FREE CONCEPTUALIZATION AND SUBSEQUENT RECALL IN CHILDREN

by

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TABLE OF CONTENTS

LIST OF TABLES

ABSTRACT

A free conceptualization task using fourteen pictures as stimuli was presented to first and sixth graders. In the initial experimental session, sixth grade children recalled more pictures and showed more clustering than first grade children. No differences between grades were observed in the number of categories used, the number of trials to criterion, or the amount of time to criterion. No significant correlation was observed in either grade between the number of categories used in the final sort and the number of pictures recalled. After one week, the free conceptualization task was re-administered. A comparison of the first and second experimental sessions revealed no significant differences between grades in the categories used in the final sort from one session to the next.

INTRODUCTION

George Mandler (1967) has recently advocated the notion that organization is the single most important variable determining the amount of recall in typical verbal learning situations. Historically, the topic of organization was first given important theoretical status by Gestalt Psychologists such as Kohler (1947) and Koffka (1935) in their study of perceptual processes. From their observations of illusions and other perceptual phenomena, the Gestaltists concluded that perception is organized and they proceeded to develop principles of perceptual organization such as figure-ground, closure, proximity, continuity and pragnanz. The application of these principles to other areas of psychology was not particularly successful. Although psychology eventually abandoned this molar approach, the Gestalt point of view strongly influenced the fields of child psychology, social psychology, perception, learning, and more recently, clinical psychology.

The importance of organization was further elaborated in Organization and memorization (Katona, 1940). Katona made an attempt to apply Gestalt principles to the area of human memory, by stressing the role of organization as an essential part of learning and memorizing. Katona viewed organization as primarily involving the formation of meaningful groups such that the members of these groups, and the groups themselves,

bear some relationship to one another. In a simple experiment, for example, Katona demonstrated how organizing a series of numbers into meaningful groups enables a person to extend the limits of his memory. Unfortunately, psychologists paid little attention to the importance of Katona's book.

Not until the appearance of information theory and the work of George Miller (1956) did the topic of organization and grouping assume a position of major importance in the study of human memory. A review of experiments in absolute judgment and immediate memory (Miller, 1956) led to the conclusion that a person's capacity for processing information is limited to about seven items. This finding appeared somewhat paradoxical in light of the obvious fact that the human organism is able to store and retain more than seven items of information. In order to explain this apparent paradox, Miller (1956) formulated the unitization hypothesis. According to this hypothesis, a recoding or regrouping process serves as the basic mechanism responsible for extending human memory. Whenever input exceeds seven items, a recoding process occurs which reorganizes items of information into groups called units or chunks. While the number of chunks is limited to seven plus or minus two, the amount of information contained within a chunk is, theoretically, unlimited.

In his 1956 article, Miller spoke of two ways by which the amount of information contained in a chunk may be increased. One

method, commonly used in experiments on absolute judgment, involves increasing the dimensions of each stimulus so as to facilitate discrimination. A second method involves the hierarchical organization of items within a group or chunk. Although limited to seven, plus or minus two, these items are informationally rich, such that each contains seven additional items; these items in turn contain seven others and so on. Such a process of hierarchical organization permits a vast amount of information to be contained within a chunk.

As an alternative to informationally rich chunks, Miller (1962, and Miller, Galanter and Pribram, 1960) has more recently advocated the notion of a hierarchical system as a major means of overcoming the "informational bottleneck." According to this hierarchical system, there are a limited number of items per chunk. When this limit is exceeded, the chunks are reorganized or recategorized into superchunks, thereby creating a new level within the hierarchy. As more information is encoded, new levels and categories evolve within the hierarchy.

Mandler's (1967) extension of the unitization hypothesis to verbal learning has served as a basis for the hypothesis that categorical organization is one of the most important variables determining recall. According to this model, words serve as the items of information which are organized into chunks. Chunking occurs when words are grouped together to form concepts or categories. Consequently, a category is

equivalent to a chunk. If, as Mandler assumes, learning or memorization is essentially an organization process whereby words are grouped into hierarchically arranged groups, then it would follow that recall should be determined by the number of categories a subject used during organization. Mandler has conducted a number of experiments which yield data supporting this notion. The first of these studies (Mandler and Pearlstone, 1966) investigated free concept learning using four types of stimuli: high frequency English nouns, low frequency English nouns, simple stimulus patterns and complex stimulus patterns. The stimulus materials consisted of a set(s) of cards, each card having a word or printed pattern. The subject was given a deck of cards and was instructed to sort the words (or patterns) into anywhere from two to seven groups using "any criterion, rule or category" he wished. The subject was also told that after he was finished, he would be required to sort another deck of cards containing the same words (or patterns) but presented in a different order. This procedure was repeated until the subject produced two identical sortings. Following this final criterion sort, the subject was instructed to write all the words he could remember.

Mandler and Pearlstone reported a number of findings supporting the hypothesis that organization is a major determinant of recall. The number of words recalled was not determined by the number of sorting trials the subject required, but rather by the development of a stable

category system. Subjects used approximately four categories in the final sort and recalled an average of five words from each category. This finding is consistent with data provided by Miller (1956) that the memory span for monosyllabic words is approximately five, plus or minus two. The number of categories (NC) used in the final criterion sort was directly related to the number of words recalled (R). The nature of this relationship (NC-R) was such that more words were recalled as the number of categories increased. These findings support Mandler's hypothesis that organization is a major determinant of recall.

In 1967 Mandler conducted a subsequent series of experiments which further investigated the NC-R relationship. The general method employed was essentially the same as that for the free conceptualization group of Mandler and Pearlstone (1966). The results of these experiments were consistent with their previous findings. Mandler reported that in those cases where subjects used more than seven categories, the NC-R relationship did not hold; i.e., the use of more than seven categories did not produce a linear increase in the number of words recalled. This finding provides evidence supporting the number five, plus or minus two, as the limiting value for Mandler's hierarchical system. Further evidence for the existence of a hierarchical system was provided by an analysis of the recall protocols for subjects required to learn a large number of words. The results of this analysis indicate that categories were divided

into subcategories. This finding suggests that some sort of hierarchical system of superordinate and subordinate categories is involved in the subjective organization of a list of words.

A later study by Mandler and Stephens (1967) investigated the developmental aspects of organizational processes in verbal memory. Second, fourth, sixth, and eighth grade girls were given a free or constrained concept learning task using essentially the same procedure as Mandler and Pearlstone (1966). Stimulus materials consisted of fifteen familiar words. A number of differences were observed between older (grades six and eight) and younger subjects (grades two and four). The data suggest a developmental trend in that younger subjects recalled fewer words and required more time and trials to achieve criterion than older subjects. A significant NC-R relationship was observed only for subjects in the eighth grade. The investigators related this finding to the assumed absence of established categories in the younger children's cognitive structure. Evidence supporting this assumption was provided by a clustering measure in which "the number of categories was tabulated from which each subject recalled two or more words in succession." This measure indicated that older subjects tended to show more clustering during recall than younger subjects. Similarly, in a free association task the authors observed a decreased tendency for children to produce a variety of responses to a stimulus word as grade level increased. These two measures suggest that older children tend to have more

established categories than younger children. Mandler and Stephens suggest that the category-recall relationship may very well depend on this ability.

The present study attempts to investigate the relation between organization and recall in children using pictures rather than words. The finding that more clustering occurs with concrete than with abstract words suggests the possibility that a more concrete stimulus (i.e., pictures) would facilitate the formation of categories and thereby increase the probability of obtaining a significant NC-R relationship in younger children. The use of pictures instead of words would also permit the study of organization and recall in young children who have not yet learned to read well.

The present study will also investigate the stability of categories used in the final criterion sort over a period of time, in order to determine if such stability relates to differences in recall among children of different grade levels.

METHOD

Subjects

A total of twenty-two children from grades one and six were used as subjects in this experiment. Two children were excluded from the final N because they did not achieve a criterion sort within six trials. The final N of twenty subjects was composed of five boys and five girls from each grade.

Materials

Stimulus materials consisted of fourteen 3x5-inch cards, each having a different picture (see Fig. 1). A long wooden box subdivided into seven equally spaced compartments was used as a sorting hamper for the cards.

Procedure

After being introduced to the experimenter, the subject was seated at a table on top of which was located a sorting hamper. The following instructions were read to the subject:

> This is an assignment to see how you sort or arrange pictures into different groups. I am going to place some pictures, like this one (subject is shown a picture) on top of the table and I want you to put them into different groups according to how you think the pictures belong or go together. It is very important that you put the pictures together the way you think

Fig. 1. Pictures sorted into categories by first and sixth grade children: stamp, airplane, flower, camera, ruler, cow, telephone, comb, triangle, pie, hydrant, coat, balloon, bottle.

Each picture was individually drawn on a 3x5 inch card.

they go together. You can use one space in this box (experimenter points to the box) for each group of pictures you choose. You can use anywhere from two to seven groups or piles depending upon how you think the pictures belong or go together. People do this all different ways and they use different numbers of groups. Some people use seven groups, some use four, some use five, some use two. It all depends upon how they think the pictures go together, so you can do whatever you want.

Here are some rules to help you:

1. You do not have to put the same number of pictures in each group. One group can have two pictures in it, another can have four pictures, or you can have one picture all by itself--it's up to you and how you think the pictures belong or go together.
2. One of the things you cannot do is to put one picture into one group and all the other pictures into another group.
3. Once you put a picture into a section of the box, you must leave it there; you cannot pick it up and put it into another section.

Once you put the pictures into the groups you want, I am going to give you the same pictures another time and I want you to put them together again. We will keep doing this until you can put the pictures into the same groups two times in a row. They don't have to be in the same order, just as long as they are in the same groups. Remember, put the pictures together that you think belong or go together. Do you have any questions?

The experimenter then placed the cards in a 2x7 array in front of the sorting hamper and said the following:

These pictures are of all different kinds of things, (pointing to the first card) here is a _____, (pointing to the second card) and here is a _____, (and so on until all the pictures had been labeled). Remember, put the pictures together that you think belong or go together. You may begin.

After the subject finished sorting all the pictures, another identical set of pictures was randomly presented in a 2x7 array. This procedure continued until the criterion of two identical sorts was achieved or until six

trials had passed. Those subjects who failed to reach criterion within six trials were excluded from the experiment. Following their last criterion sort, the subject was told to recite (aloud) all the pictures he could remember. Four minutes were allowed for recall. The subject was not informed that he would be required to repeat the task one week later.

The following instructions were added at the beginning of the subject's second experimental session:

> I have the same pictures I used last week, and I would like you to put them into groups depending on how you think they belong or go together. You may find that you make the same groups you did last week, or you might use new or different groups depending upon how you think the pictures go together. It does not make any difference if you make the same groups or different groups, just as long as you think the pictures go together. That is very important, the pictures should go into groups because you think they go together. I will read the directions to you again to help you put the pictures together. 'You can use one section of this box (experimenter points to box) for each group . . . .'

During each experimental session the experimenter recorded the time required to reach criterion, the number of categories used, the number of trials to criterion, and the pictures recalled and their order of recall.

Design

The combination of grade (one and six), sex, and experimental sessions (I and II) yielded a series of 2x2x2 mixed designs. In each experimental session, the following four measures were recorded and later used as data in the above mentioned analysis: 1) number of pictures

recalled, 2) number of categories used, 3) number of trials to criterion, and 4) amount of time required to reach criterion. A series of 2x2 analyses were also performed on the data recorded in the first experimental session in order to provide a comparison with previous studies.

Stability Measure

The following measure was developed to determine the stability, i.e., similarity, of categories used in the final sort from session I to session II:

$$\text{Stability Index} = \frac{\text{Number of identical categories}}{\text{Total number of categories used in the final criterion sort (in sessions I and II combined).}}$$

Identical categories are defined as any identical group of pictures used in the final criterion sort of each session.

Other Analyses

A Pearson Product Moment Correlation was computed between the number of categories used in the final criterion sort and the number of pictures recalled, in order to determine the extent of relationship between these two response measures.

A clustering index, previously used by Mandler and Stephens (1967), was tabulated by determining the number of categories from which each subject recalled two or more words in succession. A category is here defined as any group of pictures used in the final criterion sort.

This measure was used to determine the extent to which recall reflected prior conceptualization.

RESULTS AND DISCUSSION

Number of Pictures Recalled

A 2x2 factorial analysis of variance revealed that sixth grade children recalled significantly more pictures than first grade children during the first experimental session ($F=18.29$, $df=1,16$, $P<.01$) (see Tables 1 and 2). A mixed design analysis of variance revealed a similar difference between first and sixth graders over both experimental sessions ($F=31.38$, $df=1,16$, $P<.01$) (see Table 3). The main effect of sessions indicated that the pooled sixth grade and first grade children recalled more pictures in session II than in session I ($F=7.03$, $df=1,16$, $P<.05$).

Sex differences were observed in the number of pictures recalled during the first experimental session; boys recalled more words than girls ($F=4.57$, $df=1,16$, $P<.05$). A significant sex by grade interaction over both experimental sessions revealed that first grade boys recalled more pictures than first grade girls, whereas sixth grade girls recalled more pictures than sixth grade boys ($F=4.58$, $df=1,16$, $P<.05$). A significant sex by session interaction was also observed. During the first experimental session boys recalled more pictures than girls, while during the second experimental session girls recalled more pictures than boys ($F=5.87$, $df=1,16$, $P<.05$).

TABLE 1

SUMMARY OF MEAN SCORES FOR RESPONSE MEASURES RECORDED DURING SESSIONS I AND II FOR GRADES 1 AND 6

		Pictures Recalled	Categories Used	Trials to Criterion	Seconds to Criterion
Session I					
Grade 1	Boys	10.8	5.6	3.0	344.8
	Girls	8.0	6.6	2.6	206.8
Grade 6	Boys	12.8	5.8	3.2	206.6
	Girls	12.4	6.4	3.2	333.4
Session II					
Grade 1	Boys	11.2	5.6	2.8	196.8
	Girls	10.8	5.2	2.4	133.6
Grade 6	Boys	12.6	5.2	2.2	91.6
	Girls	14.0	6.0	2.6	121.8

TABLE 2

ANALYSIS OF VARIANCE FOR RESPONSE MEASURES IN SESSION I

		Pictures Recalled		Categories Used		Trials to Criterion		Seconds to Criterion	
Source	df	MS	F	MS	F	MS	F	MS	F
Grade (A)	1	51.20	18.29*	0.00	0.00	.80	.81	168.20	0.00
Sex (B)	1	12.80	4.57*	3.20	3.56	.20	.21	156.80	0.00
A x B	1	7.20	2.57	.20	.22	1.20	1.21	87,648.20	2.62
Error	16	2.80		.90		.99		33,508.54	

*P .05.

TABLE 3

ANALYSIS OF VARIANCE FOR RESPONSE MEASURES IN SESSIONS I AND II

		Pictures Recalled		Categories Used		Trials to Criterion		Seconds to Criterion	
Source	df	MS	F	MS	F	MS	F	MS	F
Sex (A)	1	3.02	1.25	2.50	.88	.10	.11	1,221.02	.07
Grade (B)	1	75.62	31.38**	.10	.04	.10	.11	10,336.22	.56
A x B	1	11.03	4.58*	.40	.14	.90	1.00	80,192.02	4.35
Error	16	2.41		2.84		.90		18,429.00	
Trials (C)	1	13.22	7.03*	3.60	4.86*	2.59	2.78	187,553.02	9.14**
A x C	1	11.03	5.87*	.90	1.21	.10	.11	297.03	.01
B x C	1	2.03	1.08	.10	.14	.90	1.00	6,943.23	.34
A x B x C	1	5.22	2.78	1.60	2.16	.10	.11	18,361.47	.90
Error	16	1.88		.74		.90		20,510.73	

*P .05.

**P .01.

Number of Categories Used

A 2x2 factorial and mixed design analysis of variance revealed no significant differences between grade or sex (F's<1). However fewer categories were used during the final sort of session II than session I (F=4.86, df=1,16, P<.01).

Number of Trials to Criterion

No significant differences were observed among grades, sexes, or sessions using a 2x2 factorial or mixed design analysis of variance (F's<1).

Amount of Time to Criterion

A 2x2 factorial and mixed design analysis of variance revealed no significant differences between grades or sex for the amount of time required to reach criterion (F's<1). A significant difference was observed between sessions, such that less time was required to reach criterion during session II than during session I (F=9.14, df=1,16, P<.01).

Clustering Measure

An analysis of the clustering measure using a t-test revealed that sixth grade children showed significantly more clustering than first grade children (t=8.42, P<.01).

Stability Measure

A 2x2 factorial analysis of variance of the scores tabulated using the stability measure revealed no significant differences between grades or sex (F's<1). No significant correlation was observed in grades one or six between the number of categories used in the final criterion sort and the number of pictures recalled (r=.53, r=.16).

Using printed words as stimuli Mandler and Stephens (1967) reported no significant differences in the number of categories used by older and younger children. The present study observed similar results using pictures as stimuli. Unlike the previous findings of Mandler and Stephens (1967) the present study did not reveal a significant difference between younger and older children in the number of trials or amount of time needed to reach criterion. This inconsistency may be attributed to the use of different materials (i.e., words vs. pictures) as stimuli, or to the possibility that the task was not difficult enough to differentiate between these grade levels. Differences in recall between older and younger children do not appear for the response measures number of trials or amount of time required to reach criterion.

The observation that older children recall more pictures than younger children is consistent with previous studies using words and/or pictures as stimulus materials (Paivio, Rogers and Smythe, 1968; Mandler and Stephens, 1967; Milgram and Furth, 1963). The relationship between recall (R) and the number of categories (NC) used in the final sort has been

a topic of major concern in a series of studies reported by Mandler (1967). A significant NC-R relationship has been observed for adults and children in grades as low as eight using words as stimuli. Despite the finding that more clustering occurs with concrete than with abstract words, the use of a more concrete stimulus (i.e., a picture) in the present study did not facilitate the formation of categories to a degree sufficient to produce a significant NC-R relationship in first or sixth grade children.

The stability measure did not reveal any significant differences between grades in the categories used in the final sort from one session to the next. However, an analysis of the clustering index strongly suggests that older children have a greater tendency to cluster material in recall according to how the material was conceptualized, i.e., how the material was categorized in the final sort. Since clustering may be viewed as a measure reflecting the degree of organization used by the subject, it would appear that this organization accounts for the greater recall in older children.

Future research involving a direct comparison between words and pictures should be conducted to determine what effect these different stimuli have on categorization and subsequent recall in children of different grade levels.

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