NESTING AND CATEGORIZATION AS MODES OF CONCEPTUAL ORGANIZATION

by

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B.S., Fordham University, 1966

A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

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1969

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1969
P72

ACKNOWLEDGEMENTS

Several individuals contributed greatly towards the formulation of this thesis. Appreciation is especially due Stephen Handel, Robert Haygood, Samuel Brown and my wife, Carol Preusser.

D. F. Preusser

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CHAPTER I

INTRODUCTION

Investigators interested in conceptual organization have traditionally tended to use stimuli on the same level of abstraction. For instance, a list containing examples of trees will probably not include the concept tree itself or the more general concept plant. Recent work in memory, however, suggests that conceptual organization may follow a hierarchical, or nested, structure (Bower, 1968; Mandler, 1968). If this is true, it is possible that the use of same-level concepts has tended to obscure the importance of the hierarchical structure. The purpose of the present study is to investigate the conceptual properties of hierarchical structures, and to compare the relative preference for hierarchical (multi-level) organization with categorical (same-level) organization.

Since the primary interest of this study is preferred organization (hierarchical vs. categorical), free classification was chosen as the experimental procedure. In free classification the subject is presented with a stimulus array and he is asked to organize or group the stimuli in any way that makes sense to him (see also Imai and Garner, 1968). The critical variable is the rule or relationship upon which his organization is based. Free classification, then, is a direct measure of preferred or-

ganization.

In this study the relationships upon which the subject can base his grouping or classification are nesting (hierarchical) (see also Handel and Garner, 1966) and categorization. Two stimuli are related by nesting when one of the stimuli is contained in or included in the other (e.g. Chicago is contained in Illinois). Two stimuli are related by categorization when they are similiar or can be joined with some integrating principle (e.g. Chicago and St. Louis are both large midwestern cities). From an intuitive point of view, it would seem that nesting and categorization are used constantly in everyday experience. When given the stimulus "Philadelphia", for instance, sometimes we think of its inclusion in Pennsylvania (nesting) and sometimes we think of it as a major eastern city along with New York, Boston and Baltimore (categorization).

Figure 1 shows a general schema for any complex hierarchy. Geometric figures, plants, animals, geographical concepts and many other types of stimuli could all be organized within this structure. Figure 2 shows how this general schema can be used to accomadate geographical concepts.

Each set or stimulus array used in this study consisted of three particular stimuli selected from a given hierarchy. Most of these sets were of the type referred to as the general case. In the general case, stimuli 1 and 2 are related by nesting and stimuli 2 and 3 are related by categorization. From Fig. 1, sets conforming to the general case would include B_1, C_1, C_3; B_1, C_2, C_4; and C_3, D_5, D_7. From Fig. 2, sets conform-

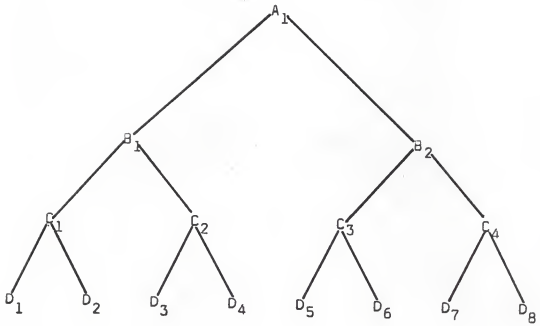

Figure 1 -- General Schema for Any Complex Hierarchy.

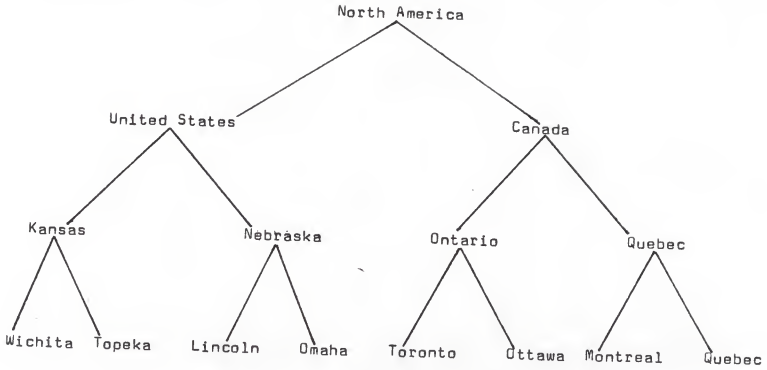

Figure 2 -- Possible application of general schema to geographical concepts.

ing to the general case would include United States, Michigan, Ontario; Kansas, Topeka, Lincoln; and Nebraska, Omaha, Wichita. Considering the set United States, Michigan, Ontario, the subject is using nesting when he groups United States with Michigan and categorization when he groups Michigan with Ontario.

Three different types of manipulations will be used in this study. First, it was felt that changes in the relative strength of the nesting vs. the categorization relationship should produce corresponding changes in classification. For purposes of explanation, "conceptual distance" will be used to refer to the strength of the nesting and categorization relationships. Therefore, increases in hierarchical distance refers to a weakening of the strength of the nesting relationship, and increases in categorical distance refers to a weakening of the strength of the categorical relationship. Taking the set Michigan, Detroit, Toronto, hierarchical distance is increased in the set United States, Detroit, Toronto, and categorical distance is increased in the set Michigan, Detroit, Vancouver. The sets testing changes in conceptual distance all follow the general case.

It is possible, however, to construct sets which do not follow the general case. United States, Michigan, Detroit, for instance, contains only hierarchical relationships. Therefore, the second manipulation is the testing of systems of relationships other than the general case. Of further interest in this study is the ability of findings from one hierarchy to generalize to other hierarchies. Therefore, the third manipulation is

the use of four distinct types of stimulus material. It is thought that these manipulations will demonstrate some of the conceptual properties of hierarchical structures, and determine the conditions under which hierarchical organization is preferred over categorical organization.

CHAPTER II

METHOD

Subjects. A total of 40 subjects, male and female undergraduates enrolled in Introductory Psychology at Kansas State University, participated as part of their course requirement.

Stimuli. The specific sets used in this study all contained 3 stimuli, and will be presented later. The sets, themselves, are of four types.

1. Countries, States and Cities. These represent what is perhaps the most naturally available hierarchy in the subjects' repertoire. If a given set had a logical opposite, half the subjects saw the set, and half saw the opposite. For example, half the subjects saw United States - Detroit - Toronto, and half saw Canada - Toronto - Detroit. The stimuli were typed on 3" x 3" blue cards.

2. Triangles and Squares. These were constructed to vary in similarity between forms. The stimuli were mounted on 3" x 3" blue cards.

3. Circles and Squares. These were constructed to vary in similarity defined by number of forms common between stimuli and number of forms present in any stimulus. For any given set, half the subjects saw what was logically the same set with square as the simplest form and half the subjects saw what was logically the same set with square as the simplest form. These stimuli were mounted on 3" diameter, round, blue cards. The round cards were used so that the position variable could be eliminated. This was necessary since more than one type of figure appeared on a stimulus. The elimination of the position variable was accomplished by positioning each form equidistant from the center of the card and equidistant from other forms on the stimulus card.

4. English nouns. These nouns were selected to represent

varying levels of association between the stimuli.

Task. The subject was seated at a table in a room with only the experimenter present. The subject was instructed to group the cards of each set of stimuli in the way that made the most sense to him, and was told that there were no right or wrong answers. He was then presented with the first set, and was shown (by the experimenter), the five possible ways in which the stimuli could be grouped; three combinations of two together, one separate; all cards separate; all cards together. Subjects seldom required any additional instruction.

The subject then proceeded to group the first set and each set thereafter until the task was completed. He was allowed to view only one set at a time, he was self-paced, and each succeeding set was placed face down in á random stack in front of the subject. The order of presentation of sets was counterbalanced across all subjects with each subject seeing each set. The total test period lasted approximately 30 minutes.

CHAPTER III

STIMULI AND RESULTS

Manipulations of Conceptual Distance

Within the general case, the strength of the nesting relationship relative to the strength of the categorical relationship should affect subsequent classification (manipulation of conceptual distance).

Effect of Varying Hierarchical Distance. As hierarchical distance increases, the conceptual distance between Cards 1 and 2 increases. Increases in hierarchical distance should produce less nesting and more categorical calssifications. Table I compares those sets in which hierarchical distance has been varied.

The first two sets of Table I increased hierarchical distance by replacing the higher order stimulus of Card 1 (Michigan) with an even larger, more distant, concept (United States). The data showed that nesting classification decreased slightly and categorical classification increased. The next three sets (Sets 3 - 5) increased hierarchical distance by making the stimulus of Card 1 increasingly dissimilar from the stimuli of Card 2. This manipulation produced a clear decrease in the percentage of subjects using nesting classification and increases in the percentage of subjects using categorical classification. The percen-

TABLE 1

Effects of Changing Hierarchical Distance

Set	Card 1	Card 2	Card 3	Nesting (12)(3)	Categorization (1)(23)	Ungrouped (1)(2)(3)	Other (13)(2) & (123)
1	Michigan	Detroit	Toronto	80%	10%	0%	10%
2	United States	Detroit	Toronto	75%	22.5%	0%	2.5%
3	△ *	△△△ *	□□□	42.5%	50%	7.5%	0%
4	⧋ **	△△△ *	□□□	20%	62.5%	15%	2.5%
5	▱ ***	△△△ *	□□□	10%	65%	25%	0%
6	○	○○	□□	42.5%	32.5%	22.5%	2.5%
7	○	○○○	□□□	37.5%	52.5%	10%	0%
8	○	○○○○	□□□□	22.5%	72.5%	5%	0%

* 60^{o}, 60^{o}, 60^{o}
** 90^{o}, 45^{o}, 45^{o}
*** 120^{o}, 30^{o}, 30^{o}

Note 1 - Ungrouped represents percentage of subjects leaving all cards separate.

Note 2 - Where a set had a logical opposite as Set 1, half the subjects saw the set shown above and half saw the possible opposite. Results were summed since no differences appeared.

Note 3 - ( ) denotes cards grouped together.

tage of subjects leaving all cards separate also increased. The last group of sets (sets 6 - 8) in Table I varied hierarchical distance by making Cards 2 and 3 increasingly more complex relative to Card 1. Nesting classification dropped by 20% and categorical classification increased by 40% in this group of sets. Clearly, changes in hierarchical distance produce changes in classification and changes in hierarchical distance can be accomplished in at least three different ways.

Effect of Varying Categorical Distance. Increases in categorical distance should produce changes in classification which are opposite the changes found with increases in hierarchical distance. Namely, as categorical distance increases, nesting classification should be more preferred. Table II compares those sets in which categorical distance has been varied.

The first two sets of Table II (sets 9 and 10) increased categorical distance by increasing the distance (actual distance in miles) between the stimuli of Cards 2 and 3. Use of nesting classification increased by 37.5%, and use of categorical classification decreased by 32.5%. In sets 10 and 11, the hierarchical relationship is formed in exactly the same way (Topeka - Kansas). The categorical relationship, however, is formed between cities in set 10 and states in set 11. The results suggest that this change had no effect on subsequent classification. The second group of sets (sets 12 - 14) increased categorical distance by making the stimuli of Card 2 increasingly dissimilar from the stimuli of Card 3. The data showed that as categorical

TABLE 2

Effects of Changing Categorical Distance

Set	Card 1	Card 2	Card 3	Nesting (12)(3)	Categorization (1)(23)	Ungrouped (1)(2)(3)	Other (13)(2) & (123)
9	Kansas	Kansas City, Ks.	Kansas City, Mo.	30%	62.5%	0%	7.5%
10	Kansas	Topeka	Omaha	72.5%	25%	0%	2.5%
11	Topeka	Kansas	Nebraska	67.5%	30%	0%	2.5%
12	△ *	△ △ △*	△ △ △ *	0%	90%	0%	10%
13	△ *	△ △ △*	◺ ◺ ◺ **	40%	50%	5%	5%
14	△ *	△ △ △*	◺ ◺ ◺ ***	45%	45%	7.5%	2.5%
15	○	○ ○	○ ○	0%	97.5%	0%	2.5%
16	○	○ ○	○ □	30%	30%	27.5%	12.5%
17	○	○ ○	□ □	42.5%	32.5	22.5%	2.5%

* 60^{o}, 60^{o}, 60^{o}
** 90^{o}, 45^{o}, 45^{o}
*** 120^{o}, 30^{o}, 30^{o}

TABLE 2 (Cont.)

Set	Card 1	Card 2	Card3	Nesting (12)(3)	Categorization (1)(23)	Ungrouped (1)(2)(3)	Other (13)(2) &(123)
18	O	OOO	OOO	2.5%	87.5%	0%	10%
19	O	OOO	OO□	30%	40%	25%	5%
20	O	OOO	O□□	30%	37.5%	25%	7.5%
21	O	OOO	□□□	37.5%	52.5%	10%	0%
22	O	OO□	OO□	0%	97.5%	0%	2.5%
23	O	OO□	O□□	5%	70%	12.5%	12.5%
24	O	OO□	□□□	17.5%	47.5%	32.5%	2.5%

distance was increased, use of nesting classification increased and use of categorical classification decreased.

Sets 15 - 17, 18 - 21, and 22 - 24 of Table II increased categorical distance by decreasing the number of forms common to both Cards 2 and 3. The data again showed a general decrease in the use of categorical classification as categorical distance was increased.

The data from sets 15 - 24, however, suggest that number of forms in common is not the only measure of categorical distance. When Cards 2 and 3 were constructed by the same rule, they produced a pattern of results which was different from the pattern of results when Cards 2 and 3 were constructed from different rules regardless of actual forms involved. Essentially, there are two possible rules of construction when Cards 2 and 3 contain three forms (sets 18 - 24); (a) all three forms are the same (all circles or all squares), (b) two forms are the same and one form is different (two circles and one square or two squares and one circle). If Cards 2 and 3 were both constructed from the same rule, rule (a) or rule (b), two things happened above what could be predicted by form alone. First, the number of subjects preferring not to group the stimuli decreased; and second, there seemed to be an increase in the number of subjects preferring categorical classification. These effects can be seen in Sets 16 and 17, and Sets 20 and 21. Cards 2 and 3 of Sets 16 and 20 are constructed from the same rule, and Cards 2 and 3 of Sets 17 and 21 are constructed from different rules. The result is a decrease in ungrouped classification and an increase in cate-

gorical classification above what would be predicted from form alone. Another example can be seen by comparing Sets 23 and 24. Cards 2 and 3 of Set 23 were both constructed from rule (b), while Cards 2 and 3 of Set 24 were constructed from different rules. The result was that ungroup classification rose from 12.5% in Set 23 to 32.5% in Set 24.

In summary, changing the conceptual distance between the stimuli did produce consistent and systematic changes in classification. When the categorical distance was increased, nesting became more preferred. When the hierarchical distance was increased, categorization became more preferred.

Relational Changes

The system of relationships within any set do not necessarily have to follow the general case. Some variations of the general case were selected for further study.

Nesting Only. Categorization is not possible in Set 25 of Table III, but nesting is possible since Topeka is nested in Kansas is nested in United States. The results showed that 45% of the subjects grouped Topeka with Kansas and 42.5% of the subjects simply grouped all cards together. Subjectively, more indecision on the part of the subject was observed with this set than with any other.

Categorization is also not possible in Sets 26 and 27 of Table III. In Set 26, nesting is possible only between Cards 1 and 2; but in Set 27, nesting is possible between Cards 1 and 2

TABLE 3

Other Cases

Set	Card 1	Card 2	Card 3	CLASSIFICATION (12)(3)	(1)(23)	(13)(2)	(1)(2)(3)	(123)
25	United States	Kansas	Topeka	5%	45%	0%	7.5%	42.5%
26	United States	Michigan	Toronto	75%	12.5%	0%	10%	2.5%
27	United States	Kansas	Omaha	50%	12.5%	2.5%	30%	5%
28	United States	Topeka	Omaha	7.5%	75%	2.5%	5%	10%
29	United States	Topeka	Wichita	2.5%	92.5%	0%	0%	5%
30	Kansas	Topeka	Wichita	10%	45%	0%	2.5%	42.5%

and between Cards 2 and 3. The presence of the second nesting relationship led to a greater number of subjects who preferred to leave the cards separate, and fewer subjects who preferred the country - state relationship. Apparently, the country - state relationship did not differentiate the set as clearly when the country - city relationship was present (Set 27) than when it was absent (Set 26).

Categorization Dominant. The problem of finding a relalationship which clearly differentiates the stimuli is also present in Sets 28, 29, and 30 of Table III. In each of these sets, there were two roughly equivalent ways in which the subject could exhibit nesting. However, categorization is also available in these sets and the subjects avoided making a choice between the two nesting relationships by using categorization. In Set 30, 42.5% of the subjects avoided the problem by simply grouping all the stimuli together.

Role of Association. A possible explanation for at least some of the results presented thus far is simple association. For example, it can be argued that Detroit would elicit Michigan more often than Toronto, and that this is the only reason Detroit is grouped with Michigan and not Toronto. As a test of this, eight sets were constructed from English nouns whose associative linkages were known (College Sample of Minnesota Norms). All of these sets were constructed from the general case, therefore, Card 2 was nested in Card 1, and Card 3 was on the same level as Card 2, but Card 3 was not nested in Card 1. Two of these

sets were Plant - Cabbage - Rabbit and Mineral - Salt - Sugar. Across all eight sets, the average association value from Card 2 to Card 1 was 6.12, and the average association value from Card 2 to Card 3 was 74.88. From association value, therefore, categorization should be preferred 12 to 1 over nesting. In fact, however, across all subjects and all sets, 53% of the classifications were based on nesting while only 29% of the classifications were based on categorization. Clearly, associative strength alone cannot explain the results of this study.

Comparison Between Types of Stimulus Materials. A comparison between the different types of stimulus material reveals that nesting was preferred most often in the country - city - state sets (approximately 75%), the English nouns were second (approximately 50%), and nesting was preferred the least often in the geometric forms (approximately 25%). It would appear that the stimulus material is a variable affecting overall preference for nesting and categorization.

Summary

Nesting and categorization were shown to be two of the possible relations upon which a free classification response could be based. Preference for use of either relationship was found to be a function, at least in part, of the "conceptual closeness" or "distance" between the stimuli. Further, changing the nature of the relationships between the cards of the set did produce changes in classification (relational changes). The fact

that these results were consistant across very different types of stimulus material suggests that the results are generally reliable and that nesting and categorization are, themselves, valid available relationships.

CHAPTER IV

DISCUSSION

A possible explanation for the results here is that the subject is using simple similarity relations as a basis for classification and not the structural properties of the set. This problem was considered under Role of Association above, with the conclusion that actual properties were the most important determinant for classification. The results from sets 25-30 (Relational Changes) are also consistent with a structural properties interpretation. The problem of similarity vs. structure in free classification has also been considered by Imai and Garner (1968). They conclude "that such factors (role of stimulus similarities and differences) are not primary in perceptual classification, being distinctly secondary to factors of attribute structure (p. 171)." Our conclusion would, therefore, be that the results obtained here are a function of perceived structure.

The most important conclusion of this paper, however, is simply that the nesting relationship is an important and available relationship for classification. Also, the nesting relationship was found to interact in a consistent manner with categorization. The results presented here suggest that nesting should be considered along with the other relationships for

organization.

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The purpose of this study was to compare categorical or same level organization with various forms of hierarchical or multi-level organization. The study was prompted by recent work in memory which suggested that conceptual organization may follow a hierarchical structure.

The free classification procedure was chosen for use in this study, since free classification provides a direct measure of preferred organization. In free classification, the subject is presented with a stimulus array and he is asked to group the stimuli in any way that makes sense to him. The rule or relationship which the subject chooses to form his groups is the critical variable. In this study, the subject could base his groups on nesting (hierarchical categorization) or categorization (categorical organization).

The results showed that preference for nesting and categorization as the basis for classification varied as a function of the conceptual distance between the stimuli. This finding was consistent over a wide range of stimulus material. Changes in the system of relationships within stimulus arrays also affected classification. Further, different types of stimulus material produced different overall preference for either relationship. It was found that association value alone could not account for the findings. It was also found that when two geometric patterns were constructed from the same rule, the strength

of the relation between them was stronger than would be predicted from the pattern components alone.

It was concluded that nesting is an important and reliable relationship available to the subject for conceptual organization.