TRANSFER OF CONCEPTS AND GROUPING STRATEGY IN CHILDREN

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Transfer of learning on a conceptual sorting task was assessed to determine which element was critical in the transfer of children's sorting behavior when the similarity of the task formats was controlled. The elements assumed to have possibility of transfer were conceptual categories which function as mediators between instance and response and subject's response strategy to sort the instances on the basis of their concepts. The task formats remained constant in Experiment I and changed in Experiment II from training to shift task. The results showed that the amount of transfer, either positive or negative, depended on task similarity for the first graders whereas no similarity effect was significant for the fourth graders. While the first graders have acquired the grouping strategy specific to the relevant concepts during training, the fourth graders might have acquired the general grouping strategy which is applicable to various common concepts.

Many investigators of learning have used a discrimination shift paradigm to examine the contents of learning during the preshift task by inferring from the subject's postshift performances. They implicitly premised that what had been learned by a subject during the preshift task perfectly transferred to the postshift learning. When a subject did not learn the postshift task by the use of some kind of response element in the preshift task, he was regarded to have not learned that response element. This way of assumption appears to include some hasty judgement. An alternative explanation may be plausible. It may also be the case that the subject had actually acquired that response element but that he could not transfer it to his postshift learning.

To the best of the present author's knowledge, only few studies have been reported which examined the conditions of transfer in children. Recently Campione and Beaton (1972) conducted the following experiments to examine which aspects of the tasks affected the transfer of learning from one task to another. Preschool and kindergarten children were given a paired-associate task which consisted of their learning names for a set of four stimuli comprising a factorial combination of two colors and two forms (e.g., red T, blue T, red X, and blue X) or two sizes and two brightnesses. There were two responses available, and one of the dimensions was relevant and the other was irrelevant. For example, if color was relevant, the red T and the red X would be assigned one name and the blue T and the blue X the other name. After the subjects reached a certain criterion on this task, a transfer task was introduced. The transfer task was a two choice simultaneous discrimination with either color or form relevant and the remaining dimensions irrelevant and variable within trials.

Campione and Beaton constructed four different transfer groups. For one group, the training stimuli were retained in the
Transfer task and the relevant dimension remained the same. For the other three groups, new stimuli were introduced and the treatments corresponded to either intradimensional, extradimensional, or control shift. In the control shift group, the transfer stimuli differed along different dimensions from those of training. That is, the subjects in this group were trained on size and brightness and shifted to color and form. The results showed that there was no performance difference in the shift task among the four groups. It appeared that no transfer of the attentional response occurred when the task formats were different between training and shift problems.

However, there was no independent evidence within Campione and Beaton experiments to show that the subjects had in fact learned an attentional response to the relevant dimension initially. There was an alternative explanation for Campione and Beaton results that the subjects had not learned the attentional responses in the training task. To demonstrate that the attentional response was in fact originally learned and that the learned attentional response was not effectively transferred, they conducted the following experiment.

They trained the kindergarten children on a simultaneous or a successive discrimination task which was followed by either an intradimensional or an extradimensional shift of a simultaneous discrimination. Campione and Beaton assumed that if an attentional response transferred from one task to another even if the two tasks differed in their task format, the intradimensional shift task of successive discrimination should be learned faster than the extradimensional shift task of simultaneous discrimination as was the case in transfer between two simultaneous discrimination tasks. Their results showed that while the subjects both trained and shifted on simultaneous discrimination task formats learned the intradimensional shift significantly faster than the extradimensional shift, the subjects trained by a simultaneous and shifted to another task of successive discrimination format learned the intradimensional and the extradimensional shifts at almost the same rate. From these findings, Campione and Beaton concluded that the amount of transfer from one task to another varies with the similarity of the task formats.

Although Dickerson (1970) obtained similar results to Campione and Beaton, he found some transfer from a paired-associate task to a simultaneous discrimination. This discrepancy could be due to the use of the same stimuli in training and transfer in some conditions, and to his older subjects in Dickerson experiment.

To evaluate these possibilities, Campione (1973) trained the second and the fifth graders on either a simultaneous or a successive discrimination task and shifted to a simultaneous discrimination with new color and form cues. Half of the subjects in each task condition were given an intradimensional shift and the remaining subjects were given an extradimensional shift. The results showed a similar patterns of transfer for the second and the fifth graders and yet for the kindergarteners in Campione and Beaton (1972) experiment. Thus, Campione (1973) failed to obtain any developmental difference in the transfer of an attentional response.

Campione also attempted to investigate the suggested hypothesis from Dickerson's data that maintaining the training stimuli in transfer would increase the subject's probability to transfer. Second graders were trained on a successive discrimination with either the same or the different stimuli as were used in the training. Half of the subjects in each group were given an intradimensional shift and the remaining subjects were given an extradimensional shift. The results showed the similar trends as Dickerson that the intradimensional-extradimensional difference was reliable when the training sti-
multi were maintained, but fell short of significance when the training stimuli were changed in transfer. These data were nearly consistent with the contextual elements hypothesis (Campione & Brown, 1974) that discriminability of training and the transfer tasks results in no transfer of the attentional response learned initially. According to the contextual elements hypothesis, the amount of overlap between elements associated with a pair of tasks provides a definition of the similarity of the two tasks.

Considering the overall series of the above experiments, an inference may be drawn. That is, the task format provides more salient cues than do the stimuli, although both are the determinants of similarity.

The main purpose of the present study was to assess the transfer of learning on a conceptual sorting task and to determine which element was critical in the transfer of children's sorting behavior when the similarity of the task formats was controlled. The elements assumed to have possibility of transfer were conceptual categories which functioned as mediators between instances and their corresponding sorting responses and the subject's response strategy to sort the instances on the basis of their concepts.

The second purpose of the present study was to see if there is any age difference in transfer of learning. The first and the fourth graders served as the subjects. Even the younger children as the first graders have been confirmed to use the conceptual categories as mediators to learn the conceptual sorting task (Sugimura & Terao, 1976).

**Experiment I**

**Method**

**Subjects.** The subjects were 30 first graders (16 boys and 14 girls) and 30 fourth graders (15 boys and 15 girls). They were drawn from a public elementary school in Hiroshima City. Their ages ranged from 6:8 to 7:7 for the younger children and from 9:11 to 10:10 for the older children with means of 7:2 and 10:5, respectively. The subjects at each age level were equally divided into two groups and were assigned to one of two experimental conditions, same concept (SC) and different concept (DC) conditions.

**Materials.** A set of four colored pictures were used in the preshift task. Two of them were the instances of fruit (i.e., strawberry and a bunch of grapes) and the other two were of vegetable (i.e., carrot and cucumber). The two experimental conditions used the same materials in the preshift task. In the postshift tasks, these conditions used different sets of four instances each. The instances used in the SC condition were those which belonged to the same conceptual categories as those used in the preshift task (i.e., apple and banana for fruit and onion and cabbage for vegetable). The instances used in the DC condition were from different conceptual categories from those used in the preshift task. That is, the DC condition used a pigeon and a sparrow for bird and an ant and butterfly for insect. In addition, some cards with "chair" and "watch" were used for practice. Each picture was mounted on a 5.0×6.5 cm white card and a pack of 15 cards were prepared for each picture.

**Apparatus.** A 15×27×15 cm red box was used. Two slots were located side by side on the top of the sorting box.

**Procedure.** The subjects were run individually in a quiet room of their school. When a subject entered the room and was seated, he was shown some cards for practice and was given the following instruction.

"Let's play a card game. I have many cards here. Some of them have a picture of watch and the others have a picture of a chair. Here is a sorting box with two slots. I have already decided which cards should be put into the right or the left slot of this box. Now I will give you these cards one by one. Your task is to guess which is the correct slot for the card and to put it into the correct slot. When you put a card into the correct
slot I will say ‘Right’. If you are wrong, I will say ‘Wrong’. Try to get as many ‘Rights’ as you can. OK? Then let’s begin.”

In the practice trials, the cards were arranged in a random order so as to eliminate the subject’s irrelevant response habit such as position response. After confirming that the subject understood how to perform his task, the preshift task was introduced together with the following instruction. “You are very smart. Now let’s play with another set of cards. Try to get as many ‘Rights’ as possible.” The four instances for the preshift task were arranged randomly with a restriction that the same cards did not appear successively. The experimenter handed the subject these cards one by one and required him to put it into either of the two slots. For the first card the experimenter told the subject which was the correct slot for that card. The subjects were trained to put the cards with instances of fruit into the left slot and those of vegetable into the right slot of the sorting box.

About 30 sec after reaching a criterion of eight successive correct responses, the subject was given the postshift task. Again the subject was told the correct responses for the first card. The subjects in the SC condition were trained to put fruits into the left slot and vegetables into the right slot. The subjects in the DC condition were trained to put birds into the left and insects into the right slot. They were trained to reach the same criterion as before.

Results

Table 1 shows the means and the SDs of trials to criterion for the four groups. Because of some heterogeneity in distributions of the numbers of trials to criterion among groups ($F_{max}=16.67$, $df=8/14$, $p<.01$), a $\sqrt{X+0.5}$ transformation was performed and the transformed scores were further analyzed ($F_{max}=2.50$, ns.).

In order to see if there was any significant sampling bias in the two experimental conditions, a 2 (Grade: First and fourth)×2 (Condition: SC and DC) analysis of variance was conducted on their scores in the preshift task. A significant main effect of Grade was obtained ($F=11.92$, $df=1/56$, $p<.01$), revealing that the fourth graders learned the preshift task faster than the first graders. There was neither a significant main effect of Condition ($F<1$) nor significant interaction between Grade and Condition ($F=1.16$, $df=1/56$, ns.).

On the basis of these findings, further analyses were conducted for the first and the fourth graders separately.

$T$ tests were conducted for the postshift performances between the SC and the DC conditions. For the first graders, the subjects in the SC condition learned the postshift task significantly faster than those in the DC condition ($t=2.31$, $df=28$, $p<.05$). But for the fourth graders, the subjects in the two conditions did not differ significantly in their postshift performances ($t=1.58$).

$T$ tests were also conducted for the performance difference between the preshift and the postshift tasks for each group to assess the facilitating effect of experiencing the preshift task on learning the postshift task. The first graders in the SC
condition learned the postshift task significantly faster than the preshift task \(t = 2.81, df = 14, p < .02\), revealing the significant facilitating effect of the preshift learning. The fourth graders in the SC condition also learned the postshift task faster than the preshift task \(t = 2.50, df = 14, p < .05\). The first and the fourth graders in the DC condition did not learn the postshift task significantly faster than the preshift task \(t = 0.76\) and \(t = 0.21\), respectively. Although the two groups for each grade did not differ significantly in their performances on the postshift task, the \(\sqrt{X^2 + 0.5}\) transformed scores revealed a significant facilitating effect only for the SC condition of the first graders and not for the other groups. This may appear somewhat contradictory, but an analysis performed on their raw scores did not indicate any significant difference between the preshift and the postshift performances for the four graders in the SC condition \(t = 1.83\).

**Discussion**

The elements which were assumed to be learned during the preshift training were (a) the instrumental sorting responses to the individual instances, (b) the names of the relevant conceptual categories (i.e., fruit and vegetable), and (c) the general grouping strategy to sort on the basis of some kind of concepts. Of these three elements, the SC condition included the possibility of transfer of the names of the relevant conceptual categories and the general grouping strategy. On the other hand, the DC condition included the possibility of transfer of only the latter element.

The fact that the facilitative effect of learning was obtained only in the SC condition for the first graders indicates that children of this age can transfer their grouping strategy only when the names of the relevant conceptual categories remain the same. For the fourth graders, the significant facilitative effect was not found in either condition. In addition, there was no significant difference in the postshift performance between the two conditions. This suggests that the sameness of the names of the relevant conceptual categories in the preshift and the postshift tasks is not critical to the transfer of the grouping strategy for the fourth graders. Children of this age may be able to facilitate their learning if only the grouping strategy remains the same.

Considering the fact that their mean number of trials to criterion in the preshift task was rather small, it is reasonable to assume from the results that a floor effect appeared in the fourth graders' performances.

**Experiment II**

Experiment I failed to strictly assess the amount of positive transfer of children's grouping strategy because of the obtained floor effect in the fourth graders. The present experiment was designed to assess the negative transfer and the extinction of the grouping strategy as a function of similarity between the preshift and the postshift tasks. Children were trained on a conceptual sorting task and shifted to a half-conceptual sorting task which required them to extinguish their learned grouping strategy. It was assumed that the more the possibility of transfer the more difficult to it is extinguish it when necessary.

**Method**

**Subjects.** The subjects were 45 first graders (24 boys and 21 girls) and 45 fourth graders (23 boys and 22 girls). They were drawn from a public elementary school in Hiroshima City. Their ages ranged from 6:9 to 7:7 for the younger children and from 9:11 to 10:10 for the older children, with means of 7:3 and 10:5, respectively. The subjects at each age level were equally divided into three groups and were assigned to one of the three experimental conditions, same instance (SI), same
TABLE 2

Instances used for the preshift and the postshift in the three experimental conditions
(Experiment II)

<table>
<thead>
<tr>
<th></th>
<th>Same instance</th>
<th>Same concept</th>
<th>Different concept</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Left</td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>Preshift task</td>
<td>strawberry</td>
<td>carrot</td>
<td>strawberry</td>
</tr>
<tr>
<td></td>
<td>grapes</td>
<td>cucumber</td>
<td>grapes</td>
</tr>
<tr>
<td>Postshift task</td>
<td>strawberry</td>
<td>cucumber</td>
<td>apple</td>
</tr>
<tr>
<td></td>
<td>cucumber</td>
<td>grapes</td>
<td>cabbage</td>
</tr>
</tbody>
</table>

concept (SC), and different concept (DC) conditions.

Materials and apparatus. The same sets of four pictures of instances as in Experiment I were used in the present experiment. The sorting box was the same as that used in Experiment I.

Procedure. The subjects were run individually. Prior to the preshift learning, they were given the same instruction and the same practice trials as in Experiment I. After confirming that the subject understood how to perform his task, the preshift task was introduced. The subject was required to sort the instances and to try to get as many 'Rights' as possible. About 30 sec after reaching a criterion of eight successive correct responses, the subject was given the postshift task. For all three conditions the half-conceptual sorting tasks (HSTs) were provided as the postshift tasks. In the HST, half the number of instances of each conceptual category should be put into one of the two slots of the sorting box. For example, the subjects in the SI condition were required to put a strawberry (fruit) and a cucumber (vegetable) into the left slot and to put a bunch of grapes (fruit) and a carrot (vegetable) into the right slot of the sorting box. The tasks used in the present experiment are shown in Table 2. Again in the postshift task, the subject was trained with verbal feedback by the experimenter to reach a criterion of eight successive correct responses.

Results

The means and the SDs of the numbers of trials to criterion in the six groups are shown in Table 3. As the distributions of the numbers of trials for the six groups were not homogeneous ($F_{max}=22.70, df=12/14, p<.01$), a $\sqrt{X}+0.5$ transformation was performed and the transformed scores were further analyzed ($F_{max}=3.15, df=12/14, ns$).

In order to assess the homogeneity among the six groups, a $2 \times 3$ analysis of variance was performed for their preshift performances. A significant main effect of Grade was obtained ($F=17.47, df=1/84, p<.01$). But no other main effect nor the interaction was significant. As can be seen in Table 3, the fourth graders learned the preshift task faster than the first graders.

Performance differences among the three conditions on the postshift task were tested. T tests revealed that (1) for the first graders, the subjects in the SI condition learned the postshift task faster than those in the SC condition ($t=2.23, df=28, p<.05$) and those in the DC condition ($t=2.27, df=28, p<.02$), and (2) for the fourth graders, the three conditions did not make any difference in their postshift performances ($t=1.71$).

In order to examine the effect of the preshift learning on the postshift performance, t tests were done for each of the six groups. The results showed that (1)
TABLE 3
Mean and SDs of the numbers of trials to criterion on the preshift and the postshift tasks
(Experiment II)

<table>
<thead>
<tr>
<th></th>
<th>First graders</th>
<th>Fourth graders</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Same instance</td>
<td>Same concept</td>
</tr>
<tr>
<td>Same instance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preshift task</td>
<td>9.27 (9.01)</td>
<td>9.33 (12.38)</td>
</tr>
<tr>
<td>Postshift task</td>
<td>46.47 (23.01)</td>
<td>28.67 (21.81)</td>
</tr>
<tr>
<td>Preshift task</td>
<td>2.82 (1.34)</td>
<td>2.58 (1.78)</td>
</tr>
<tr>
<td>Postshift task</td>
<td>6.63 (1.80)</td>
<td>5.01 (2.02)</td>
</tr>
</tbody>
</table>

Note: The SDs are in parentheses.
The upper half of the table shows the raw scores and the bottom half shows the $\sqrt{X+0.5}$ transformed scores.

for the first graders, the postshift tasks were learned much faster than the preshift task in all three conditions ($t=8.50$, $df=14$, $p<.001$ for the SI; $t=4.28$, $df=14$, $p<.001$ for the SC; and $t=2.35$, $df=14$, $p<.05$ for the DC conditions, respectively), and (2) for the fourth graders, the similar retarding effects of the preshift learning on the postshift performances were also obtained for each condition ($t=6.39$, $df=14$, $p<.001$ for the SI; $t=5.78$, $df=14$, $p<.001$ for the SC; and $t=3.61$, $df=14$, $p<.05$ for the DC, respectively).

In order to confirm that the subjects learned the preshift task by the use of the conceptual categories of fruit and vegetable, a subproblem analysis was performed on the performances in the SI condition. Six out of 15 first graders and three out of 15 fourth graders responded on the first block of four trials of the postshift task in the independent manner. As there was no age difference between the first and fourth graders' performances ($\chi^2=0.64$), they were combined and a $\chi^2$ test was performed between numbers of subjects who were assumed to learn the preshift task independently and dependently. The result showed that the number of the dependent learners was greater than that of the independent learners ($\chi^2=4.08$, $df=1$, $p<.05$). This can be interpreted to show that children of these ages could learn the preshift task (conceptual sorting task) by the use of the relevant conceptual categories (i.e., fruit and vegetable).

Discussion
The present experiment assessed the amount of negative transfer as a function of task similarity between the preshift and the postshift tasks. The three experimental conditions differed in their assumed elements to transfer to the postshift learning. The DC condition involved the possibility of transfer of only the grouping strategy on the basis of the conceptual categories. The SC condition involved the transfer of the grouping strategy and the relevant concepts. The SI condition involved three elements, the grouping strategy, the relevant concepts, and the instrumental responses to the individual instances.

The results revealed considerable amount of negative transfer in all conditions. This may be due to the difference in experimental paradigm. The grouping strategy which was acquired by a
subject during the preshift training might serve as an important factor of the negative transfer from the preshift learning.

For the first graders, the amount of negative transfer varied as a function of the similarity between the preshift and the postshift tasks. This was mainly due to the greater transfer in the SI condition. The subjects in this group might be unable to distinguish the preshift and the postshift task situations because both tasks involved the same four instances. They might persist in adopting their previously acquired strategy to group the instances on the basis of their conceptual categories. For the fourth graders, the three conditions did not differ in the amount of negative transfer. This may be explained by a possible interpretation that the fourth graders had not acquired nor used the grouping strategy during the preshift training, resulting in no interfering effect of this strategy at the postshift learning. This interpretation was not supported by the subproblem analysis performed for the SI condition which indicated that the subjects had learned the preshift task independently by the use of the relevant concepts.

An alternative explanation is that the fourth graders spontaneously gave up their formerly acquired grouping strategy to meet the demand of their confronting task. They may easily be able to change their strategy as the occasion calls for. This may also be suggested by the fact that the fourth graders learned the postshift tasks faster than the first graders in all three conditions. However, this line of interpretation appears somewhat inconsistent with a conventional assumption that the older children are more likely to use some mediators such as conceptual categories to sort some instances. If this were the case, the older children should have revealed greater negative transfer than the younger children in learning HSTs. The faster learning of the postshift tasks by the fourth graders may well be explained by assuming that they had extinguished their old way of responding quickly.

Still another tentative explanation may be also possible for the faster learning of the postshift task by the fourth graders than by the first graders. That is, the fourth graders may have higher ability to learn this kind of tasks faster than the first graders. The subjects must learn and retain the individual associations between instance and response when given HST. To test this assumption, 90 children of the first and the fourth grades were trained to sort four unrelated instances (umbrella, piano, airplane, and strawberry) according to certain experimentally predetermined groups. The results showed no significant performance difference between the first (mean number of trials to criterion was 14.89) and the fourth graders (16.11) with \( t = 0.24 \). This excluded the possibility of the tentative explanation mentioned above.

Inspection of the obtained results of Experiment I and Experiment II reveals some consistent tendency that the amount of transfer (either positive or negative) depended on task similarity for the first graders whereas no similarity effect was significant for the fourth graders. This suggests that the first graders acquired the grouping strategy which was specific to the relevant concepts during the preshift task. On the other hand, the fourth graders might acquire the general grouping strategy which could be applied to a variety of other concepts.

**References**


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