the VV condition and in the visual modality in the TT condition and the subjects were required to respond as before. The subjects were not informed of this test before the training. In the VT and TV conditions there were tests for learning in the inspection modality after the training stage. That is, the stimuli were presented in the visual modality in the VT condition and in the tactual modality in the TV condition and the subjects were required to respond as before.

The other group for each modality condition was trained to a criterion of seven correct responses on one trial, i.e., to a criterion of 100% learning. In VV and TT conditions there were tests for cross-modal transfer after 4 and 7 trials respectively. The training was then continued to the criterion. In the VT and TV conditions there were tests for learning in the first modality after 4 and 7 trials respectively. Training was continued until the criterion had been reached.

RESULTS

The mean number of trials to criterion was calculated for each group. The results are shown for each modality condition and criterion in Table 1.

Table 1. Mean number of trials to the two criteria for each modality condition.

Criterion	Modality condition			
	W	TT	VT	TV
4 correct R on 2 trials	3.5	6.7	6.2	7.1
7 correct R on 1 trial	5.4	10.3	9.4	11.7

The number of trials to the lower criterion and the number of trials to the higher criterion for each modality condition were analyzed separately in a one-way analyses of variance. Both analyses yielded a significant effect of modality condition ($F = 3.88$, $df = 3/36$, $p < .05$ and $F = 7.29$, $df = 3/36$, $p < .01$ respectively). For both analyses Newman-Keuls tests showed that the W condition was superior to the other conditions VT, TV, and TT. No other differences were significant. As can be seen in Table 1 the groups where the tactual modality is involved either as inspection modality or as test modality or both require about twice as many trials to reach their criterion as the purely visual learning group.

It is also clear that the VT and TV conditions do not differ from each other nor from the TT condition. These results are congruent with those obtained in earlier studies of cross-modal transfer and in studies of intra-modal and cross-modal matching (e.g.,

Garvill, et al., 1968, 1973; Molander, et al., 1977). For each subject, the amount of cross-modal transfer was then calculated according to the formula: p_t/p_l where p_t is the proportion correct responses in the transfer modality and p_l the proportion correct responses in the learning modality with the restriction that no transfer value could exceed 1.0 or be negative. In the VV and TT conditions the p_l -value was the proportion correct responses on the last trial before the transfer test and the p_t -value the proportion correct responses on the transfer test. In the VT and TV conditions the p_l -value was the proportion correct responses on the test for learning and the p_t -value was the proportion correct responses on the last trial before the test. For a detailed discussion of this transfer measure see Björkman, et al., (1965) and Molander, et al., (1977).

Table 2. Mean proportion cross-modal transfer for each group.

Transfer measured	Modality condition			
	VV	TT	VT	TV
after criterion of 4 correct R on 2 trials	.57	.65	.80	.98
after 4 or 7 trials	.57	.70	.78	.89

The mean proportion of cross-modal transfer in each groups is shown in Table 2.

In the VV and VT conditions we have transfer from vision to touch and in the TT and TV conditions we have transfer from touch to vision. As can be seen in the table there is a greater amount of transfer in the TT condition than in the VV condition and a greater

amount of transfer in the TV condition than in the VT condition. That is, there is more transfer from touch to vision than from vision to touch. This result is congruent with earlier findings (e.g., Garvill et al., 1968; Molander et al., 1977). It can also be seen from Table 2 that the transfer values in the TV and VT conditions where the subjects have practiced transfer on each trial are higher than in the TT and VV conditions. Since the transfer values within each modality condition did not differ (students t-test, $p < .05$) the two groups for each condition were combined and the transfer values were subjected to a two-way analysis of variance with direction of transfer (vision to touch, VV and VT vs. touch to vision, TT and TV) and practice of transfer (no practice before transfer test, VV and TT vs. practice, VT and TV) as factors. The analysis confirmed the results in Table 2 in that we obtained a significant main effect of direction of transfer ($F = 5.16$, $df = 1/76$, $p < .05$) and a significant main effect of practice ($F = 19.50$, $df = 1/76$, $p < .01$).

DISCUSSION

The results in this experiment show that effects obtained in experiments on intra-modal and cross-modal matching and effects obtained in experiments on cross-modal transfer of learning are compatible and can be discussed in a common frame of reference. The results also support our hypothesis that most of the effects obtained can be explained in terms of differences in information processing capacity between vision and touch. The difference between the VV and the TT conditions shows the greater capacity of the visual modality. The difference between the VV and VT conditions and the lack of differences between the VT, TV, and TT conditions indicate that due to the lower capacity of the tactual modality all of the information acquired visually cannot be utilized in that modality. On the other hand, all or almost all, of the information acquired tactually can be utilized visually. Hence, there is relatively more transfer from touch to vision

than from vision to touch. This line of reasoning is also valid for the differences found in transfer values as a function of direction of transfer. This is in agreement with the conclusions by von Wright (1969) in his review of cross-modal transfer, that there is generally more transfer from the more difficult task, i.e., the less efficient modality, to the less difficult task, i.e., the more efficient modality, than vice versa.

The results in this experiment also show that it is possible to affect the amount of cross-modal transfer by letting the subjects practice the transfer task on each trial. It should also be pointed out that since the VT and TV conditions reach the criterion of 100% learning which in this case also means 100% cross-modal transfer the asymmetry is changed into symmetry. Whether these effects are due to a change in selection of information from the stimuli or in the coding of information or in both cannot be decided.

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