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ABSTRACT

The problem which this study addresses is the effects of cognitive style and variations in the free sort procedures on the sorting outcome of sorting time and number and quality of manifest partitions. This experiment was designed to look at the effects of the cognitive styles of field dependence, category width and equivalence range, initially-presented homogeneous, heterogeneous or completely randomized stimuli, an explicit sorting cue and resorting versus no resorting on total sorting time, and the number and quality of manifest categorization. Based on a review of the literature and results of a pilot study, a conceptual model of sorting was generated to predict the results. Subjects for the study were 12th grade, male students drawn from two schools within the same district of white middle class communities. On the basis of this research it would seem that some cognitive styles and variations in sorting procedure do affect sorting outcomes. Specific results are presented. (Author/RC)

A Conceptual Model of Selected Parameters in Categorization Studies[1]

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A Conceptual Model of Selected Parameters

in Categorization Studies[1]

PURPOSE OF THE STUDY:

Categorization methodology evolved during the mid-1960's as a unique procedure for generating and analyzing qualitative information. This procedure was developed out of an empirical study of teacher's views regarding the facilitation of learning which required an adequate method of categorizing and summarizing content units. Existing techniques at that time to qualitatively differentiate substance and structure out of perceptions were inappropriate because of investigator bias in the instrumentation. The generated procedure allowed the subject to sort these content units into as many categories as necessary (the Free- or F-sort) and provided for analysis of these sorts by Latent Partition Analysis (LPA). This sorting task was proscribed to simulate the basic perceptual process of simplifying the complex environment.

The problem which this study addresses is the effects of cognitive style and variations in the F-sort procedures upon the sorting outcomes of sorting time and number and quality of manifest partitions.

Cognitive styles are individual preferences and consistencies which affect cognitive tasks. Three commonly recognized cognitive styles are field dependence, category width and equivalence range. Field dependence refers to the ability to separate figures from an embedded context. Category width refers to the range of stimuli which a person is willing to include as representative of some central exemplar. Equivalence range is the range of stimuli which a person is willing to include within one conceptual context. Equivalence range differs from category width since the former requires the conceptualization of categories as well as the comparison of each stimulus to the categorical exemplars. These cognitive styles, due to their measurement similarity to the F-sort and its characteristics, should have some effect on the sorting outcomes.

The recency of the development of the F-sorting techniques has precluded any extensive research on the effects of procedural variation upon sorting outcomes. Typically, the standardized administration procedures include: randomization of the stimuli, presentation of an explicit sorting cue, and the "free-sorting" and re-sorting of these stimuli into manifest categorizations. Order of stimulus presentation, explicit versus implicit sorting cues and the absence or presence of re-sorting may have marked effects on the sorting results.

PILOT STUDY:

A pilot study was conducted to look at the effects of varying just one of these procedures. Stimuli were presented to the sorters in either homogeneous or heterogeneous clusters. In the homogeneous clusters stimuli which were homogeneous with respect to the underlying or latent structure were presented in groups. It was hypothesized that subjects sorting stimuli presented in this manner would make finer discriminations on the first homogeneous cluster which combined with later categorizations would result in more manifest categories.

In the heterogeneous clusters, stimuli which were heterogeneous with respect to each other based on the latent structure were presented in groups. It was hypothesized that subjects sorting stimuli presented in this manner would tend to lump the initially-encountered heterogeneous stimuli into fewer categories than represented by the underlying structure.

The results of the pilot study (reported in Haenn, 1971) supported these hypotheses and led to the design of the present study. In addition, sorting time in the pilot study was unrelated to type of stimulus-presentation.

THE CONCEPTUAL MODEL OF SORTING:

The present experiment was designed to look at the effects of the cognitive styles of field dependence, category width and equivalence range, initially-presented homogeneous, heterogeneous or completely randomized stimuli, an explicit sorting cue versus an implicit sorting cue and re-sorting versus no re-sorting upon total sorting time and the number and quality of manifest categorizations.

Based on the review of literature and results of the pilot study a conceptual model of sorting was generated to predict the results. This model is presented in Figure 1.

There were four measured variables of interest in this

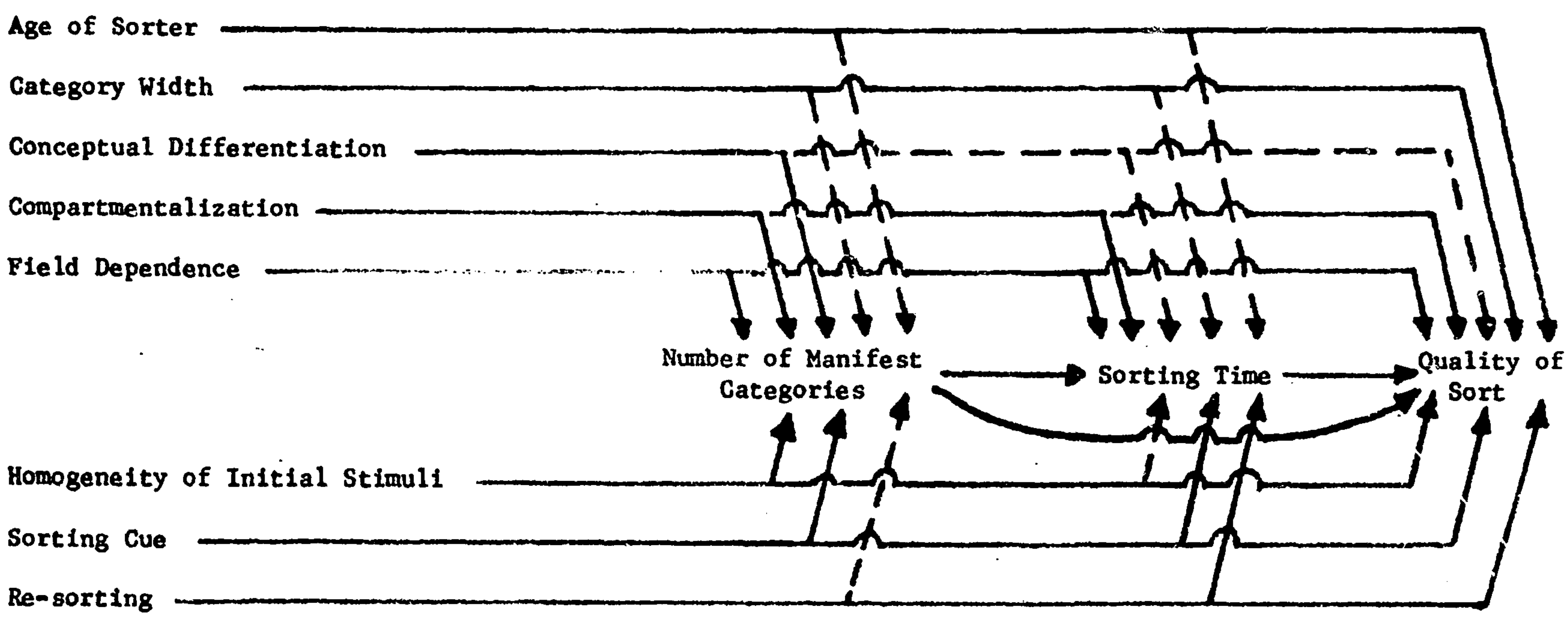


Figure 1. A Conceptual Model of Sorting

study: the cognitive styles of field dependence, category width and equivalence range plus the age of the sorter. Field dependence estimates the degree of fineness with which a person perceives a stimulus field and the Hidden Figures Test--Form V (Jackson, Messick and Myers, 1962; 1964) was used as the measurement instrument.

Field dependent persons have been classified in the relational style category (Cohen, 1969) which includes persons who typically perceive only obvious or sensed features and are most sensitive to global characteristics. They also form few piles while sorting, are easily distracted and are unable to re-sort. Their counterparts, the field independent subjects, are categorized in the analytic style. These subjects look for obscure or abstract features and are sensitive to parts and their features. They form many piles while sorting, are not easily distracted, and can re-sort many times. Thus, it was predicted that field dependence would affect number of manifest categories, sorting time and the quality of the sort.

Equivalence range was measured by the Clayton and Jackson (1961) Object Sort Test, a paper-and-pencil adaptation of and suitable replacement for the original Gardner's Object Sorting Test (Gardner and Long, 1960), which required a physical manipulation of objects. Three scores can be obtained from this instrument. The first is simply the total number of categories which are formed. The second and third scores, Compartmentalization and Conceptual Differentiation, are subscores which combine to form the total number of categories.

Compartmentalization is the total number of categories which contain just one object. It was predicted that a tendency for the formation of such categories would increase the amount of sorting time and the number of manifest categories, which in turn would affect the quality of the sort.

Conceptual Differentiation refers to the number of categories containing multiple stimuli. It was predicted that this tendency would be directly related to the total number of manifest categories formed, but would not affect the total sorting time or the quality of the sort.

Category width, which estimates category inclusiveness or willingness to include vague stimuli, was measured by Pettigrew's (1958) Estimation Questionnaire. This instrument, like the other two cognitive style instruments, was a group-administered, paper-and-pencil test. Since category width seems to concern structure within categories, it was predicted that category width would only affect the quality of the sort.

The final measured variable of interest was age of the sorters. This was measured as age in months at the time of testing and was predicted to possibly affect the quality of the sort in that older subjects would be atypical of the given population.

There were three manipulated variables in this study which provided the basis for the experimental design (Table 1). Homogeneity of stimuli presentation was based on the results of the pilot study. However, a completely randomized stimuli group was added to this study to emulate the standard procedure.

TABLE 1

EXPERIMENTAL DESIGN FOR THE STUDY

		Initial-Homogeneous Stimuli	Initial-Heterogeneous Stimuli	Completely-Randomized Stimuli
Implicit Sorting Cue	No Re-sort	1	5	9
	Re-sort	2	6	10
Explicit Sorting Cue	No Re-sort	3	7	11
	Re-sort	4	8	12

In their original study, Miller <u>et al.</u> (1967) completely randomized their sorting stimuli to eliminate primacy or recency effects and stated ". . .there are certainly differences between the information processing of the first item and of succeeding items" (p. 111). Upshaw (1970) further believes that the nature of the stimuli provides a major cue concerning the expected range of the judgment scale. This "context effect" (Johnson and Mullally, 1969) will then form the basis for future stimuli as each new stimulus will be judged in the context of already sorted stimuli.

Thus, subjects sorting homogeneous stimuli early in the deck should make finer discriminations among the initial stimuli resulting in a greater number of initial manifest categorizations on these stimuli. These subjects will then have difficulty fitting later-encountered, more heterogeneous stimuli into these existing categories and must form additional new categories, resulting in a greater total number of manifest categories. Subjects sorting heterogeneous stimuli early in the deck should make more gross discriminations among these initial-heterogeneous stimuli, even to the point of combining categorical exemplars into the same category, resulting in fewer initial manifest categorizations than would be expected for such diverse stimuli. These initial categorizations then form the sorting schema into which almost all of the later-encountered stimuli will readily fit.

It was predicted that homogeneity of stimulus presentation, especially initially-encountered stimuli, would not affect sorting time, but would affect the number of manifest categories formed which in turn would affect the quality of the sort.

Sorting cue was selected for study to determine its relative importance to the outcomes of the sorting task. Although generally used, the effects of sorting cue presence or absence have not been explored. If the sorting cue itself is a strong determinant of sorting behavior, then the results of differentiating sorting cues could be explored.

The implicit sorting cue treatment received only task-orienting instructions--"sort those verbs together which you feel should be together." Subjects in the explicit sorting cue treatment received the explicit sorting cue--"sort these verbs according to your views of facilitating learning in the classroom"--several times in different permutations in addition to the task-orienting instructions. All subjects were given general instructions concerning the physical nature of the task.

The administration of an explicit sorting cue which reveals some substantive content should indicate something of the expected structure and should thus affect both the number and quality of manifest categorizations. In addition, the task should be more clearly defined resulting in shorter sorting times. Subjects receiving an implicit sorting cue which is primarily operational should be less clear of the nature of their task and show greater variation in the number of categories which they form.

The final manipulated variable was re-sorting. This portion of the procedure was an addition based on the early experimental findings ". . .to provide an opportunity for sorters to review the composition of their categories. . . " (Miller et al., 1967, p. 105). It was primarily intended ". . .to ensure that (stimuli) were homogeneously grouped and not necessarily to provide opportunity for extensive restructuring or redefinition of categories" (ibid., p. 106). To achieve this function, re-sorting should primarily affect the quality of categorizations, but not necessarily their number. In addition, this re-sorting phase should require additional sorting time to complete.

Thus, the design of the study is a complete factorial design with two levels of sorting cue (explicit versus implicit sorting cue), three types of initial-stimulus presentation (initial-homogeneous, initial-heterogeneous, and completely-randomized stimulus decks), and two re-sorting effects (re-sorting versus no re-sorting).

There were three outcome variables in the study. Number of manifest categories was determined by examining the results of the sorting process for each subject. Sorting time was measured as total time, in rounded minutes, to complete the sorting task.

There were two quality of sort measures, Each measure estimated the quality of the sort as compared to a criterion sort. In this study the criterion sort was the combined S-matrices (a statistic obtained from LPA) which were obtained from the Miller (1967) study. Cell #12 of the present design was analogous to the sorting conditions under which that study was completed. Thus, quality of sorting estimates the resemblance of the results of this study to the results which were produced by the paradigmatic methodology which was unbiased and most refined.

There has been a need for obtaining methods of scoring individual categorization behavior ". . .which accurately reflect quality of conceptual categorization, as well as the number of categories" (Sloane, Gorlow, and Jackson, 1963, p. 402). Prototypic Discordance (PD) has been presented as one such method (Miller et al., 1967). It was designed to measure the ". . .extent to which the composition of a sorter's categories differed from the composition of the latent partition" (ibid., p. 125). PD is defined as:

$$PD = \sum_i \sum_j ({}_{ij}\text{th element of the S-matrix for the total sample} - {}_{ij}\text{th element of the S-matrix for a given subject})^2.$$

The S-matrix is the symmetric joint proportion matrix indicating the probability that any two items were sorted together. Thus, larger PD weights will be obtained for poorer sorts and indicate a lack of concordance with other sorters.

A second measure has been proposed by the author and was considered as an exploratory measure in this dissertation. The Conceptual Disparity (CD) score is also based on the sample population S-matrix, but considers the latent category (Φ) matrix as well.

The equations consist of two stages. In stage one, a standardizing coefficient (CD*) is derived from the S and Φ matrices by the following equations:

$$\underset{NSxNLC}{\Lambda} = \underset{NSxNS}{S} \cdot \underset{NSxNLC}{\Phi}$$, where NS = number of stimuli, and NLC = number of latent categories

$$K = \underset{NSxNLC}{\Lambda} \text{ xx } \underset{NSxNLC}{\Phi}$$, a Haddamard multiplication.

$$CD^* \quad \sum_{i=1}^{NS} \sum_{j=1}^{NLC} K_{ij}$$

In stage two, the Conceptual Disparity (CD) score is computed from the sample joint proportion (S) matrix, the matrix of manifest partitioning for a given subject (Z_i), and the standardizing coefficient (CD*) by

$$\underset{NSxNMC}{\Lambda} = \underset{NSxNS}{S} \cdot \underset{NSxNMC}{Z_i}$$, where NMC = number of manifest categories

$$\underset{NSxNMC}{K} = \underset{NSxNMC}{\Lambda} \; xx \; \underset{NSxNMC}{Z_i}$$

$$CD = ½ \left(CD^* - \left(\sum_{i=1}^{NS} \sum_{j=1}^{NMC} K_{ij} \right)\right)$$

In each stage, the joint proportion (S) matrix is postmultiplied by either the latent category (Φ) or manifest partition (Z_i) matrix and then this product is Haddamard multiplied (element-by-element multiplication) by these same matrices to produce a matrix K. This K matrix is simply a joint proportion (S) matrix which has been re-scaled by either the latent category (Φ) matrix or the manifest partition (Z_i) matrix. The elements of the K matrix are then summed and subtracted from the standardizing coefficient to give CD.

Thus, we arrive at a score which estimates the degree of disparity for a given manifest sort from the underlying latent structure. In addition, the sign of the score may indicate whether the number of manifest categories is greater than, or less than, the number of underlying latent categories.

In a pilot computation four latent categories were assumed as the underlying latent structure for seven stimulus items. For all manifest partitions with at least one more (less) category than the number of latent categories, the computed CD's were positive (negative).

The computational values of CD contain information not only about the quality, but also about the number of manifest partitions. This statistic is limited only in the extreme cases where all NS stimuli are sorted into either 1 category or NS categories, for which there is no solution.

METHODOLOGY:

Subjects

The subjects of this study were twelfth-grade, male students drawn from two senior high schools within the same school district of white, middle class communities in the suburbs of a large midwestern city.

An all male sample was selected to negate the possibility of sex differences as were found in previous studies involving cognitive style. Their twelve years of schooling experience should make them aptly suited for the stimuli to be utilized in the sorting procedure. The results from their sorts could then be compared with the already obtained results from teacher trainees and experienced elementary and secondary school teachers.

The subjects were selected from senior physical education classes. One hundred twenty-five subjects completed all phases of testing. They ranged in age from 17-2 to 19-9 years of age, with a mean of a little over 18 years and a standard deviation of over 5½ months. Since most graduating seniors are either 17 or 18 years of age and the mean for this study was over 18 years, it was decided to covary age as older seniors may have encountered learning difficulties during their schooling.

Sorting stimuli

The F-sort was completed by each subject utilizing a refinement of the fifty education-relevant verbs used in later portions of the Wisconsin study (Miller et al., 1967). Present tense, third person verbs which described definite classroom actions comprised these sorting stimuli.

The refinement of these fifty verbs by the present study attempted to eliminate ambiguities in the latent category structure. The original data from one of the most popularized of the Wisconsin sub-studies--the elementary and secondary teacher data (ibid.)--was secured and analyzed by Latent Partition Analysis (LPA). The category selection criterion was the number of non-iterated successive differences between roots greater than or equal to 0.10, a criterion which Gross (1970) found to be the most efficient for either real or artificial data.

The verbs which were rejected as ambiguous were: advises, answers, assigns, confirms, discusses, enforces, exemplifies, questions, reasons and tutors. The remaining 40 verbs are listed in Table 2. The resulting 9-category solution of these 40 verbs was extremely well structured.

Procedure

On the first day of testing, all subjects within a classroom were given the three tests of cognitive style. The Pettigrew Estimation Questionnaire was administered first, followed by the 10-minute, timed Hidden Figures Test--Form V, and concluding with

TABLE 2

LIST OF SELECTED TEACHER VERBS

1	Arranges	21	Organizes
2.	Clarifies	22	Penalizes
3	Commends	23	Permits
4	Controls	24	Persuades
5	Convinces	25	Plans
6	Demands	26	Regulates
7	Demonstrates	27	Reinforces
8	Displays	28	Reminds
9	Drills	29	Repeats
10	Encourages	30	Reprimands
11	Evaluates	31	Restricts
12	Explains	32	Reviews
13	Grades	33	Rewards
14	Illustrates	34	Schedules
15	Impels	35	Simplifies
16	Inspires	36	Stimulates
17	Interprets	37	Supervises
18	Introduces	38	Tests
19	Judges	39	Threatens
20	Lectures	40	Urges

Form I of the Clayton and Jackson, paper-and-pencil Object Sort Test.

On the second day of testing, all subjects within a classroom completed the F-sort with the 40 education-relevant verbs. Total testing time for each classroom was about 90 minutes, excluding the time for make-ups. All testing was completed under the supervision of the author.

Classrooms at the first school were randomly assigned to sorting cue and re-sorting treatments. Stimulus-presentation treatments were randomly assigned within classrooms. Four classrooms at the first school were sampled so that each cell would contain at least ten subjects. However, due to the nature of physical education scheduling, some classrooms did not have the expected thirty students. Therefore, students from one classroom at the second school were selected and randomly assigned to those cells with smaller numbers of subjects.

Analysis

The results passed through a three-stage analysis. During stage one, LPA was utilized to obtain the underlying latent categorization of the total sample. Then, number of manifest categories, the Prototypic Discordance score and the Conceptual Disparity score were computed for each subject. These sorting behavior measures, plus sorting time, became the input for stage two, where Pearson product-moment correlations were computed among variables.

The third stage consisted of three parts. For the first part the effects of the concomitant variables--age and the cognitive style measures--were tested by a regression analysis with number of manifest categories as the dependent variable. This was followed by an analysis of covariance (ANCOVA) with the same independent variables as covariables and number of manifest categories as the dependent variable in an effort to determine the effects of the design variables of sorting cue, homogeneity of initial-stimuli, and re-sorting.

The second and third parts consisted of the same covariables utilized in a regression analysis and ANCOVA to test the same design variables. However, the dependent outcome variable for the second part was sorting time, with number of manifest categories as an additional covariate, and the dependent variables for the third part were the Prototypic Discordance and Conceptual Disparity quality of sorting measures, with the additional covariates of number of manifest categories and sorting time.

RESULTS:

Six of the eleven variables examined in the study were not normally distributed and required logarithmic transformations. These variables included equivalence range and its two subscores, sorting time, number of manifest categories and Prototypic Discordance scores. Univariate statistics for all variables are presented in Table 3.

Some interesting and expected results can be gleaned from these means. In the study reported in Miller et al. (1967) using 84 percent females, the average score on the Hidden Figures Test

TABLE 3

UNIVARIATE STATISTICS, BY VARIABLE

No.	Coded Name	(Full name in parenthesis)	Mean	S.D.	Minimum Value	Maximum Value
1	AGE	(age of subjects, in months)	216.87	5.51	206.00	237.00
2	ACT	(ACT composite performance test)	21.78	5.28	7.00	32.00
3	HFT	(Hidden Figures Test score)	8.79	4.71	0.00	16.00
4	C-W	(Category Width score)	70.99	17.63	33.00	120.00
5	EQ.R	(Equivalence Range score)	12.59	6.13	1.00	28.00
			2.38	0.60	0.00	3.33
6	CONDIF	(Conceptual Differentiation score)	9.25	3.33	1.00	16.00
			2.14	0.47	0.00	2.77
7	COMP	(Compartmentalization score)	3.34	4.02	0.00	19.00
			1.07	0.90	0.00	2.99
8	TIME	(Sorting time, in minutes)	16.44	6.82	4.00	39.00
			2.71	0.43	1.39	3.66
9	NO.C	(Number of manifest categories)	7.03	3.72	2.00	21.00
			1.83	0.49	0.69	3.04
10	PD	(Prototypic Discordance score)	111.06	56.63	40.29	349.31
			4.59	0.48	3.70	5.86
11	CD	(Conceptual Disparity score)	-9.79	17.36	-74.36	22.35

Where two scores are listed, the top score is the raw score and the bottom score is the logarithmically transformed score.

was only 6.4 correct, while the males in the present study averaged 8.8 correct. This supports previous findings that males perform better on embedded figures tasks. Also, the subjects in Miller's study (ibid.) had lower category width scores than in the present study (65.6 versus 71.0) supporting previous research findings of greater category widths for males. This finding is somewhat reinforced by the average number of stimuli included in each category (6 in the average 7 manifest categories in this study versus 5 in the average 10 manifest categories in Miller's study).

In order to examine the relationships among variables, Pearson product-moment and the error correlations were computed. Only the latter computations are presented here (Table 4) since they better represent the within cell correlations between variables. With the exception of the correlation of the ACT performance measure with Hidden Figures Test (field dependence) results, the only significant correlations involved equivalence range and its subscores and the four outcome measures. [Because an intelligence measure was desired, but could not be obtained and because many subjects did not take the ACT and means had to be used, the ACT performance measure was dropped from further consideration.]

Analyses to test the model were computed in four parts, with each part focusing on one of the outcome variables. For each of these parts of the model, adjusted cell means were computed, the effects of the measured variables were analyzed by a regression analysis and the effects of the manipulated variables were tested in an analysis of covariance.

TABLE 4

ERROR CORRELATION MATRIX AMONG TRANSFORMED VARIABLES IN THE STUDY

	AGE	ACT	HFT	C-W	EQ.R	CONDIF	COMP	TIME	NO.C	PD	CD
AGE	1.000										
ACT	-0.184	1.000									
HFT	-0.086	0.244*	1.000								
C-W	-0.060	0.165	0.088	1.000							
EQ.R	-0.075	-0.041	-0.059	0.08[illegible]	1.000						
CONDIF	-0.006	-0.076	-0.087	0.110	0.911**	1.000					
COMP	-0.151	0.065	0.010	0.075	0.803**	0.514**	1.000				
TIME	0.042	-0.042	-0.019	-0.015	0.110	0.063	0.192	1.000			
NO.C	-0.060	-0.001	-0.039	0.045	0.316**	0.226*	0.370**	0.375**	1.000		
PD	0.147	-0.087	-0.015	-0.168	-0.230*	-0.160	-0.303**	-0.388**	-0.895**	1.000	
CD	0.055	-0.068	-0.006	-0.017	0.197*	0.136	0.262**	0.3[illegible]0**	0.818**	-0.822**	1.000

113 degrees of freedom

*p < .05
**p < .01

The adjusted cell means for number of manifest categories are presented in Table 5. In the regression phase, the only significant independent variable was the Compartmentalization subscore ($F=10.703$, d.f.=1 and 108, $p<.002$). The F-ratios for age and the other cognitive style measures were all less than 0.2. In the ANCOVA phase, a contrast comparing the sorters receiving homogeneous initial-stimuli with the mean of the other two stimulus-presentation groups was significant ($F=3.160$, d.f.=1 and 108, $p<.079$), but a similar contrast comparing the completely-randomized group with the mean of the other two groups was not significant ($F<1$). In addition, the effects of sorting cue were highly significant ($F=7.892$, d.f.=1 and 108, $p<.006$). However, all other effects were non-significant ($F<1.5$).

The adjusted cell means for sorting time are given in Table 6. In the regression phase, the only significant independent variable was number of manifest categories ($F=13.778$, d.f.=1 and 108, $p<.001$). The F-ratios for age and all of the cognitive style variables were less than unity. In the ANCOVA phase, re-sorting was highly significant ($F=12.102$, d.f.=1 and 108, $p<.001$), as was the sorting cue by re-sorting interaction ($F=11.327$, d.f.=1 and 108, $p<.002$). However, all other effects were non-significant ($F<2$).

The adjusted cell means for Prototypic Discordance scores are presented in Table 7. In the regression phase, only the field dependence measure (HFT scores) and the equivalence range subscores were <u>not</u> significant ($F<2$). Category width was highly significant

TABLE 5

CELL MEANS FOR NUMBER OF MANIFEST CATEGORIES* AND

LOG NUMBER OF MANIFEST CATEGORIES ADJUSTED FOR 5 COVARIATES**

		INITIAL HOMOGENEOUS STIMULI	INITIAL HETEROGENEOUS STIMULI	COMPLETELY RANDOMIZED STIMULI	RE-SORTING AVERAGES	SORTING CUE AVERAGES
IMPLICIT SORTING CUE	NO RE-SORT	8.820 2.177	5.376 1.682	7.901 2.067	5.512 1.707	7.008 1.947
	RE-SORT	6.666 1.897	7.257 1.982	6.534 1.877	6.271 1.836	
EXPLICIT SORTING CUE	NO RE-SORT	6.013 1.794	5.068 1.623	4.778 1.564		5.512 1.707
	RE-SORT	6.385 1.854	5.824 1.762	5.186 1.646		
INITIAL STIMULI AVERAGES		6.890 1.930	5.824 1.762	5.977 1.788		

*These scores represent a conversion from the transformed scores back into the metric of the raw scores by the formula

$$\text{Raw Score} = e^{\text{Transformed Score}}$$

**The covariates were Age, Category Width, Field Dependence (HFT score), and the Conceptual Differentiation and Compartmentalization subscores of Equivalence Range.

The figures in each cell are in the order indicated in the table title.

TABLE 6

CELL MEANS FOR SORTING TIME* AND LOG SORTING TIME ADJUSTED FOR 6 COVARIATES**

		INITIAL HOMOGENEOUS STIMULI	INITIAL HETEROGENEOUS STIMULI	COMPLETELY RANDOMIZED STIMULI	RE-SORTING AVERAGES	SORTING CUE AVERAGES
IMPLICIT SORTING CUE	NO RE-SORT	16.314 2.792	13.640 2.613	16.248 2.788	17.167 2.843	15.816 2.727
	RE-SORT	16.478 2.802	14.041 2.642	15.272 2.726	13.450 2.599	
EXPLICIT SORTING CUE	NO RE SORT	19.846 2.988	21.073 3.048	16.979 2.832		15.105 2.715
	RE-SORT	12.949 2.561	10.697 2.370	12.085 2.492		
INITIAL STIMULI AVERAGES		16.216 2.786	14.411 2.668	15.029 2.710		

The figures in each cell are in the order indicated in the table title.

*These scores represent a conversion from the transformed scores back into the metric of the raw scores by the formula

$$\text{Raw Score} = e^{\text{Transformed Score}}$$

**The covariates were Age, Category Width, Field Dependence (HFT score), the Conceptual Differentiation and Compartmentalization subscores of Equivalence Range and Number of Manifest Categories.

TABLE 7

CELL MEANS FOR PROTOTYPIC DISCORDANCE* AND LOG PROTOTYPIC DISCORDANCE SCORES

ADJUSTED FOR 7 COVARIATES**

		INITIAL HOMOGENEOUS STIMULI	INITIAL HETEROGENEOUS STIMULI	COMPLETELY RANDOMIZED STIMULI	RE-SORTING AVERAGES	SORTING CUE AVERAGES
IMPLICIT SORTING CUE	NO RE-SORT	101.697 4.622	100.786 4.613	115.353 4.748	102.207 4.627	106.698 4.670
	RE-SORT	105.214 4.656	97.905 4.584	121.389 4.799	96.737 4.572	
EXPLICIT SORTING CUE	NO RE-SORT	87.707 4.474	99.385 4.599	110.498 4.705		92.573 4.528
	RE-SORT	84.099 4.432	85.541 4.449	90.831 4.509		
INITIAL STIMULI AVERAGES		94.255 4.546	95.679 4.561	108.853 4.690		

The figures in each cell are in the order indicated in the table title.

*These scores represent a conversion from the transformed scores back into the metric of the raw scores by the formula

$$\text{Raw Score} = e^{\text{Transformed Score}}$$

**The covariates were Age, Category Width, Field Dependence (HFT score), Sorting Time, Number of Manifest Categories and the subscores of Equivalence Range.

(F=10.369, d.f.=1 and 108, p<.005), as was number of manifest categories (F=378.700, d.f.=1 and 108, p<.001). Both age (F=5.359, d.f.=1 and 108, p<.050) and sorting time (F=3.004, d.f.=1 and 108, p<.086) were also significant contributors to the model. In the ANCOVA phase, re-sorting was the only main effect which was not significant (F<2). Sorting cue was highly significant (F=15.458, d.f.=1 and 108, p<.001). Both initial-stimulus presentation single degree of freedom tests were also significant: Completely-randomized versus the mean of the other two groups (F=7.375, d.f.=1 and 108, p<.008) and Initial-homogeneous versus the mean of the other two groups (F=3.495, d.f.=1 and 108, p<.065). The sorting cue by re-sorting interaction was also again significant (F=3.447, d.f.=1 and 108, p<.067).

The adjusted cell means for the Conceptual Disparity quality of sorting measure are given in Table 8. In the regression phase, the only significant independent variable was number of manifest categories (F=172.341, d.f.=1 and 108, p<.001). With the exception of age (F=3.140, d.f.=1 and 108, p<.082), all of the other independent variables, including sorting time, had low F-ratios (F<2). In the ANCOVA phase, the only significant manipulated variable was Initial-stimulus presentation, and both single degree of freedom contrasts were significant (Completely-randomized versus other: F=3.113, d.f.=1 and 108, p<.081; Homogeneous versus other: F=5.036, d.f.=1 and 108, p<.027). All other manipulated variables were non-significant (F<1.5).

<u>The resultant model</u>

Based on the analyses discussed above, the relationships

TABLE 8

CELL MEANS FOR CONCEPTUAL DISPARITY SCORES ADJUSTED FOR 7 COVARIATES*

		INITIAL HOMOGENEOUS STIMULI	INITIAL HETEROGENEOUS STIMULI	COMPLETELY RANDOMIZED STIMULI	RE-SORTING AVERAGES	SORTING CUE AVERAGES
IMPLICIT SORTING CUE	NO RE-SORT	-12.80	-8.49	-12.45	-10.73	-10.40
	RE-SORT	-13.92	-4.78	-9.96	-9.02	
EXPLICIT SORTING CUE	NO RE-SORT	-9.99	-8.22	-12.40		-9.35
	RE-SORT	-14.53	-3.88	-7.06		
INITIAL STIMULI AVERAGES		-12.81	-6.34	-10.47		

*The covariates were Age, Category Width, Field Dependence (HFT score), Sorting Time, Number of Manifest Categories and the subscores of Equivalence Range.

between the variables of the model can be presented as they pertain to the present study. For each of the independent variables the relationships to the dependent variables within each portion of the model are presented as raw regression coefficients. The effects of the design variables are also indicated, but are shown as least-square estimates adjusted for the appropriate covariates. This entire model is presented as Figure 2.

The standard errors for each statistic are presented in parenthesis following the statistic. All non-significant effects, expected or just tested, are indicated by dotted lines. Note that the significant effects of the sorting cue by re-sorting interaction are also presented.

DISCUSSION:

Field dependence was expected to be a significant predictor of each of the outcome variables, but was not related to any of these dependent variables. Apparently, the visual embedded figures task and the cognitive task of attending to relevant stimulus aspects are unrelated tasks.

The Conceptual Differentiation subscore of equivalence range was also unrelated to the predicted sorting outcomes of number of manifest categories and sorting time. There appears to be little relationship between the number of multiple-object categories formed on the paper-and-pencil Object Sort Test and the number of manifest categories formed during free-sorting tasks.

The Compartmentalization subscore of equivalence range was

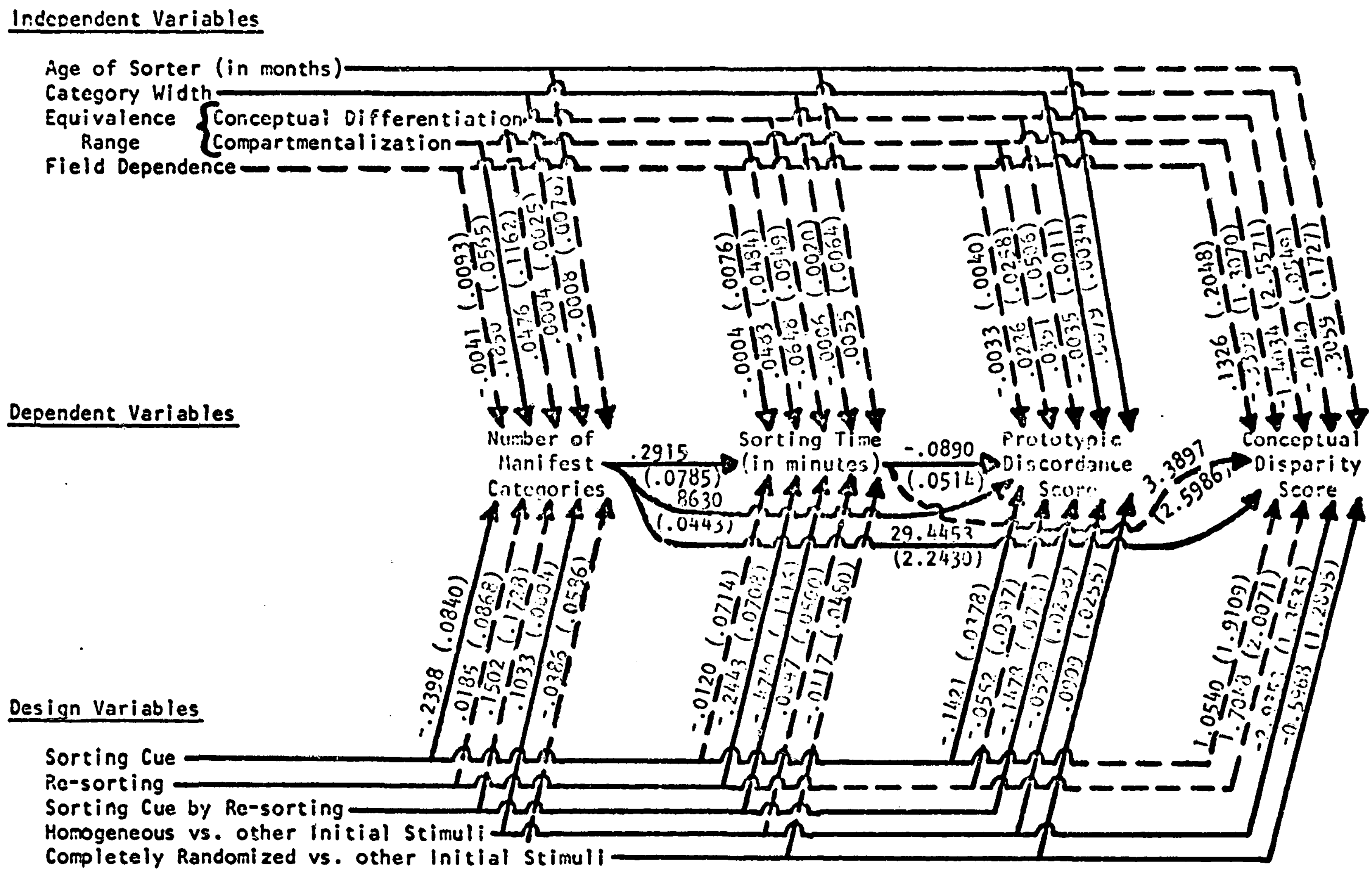


Figure 2. Relationships of Variables Within the Sorting Model
(See text on page 27 for explanation)

significantly related to the number of manifest categories formed, but not to sorting time or quality of these categorizations. It was significantly correlated with all of the sorting outcomes with the exception of sorting time. Thus, it would be sensible to covary equivalence range, or at least the Compartmentalization subscore, in future studies to account for this individual preference within sorting behavior which is not due to treatment.

Age and category width were both expected to affect quality of sorting, and both of these variables were significant on the Prototypic Discordance measure. However, only age was significant on the Conceptual Disparity measure. If age differs widely in the sample of sorters it would be important to covary its effects. Also, the cognitive style of category width significantly affects quality of sorting and should be covaried.

Number of manifest categories was a significant predictor of both sorting time and quality of the sort. One would expect that it would take more sorting time to complete the physical comparisons and sorting manipulations if there are more manifest categories. In addition, as the number of manifest categories approaches the number of underlying latent categories one would expect sorts of a higher quality.

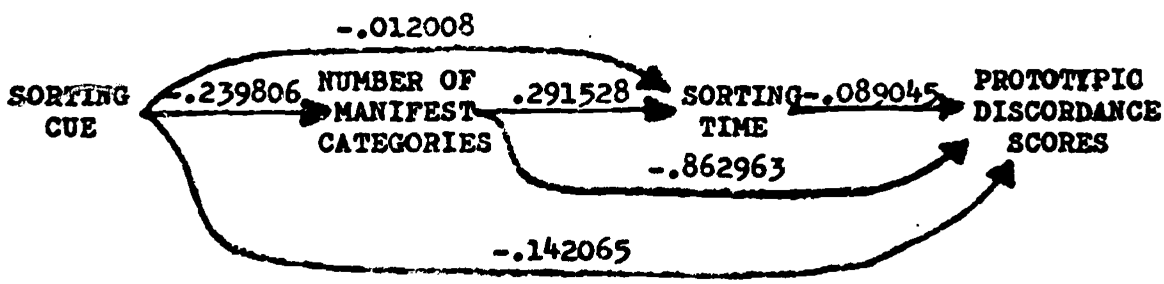
Sorting time was a significant predictor of sorting quality for Prototypic Discordance scores, but not for Conceptual Disparity scores. Thus, it appears that sorting time has at least a marginal effect on sorting quality and should be considered as a covariate.

Presentation of initial-stimuli was a significant predictor of both number and quality of manifest categorizations, but not of sorting time. These expected results strengthen the argument for presenting the same order of stimuli, but one randomly generated, to all sorters to cancel out such effects.

Sorting cue significantly affected both number and quality of manifest categorizations, but contrary to expectations did not affect the sorting time. Thus, selection of the proper sorting cue is an important requisite for any sorting experimentation and should be carefully considered. However, an explicit sorting cue will not significantly affect the time necessary to complete the sort. An interesting way of looking at the effects, both direct and indirect, is illustrated by the flow chart included in Table 9 below. Here we see that a strong direct effect of sorting cue on Prototypic Discordance scores is somewhat mitigated by an effect which is mediated by number of manifest categories, reducing the total effect. Similar tables could be constructed for the other

TABLE 9

EFFECTS OF SORTING CUE ON PROTOTYPIC DISCORDANCE SCORES



Direct Effect	-.142065
Effect mediated by number of manifest categories only	.206943
Effect mediated by sorting time only	.001069
Effect mediated by both number of manifest categories and sorting time	.006225
Total Effect	.072172

effects and outcome variables.

Re-sorting significantly affected only sorting time, but not the quality of the sort. It was anticipated that re-sorting would take additional sorting time. However, subjects who were encouraged to re-sort took significantly less time. Perhaps these subjects completed their initial categorizations very quickly and then used the re-sort as a check on these categorizations. However, re-sorting failed to achieve its avowed function of strengthening the quality of existing categorizations.

A final result was an unanticipated sorting cue by re-sorting interaction which was significant for both the sorting outcomes of sorting time and Prototypic Discordance scores.

Conceptual Disparity scores were presented as an experimental measure in this study. Theoretically, they should have a mean of zero with their magnitude indicating departure from a high quality sort and their sign indicating the relationship of the number of manifest categories with respect to the number of underlying latent categories. However, the criterion underlying sort used in this study was subjected to a mathematical refinement and reanalysis which no longer represented any real sorting population. In addition, the average number of manifest partitions for the present study was considerably less than the number of latent categories obtained from analysis of the refined data. Thus, Conceptual Disparity scores are at best only an experimental measure in the present study and all results and conclusions based on this variable must be tentative.

CONCLUSIONS AND IMPLICATIONS:

On the basis of this research it would seem that some cognitive styles and variations in sorting procedure do affect sorting outcomes. Specifically,

1. The cognitive style of equivalence range significantly affects the number of manifest categorizations.
2. The cognitive style of category width significantly affects the quality of manifest categorizations.
3. The cognitive style of field dependence is unrelated to the outcomes of the F-sort.
4. Type of sorting cue significantly affects both number and quality of manifest categorizations.
5. Type of initially-presented stimuli significantly affects the number and quality of manifest categorizations.
6. Re-sorting significantly affects sorting time, but not the number or quality of manifest categorizations.
7. A sorting cue by re-sorting interaction affects sorting time and quality of manifest categorizations.

The conceptual model of sorting which was developed and tested by this research should be the basis for many revisions and further testing of the sorting procedures. The cognitive styles of equivalence range and category width, age, and sorting outcomes should be covaried where appropriate and careful consideration should be given to the selection of a sorting cue and randomization of stimuli.

LIMITATIONS OF THE STUDY:

The limitations of the Conceptual Disparity scores have already been discussed. In addition, subjects in the no re-sorting treatment were in no way prevented from re-sorting, but were not encouraged to re-sort. Also, subjects in the re-sort treatment were only encouraged, but were not required, to re-sort. This flexibility could have affected the results on re-sorting.

SUGGESTIONS FOR FUTURE STUDY:

Re-sorting should be more strictly controlled in future experimentation so that its effects can be more thoroughly examined. Initial-stimuli could be explored in more detail on a one-to-one basis in an attempt to isolate sorter tendencies from the importance of stimulus characteristics. The effects of varying explicit sorting cues should also be explored. Additional procedural variations not explored in this research, such as number of stimuli, maximum or controlled sorting times, number of sorters, and the like, could also be examined.

Finally, the findings reported here should be replicated and extended so that we may better understand sorting behavior. It is especially important that the Conceptual Model of Sorting be replicated with respect to its significant findings.

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