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THE RELATIONSHIP OF SELECTED COGNITIVE ABILITIES TO CONCEPT ATTAINMENT AND INFORMATION PROCESSING.

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FACTOR ANALYSIS WAS CONDUCTED ON SEVERAL COGNITIVE ABILITIES IN AN EFFORT TO RELATE THESE ABILITIES TO TASKS OF CONCEPT ATTAINMENT AND INFORMATION PROCESSING. THE ABILITIES UNDER CONSIDERATION WERE DESCRIBED AS GENERAL REASONING, VERBAL COMPREHENSION, INDUCTION, DEDUCTION, SPATIAL SCANNING, PERCEPTUAL SPEED, ROTE MEMORY, AND SPAN MEMORY. ABILITY AND TASK SCORES WERE OBTAINED FROM A SAMPLE OF 94 FEMALE COLLEGE STUDENTS ENROLLED IN EDUCATIONAL PSYCHOLOGY. INTERCORRELATIONS AND FACTOR ANALYSES WERE PERFORMED ON 34 TASK AND ABILITY VARIABLES. THREE ABILITIES (GENERAL REASONING, INDUCTION, AND VERBAL COMPREHENSION) WERE FOUND TO BE HIGHLY RELATED TO CONCEPT ATTAINMENT AND INFORMATION PROCESSING. THE CONCEPT ATTAINMENT AND INFORMATION PROCESSING TASKS WERE OBSERVED TO BE RELATIVELY DISTINCT, RATHER THAN UNITARY ACTIVITIES. (JH)

THE RELATIONSHIP OF SELECTED COGNITIVE ABILITIES TO CONCEPT ATTAINMENT AND INFORMATION PROCESSING

RESEARCH AND DEVELOPMENT
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Technical Report No. 11

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PREFACE

The primary goal of the R & D Center for Learning and Re-education is to improve cognitive learning in children and adults, commensurate with good personality development. Knowledge is being extended about human learning and other variables associated with efficiency of school learning. This operation is being performed through synthesizing present knowledge and through conducting research to generate new knowledge. In turn, the knowledge is being focused upon the three main problem areas of the Center: developing exemplary instructional systems, refining the science of human behavior and learning on the one hand and the technology of instruction on the other, and inventing new models for school experimentation, development activities, etc.

This technical report is based on the doctoral dissertation of Elmer A. Lemke. Members of the examining committee were Chester W. Harris, Chairman; Herbert J. Klausmeier; Edgar F. Borgatta; Theodore L. Harris; and J. Kenneth Little.

Dr. Lemke reports a study of the role of eight convergent cognitive abilities on concept attainment behavior studied under two conditions, selection of instances and reception of instances. Results indicate that memory does not have a significant role in laboratory concept attainment tasks although general reasoning, induction, and verbal comprehension are important. Dr. Lemke proposes a study, designed for an analysis of abilities by type of information presented, to further clarify the relationship of variables in concept learning.

Herbert J. Klausmeier
Co-Director for Research

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ABSTRACT

Scores from 16 tests, two for each of 8 abilities (General Reasoning, Verbal Comprehension, Induction, Deduction, Spatial Scanning, Perceptual Speed, Rote and Span Memory), and 18 scores from concept-attainment and information-processing tasks were obtained from each of 94 female Ss enrolled in educational psychology at the University of Wisconsin. The 34 task and ability variables were intercorrelated, then factored using Alpha factor analysis. The 12 Alpha factors were rotated to an oblique solution according to the Harris-Kaiser criterion. Three abilities (General Reasoning, Induction and Verbal Comprehension) were found to be related to three concept-attainment and two information-processing factors. The concept-attainment and information-processing tasks were seen to be relatively distinct rather than unitary activities.

I
INTRODUCTION

In the scientific study of human learning, variables have been classified as stimulus, organismic, and response or input, intervening, and output. Either of these systems is applicable to the study of concept attainment; however, another scheme is more typical of laboratory experiments in concept attainment completed thus far: stimulus, referring to variables associated with the material in which the concepts are embedded; instructions, referring to information presented to the subjects in oral or written form concerning the task, procedures, and the like; organismic, referring to the abilities inferred from the test performance of the subjects; motivational, dealing with incentives, reinforcements, sets, etc.; and response. While the goal of a comprehensive program of research is to ascertain functional relationships among variables in all of the categories, the present study focuses primarily on organismic variables.

Such a program of research differs from that of Hovland (1952) and Hunt (1962) who have treated concept attainment as information processing. Their approach has been to treat concept learning and information processing as synonymous. Testing this line of thinking, Tagatz (1963) found only a small positive correlation, .22, between information processing and concept attainment. Tagatz defined information processing as the ability of a S to specify the inclusion, exclusion, or indeterminance of a card to membership in a group of cards which are specified as belonging or not belonging to a concept. He defined concept attainment as the ability to utilize information from positive and/or negative instances in determining a concept. (See p. 4 for a more detailed description of concept attainment and information processing as defined in the present study.)

Despite the substantial amount of research on concept attainment, the relationship of organismic variables to concept attainment has been given little attention. This investigation is specifically concerned with identifying those factors or abilities that are highly related to concept attainment and information processing. After a review of the hypothesized factors of intellect and tests intended to measure them, eight factors were selected for study based on their presumed relevance or lack of relevance to concept-attainment and information-processing tasks. A brief description of these eight factors, based on French et al. (1963), and an indication of their presumed relationship to concept attainment will clarify the rationale of the present study.

Rote Memory is defined as the ability to retain bits of unrelated material. When a S first encounters a large amount of stimulus material of the type used in this study, he may perceive it as being unrelated (although it is actually highly related). To attain a concept wherein information is tested successively, as in the present study, a S must be able to retain the information. Some type of memory appears to be required for efficient concept attainment as defined in Task 1 of this study. (Task 1 is described more fully on p. 4.)

Span Memory involves the ability to recall perfectly for immediate production a series of items after only one presentation. Although the mode of presentation was simultaneous in the concept attainment tasks, the S's identification of instances as exemplars or nonexemplars was sequential in Task 1. The instances' sequential identification by number was seen as a basis for including the Span Memory factor.

Perceptual Speed involves speed in finding figures, making comparisons, and carrying out other very simple tasks involving visual perception. Both concept-attainment tasks and the information-processing tasks of the present study presumably require the ability to make comparisons of figural material. The S must discriminate among visual stimuli and make comparisons in order to secure essential information.

General Reasoning is the ability to solve a broad range of problems that require production of a generally accepted correct solution, including those of a mathematical nature. Although the stimulus material in the present study is not mathematical, attaining a concept presumably requires the ability to compare information and to arrive at a correct solution.

Deduction involves the ability to reason from stated premises to their necessary conclusions. In the present study, the information-processing tasks might presumably have required this ability in that propositions of a similar type comprised the items of the information-processing tasks: If the focus card is a member of the group and the second stimulus card is also, does the third card definitely belong to the group, definitely not belong to the group, or can its membership not be determined?

Induction probably involves several abilities associated with the finding of general concepts that will fit sets of data, the forming and trying out of hypotheses. The concept attainment tasks presumably involved these abilities directly; to a lesser extent the information-processing tasks presumably did also.

Spatial Scanning requires the ability to explore visually a wide or complicated spatial field. Finding one's way through a paper maze is a test of this ability. A planning ability may also be involved. If this ability is related to any task in the present study, it should presumably be concept attainment Task 1, not the other performance tasks.

Verbal Comprehension is the ability to understand the English language. The importance of the factor in both the British factor hierarchy and the Thurstone studies suggested its inclusion in the investigation.

The present study then was designed to clarify relationships among cognitive abilities, information processing, and concept attainment. A factor analysis, to an oblique criterion, of the ability (cognitive variables) and task (information processing and concept attainment criterion variables) scores provided the model for the study. The matrix of intercorrelations of ability and task factors resulting from the oblique factor rotation provided the desired relationships.

II
METHOD

TASKS

Two concept-attainment tasks and an information-processing task were utilized in the experiment. The first task, a concept-attainment task, is described by Harris:

> The experimenter (E) chooses the concept to be attained. He then points out a card on a display of 64 cards that belongs to this group; this will be called the focus-card or (F). The subject (S) is then directed to choose one card at a time from the display; for each choice, E responds "yes" if the chosen card belongs to the group, "no" if it does not. S is told initially to specify the defining characteristics of the card group (the concept) whenever he believes he has solved the problem; if his "hypothesis" is correct, the game terminates; if not, he is told "no" and asked to continue the card choice. For such play, S's card choices in the order in which he makes them, and the hypotheses he offers in their order and in relation to his card choices, or solution, may be recorded (Harris, 1963, p. 1).

In the second concept-attainment task the S was confronted with a small number of cards presented simultaneously. Unless redundancy was introduced, only the minimum number of cards necessary to attain the concept was presented. Thus S was presented a small display and was requested to state the concept into which all the cards could be classified.

The information-processing task is described by Tagatz (1963):

> That part of the experiment dealing with information processing consisted of the S responding to 60 items. The first 30 were of the type in which one card, either an exemplar or a non-exemplar, was presented in addition to the exemplar focus card. The task was to specify the inclusion, exclusion, or indeterminateness of a third card to membership in a group of cards exemplifying the concept. The problems in which exemplars were presented num-

bered 15 and those presenting non-exemplars also 15. Of those 15 exemplar items, ten cards whose membership was to be determined were definitely exemplars of the same concepts as the focus card. The membership of the remaining 5 test cards could not be determined. In the 15 problems presenting a focus card and a non-exemplar, 10 test cards were definitely not exemplars and 5 were again not determinable. Thus these 30 items could be scored on the basis of test membership exemplar, non-exemplar, and indeterminate.

The second set of 30 items was constructed, using the same focus card and test cards as in the first subtest. The information presented in addition to the exemplar focus card consisted of two cards instead of one as was the case with the first subject. One of the two cards for each problem was an additional exemplar; the other was the same in kind as its counterpart in the first 30 items. The answers to the 30 items of the second subtest were identical to those in the first subtest. Thus, the two subtests were the same except that the information presented about the test card in the second subtest included the additional complexity of one card.

Table 1 gives the design of the arrangement of exemplar and/or non-exemplar instances and number of cards or items per test. As shown in Table 1, this information-processing task resulted in eight subscores of information processing based on the type of information contained in the stimulus material.

Table 1

Summary Description of Eight Information Processing Subtests

Subtest	1st Card	2nd Card	Decision Card	No. of Cards
1	yes	-	Inclusion	10
2	yes	-	Indefinite	5
3	no	-	Exclusion	10
4	no	-	Indefinite	5
5	yes	yes	Inclusion	10
6	yes	yes	Indefinite	5
7	yes	no	Exclusion	10
8	yes	no	Indefinite	5

Task 1, in which S selected instances from a total display, had these measures of efficiency: time required to attain the concept, an index of manifested information, and total number of cards chosen prior to attaining the concept. Task 2, wherein a minimally sufficient set of information was presented to S, had time to attain the concept as the index of efficiency. In the information processing task, scores on each of eight subtests were performance criteria. The index of manifest information in Task 1 was defined as amount of information manifested in the first hypothesis, or statement of the concept, from that potentially obtained. Thus, if five bits were potentially obtained but only three were manifested in the hypothesis, the index was .60. Ss were asked for a concept after their sixth card choice if one had not been previously offered.

Stimulus materials used in this investigation were patterned by Byers (1961) after the Wisconsin Card Sorting Task. The concept-attainment display consisted of an ordered arrangement of attributes, by rows and columns, which formed an 8×8 array of 64 cards. On every card six attributes were represented by one of two defining characteristics. These six attributes and their dichotomous defining charactersitics were:

1. Border Number: one-two
2. Border Continuity: solid-broken
3. Figure Number: one-two
4. Figure Size: large-small
5. Figure Color: red-green
6. Figure Shape: circle-ellipse

Each card was different from all other cards on the display in at least one of the dichotomous defining characteristics.

TESTS

A battery of 16 ability tests, 2 for each of eight factors previously mentioned, was administered to all Ss. The tests were from the Reference Kit for Cognitive Factors (French et al., 1963). Table 2 presents the factor, number of items, and reliability coefficients for each test. Reliability coefficients for variables measuring Perceptual Speed and Spatial Scanning factors are not reported because of

Table 2

Reliability Estimates of Identification Variables for Eight Hypothesized Factors

Factor	Test	No. of Items	Procedure	r_{tt}
Rote Memory	Object-Number	15	Split-Half	.68
	First & Last Names	30	Split-Half	.77
Verbal	Vocabulary	36	Split-Half	.86
	Advanced Vocabulary	36	Split-Half	.81
Deduction	Logical Reasoning	40	Split-Half	.72
	Nonsense Syllogisms	30	K. R. 20	.88
Span Memory	Auditory No. Span	24	K. R. 20	.62
	Auditory Letter Span	24	K. R. 20	.76
General Reasoning	Ship Destination	57	Split-Half	.93
	Necessary Arithmetic Operations	15	Split-Half	.74
Perceptual Speed	Finding A's	25		a
	Number Comparison	24		a
Induction	Locations	28	Split-Half	.82
	Letter Sets	30	Split-Half	.64
Spatial Scanning	Map Planning	20		a
	Maze Tracing Speed Test	24		a

[a] Traditional computational techniques not appropriate

the spuriously high coefficients resulting from the obvious speeding of these tests.

SUBJECTS

Subjects for the study were 94 graduate and undergraduate females from two educational psychology classes. All Ss participated in four sessions of group testing and a fifth individualized concept-attainment session. All Ss were in the age range 20 to 35 and had a median age of 21 years.

PROCEDURE

Each S attained a set of two selection concepts and a set of four presented concepts. For the first two concepts the S selected instances from a display in which all the stimulus material was presented simultaneously. The concepts to be attained were of two and three relevant attributes, e.g., small, red figures; two borders, small, red figures. Subjects were randomly assigned to one of two sequences in order to control for the complexity effect of the concepts. The sequences were: 2 attribute concept, 3 attribute concept; or 3 attribute concept, 2 attribute concept.

After attaining the first two selection concepts, each S attained four concepts from a minimally sufficient set of simultaneously presented information. These four concepts were solved in a sequence with positive and negative instances varying one attribute from the focus card in the first two concepts. In the last two concepts to be attained, negative instances were varied one attribute, but only one positive instance was used to attain the minimally sufficient set of information. The sequence was comprised of concepts of 2, 3, 2, and 3 relevant attributes.

The information-processing task was administered in a large group testing session after the individually administered concept-attainment session. Stimulus materials, or instances of concepts, were presented on 3 × 3 slides. Each slide thus comprised an item and was subsequently scored as correct or incorrect.

III
RESULTS

Two scale-free models, Incomplete Image analysis (Harris, 1962) and Alpha factor analysis (Kaiser and Caffrey, 1963), which rescale the reduced correlation matrix in the metric of the unique and common parts respectively, were employed as data reduction models. Only the Alpha model is reported in the present discussion.

A Normal Varimax rotation (Kaiser, 1958) of the Incomplete Image factors yielded 23 factors, 8 of which were uninterpretable. The same orthogonal criterion applied to the Alpha factors yielded a derived matrix of 12 factors, all of which were interpretable. The 12 Alpha factors, when rotated to the Normal Varimax criterion, were found to include the following factors identified by the experimental tests of cognitive abilities (Roman numerals in Table 3): (I) Verbal Comprehension, (IV) Rote Memory, (VI) Span Memory, (VII) Spatial Scanning, (X) Deduction, (XI) General Reasoning, and (XIII) Induction. The Perceptual Speed factor was not identified. Thus seven of the eight ability factors which the 16 experimental tests were supposed to measure were in fact identified.

Five factors identified by the loadings of the task variables—three concept-attainment and two informative-processing factors—were called (Table 3): (II) Information Processing (Inclusion-Exclusion), (III) Selection (Concept 2), (V) Presented concept, (VIII) Selection (Concept 1), (IX) Information Processing (Indeterminate).

Table 3

Rotated Factors of $H^{-1}(R-S^2)H^{-1}$

(Oblique Criterion)

Variable	V. I	I. P. II	Sel. III	R.M. IV	Pres. V	S.M. VI	S.S. VII	Sel. VIII	I. P. IX	D. X	G.R. XI	I. XII
1. Object-Number	-335	054	-062	689	162	064	066	-029	189	079	-052	062
2. First and Last Names	241	072	029	694	-163	-007	-101	-039	024	-006	-049	002
3. Vocabulary	736	035	049	038	-026	072	-009	150	-038	056	-096	021
4. Advanced Vocabulary	900	-112	010	000	-013	-001	037	-080	005	051	021	-142
5. Logical Reasoning	074	-077	043	042	061	-129	-013	-042	077	754	056	063
6. Nonsense Syllogisms	035	255	-431	-104	066	123	-122	158	-082	388	534	-136
7. Auditory Number Span	-026	-049	055	010	-009	839	068	-094	025	-039	113	-024
8. Auditory Letter Span	081	-061	012	072	019	750	084	052	-016	-106	004	034
9. Ship Destination	-066	017	022	-212	-030	015	213	-143	072	-068	711	094
10. Necessary Arithmetic Operations	005	-020	171	018	-127	025	-011	-298	166	157	866	-213
11. Finding A's	055	-112	-116	303	022	110	009	040	-307	-034	438	098
12. Number Comparisons Test	178	-040	072	221	031	-305	343	-112	-304	-084	074	046
13. Locations Test	-247	060	097	-060	-043	057	-071	172	-192	139	627	204
14. Letter Sets	-073	-034	036	074	037	019	-019	-083	-010	023	-027	809
15. Map Planning	016	080	093	-042	093	178	696	046	118	-020	-039	-078
16. Maze Tracing Speed Test	005	-117	-209	-054	-186	-085	484	250	-050	027	154	386
17. Selection 1, Time-to-Criterion	045	-099	-025	-035	314	-118	117	551	147	-110	253	-170
18. Selection 2, Time-to-Criterion	133	136	893	-059	268	180	073	189	-099	025	-030	-021
19. Selection 1, Manifest Index	-130	-155	414	006	-014	-074	-082	215	114	-072	159	012
20. Selection 2, Manifest Index	-106	-109	499	015	-349	-155	064	006	068	035	292	-066
21. Selection 1, Cards-to-Criterion	007	030	-050	-038	-152	014	061	921	056	025	-150	-041
22. Selection 2, Cards-to-Criterion	134	381	478	-085	-168	322	-061	281	-179	258	-275	175
23. Presented Concept 1	238	034	256	-042	291	-198	-102	169	-105	-032	-006	200
24. Presented Concept 2	098	-020	118	033	483	-146	138	013	-016	009	162	-030
25. Presented Concept 3	092	019	-125	037	373	057	-104	138	-163	-075	357	-117
26. Presented Concept 4	-125	009	069	-034	712	013	044	-141	117	102	-154	078
27. Infor. Proc., Yes-Inc	117	592	-001	144	-139	-088	-008	040	-068	-058	163	064
28. Infor. Proc., Yes-Ind	078	112	-121	-096	113	-005	-054	014	437	028	-061	376
29. Infor. Proc., No-No Excl	-010	735	-101	-035	041	-050	082	-066	048	-176	037	-076
30. Infor. Proc., No-Ind	112	227	038	-161	-026	-028	-213	-120	191	-328	443	223
31. Infor. Proc., Yes, Yes-Inc	-026	176	072	176	-150	-108	151	128	512	-017	189	-191
32. Infor. Proc., Yes, Yes-Ind	-027	-111	-022	173	095	059	049	062	654	042	-007	016
33. Infor. Proc., Yes, No-Ind	198	-132	132	097	077	017	-305	116	311	-110	190	080
34. Infor. Proc., Yes, No-Excl	-182	726	110	063	107	-028	016	021	-004	087	-111	-040

To observe ability-task relationships, the Alpha factor matrix was rotated to an oblique solution using the Harris-Kaiser (1964) criterion. Since some variables were of complexity greater than one, the A'A proportional to L case was used. Table 3 presents the 34 × 12 oblique factor matrix.

Underlined loadings of Table 3 provide the rationale for oblique factor descriptions. Only the Induction factor, educed from the Letter Sets and Locations tests, presented some difficulty in identification. Thurstone's (1940) isolation of this factor from the Letter Grouping test facilitated the factor identification (see also Kettner et al., 1959; Goodman, 1943; and Thurstone & Thurstone, 1941). The Spatial Scanning factor, previously isolated but unidentified by Thurstone & Thurstone (1941) and suggested by French et al. (1963) as representing a "planning" function, is also of interest. The strong involvement of this factor with tests from the reasoning domain suggest that there is, in fact, a strong convergent involvement in this type of activity.

The L matrix, the matrix of factor intercorrelations for the 12 task and ability factors, is presented in Table 4. Of 21 correlations among 7 ability factors (Table 4), 7 were positive and ranged between .238 and .579; Verbal Comprehension, General Reasoning, and Induction are involved in these 7 correlations. Of 10 correlations among three concept attainment and two information processing tasks, 5 were positive and ranged between .213 and .431; the factor Information Processing—Indeterminate Inclusion was involved in 3 of 5 positive correlations. Thus correlations among variables within each of two sets of variables were of about the same magnitude, and the proportion of the total was about the same.

Of 35 correlations between the set of seven ability variables and the set of five task variables, 12 were positive and ranged from .220 to .461. Of these 12 correlations, 10 involved General Reasoning and Induction; the other 2, Verbal Comprehension. General Reasoning correlated positively with all five of the task factors, the range being from .363 to .461. Induction also correlated with all five task factors, the range of _r_s being .229 to .353. Thus General Reasoning,

Table 4

Matrix of Intercorrelations of 12 Alpha Factors

Factor Description	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
I. Verbal Comprehension	1.000	073	164	092	220	016	-002	198	317	289	425	350
II. Information Processing, Inclusion-Exclusion		1.000	111	141	334	172	144	171	431	085	397	259
III. Selection I			1.000	105	058	098	060	415	157	116	366	353
IV. Rote Memory				1.000	033	038	194	-011	089	-020	165	200
V. Presented Concept					1.000	168	106	166	213	145	461	338
VI. Span Memory						1.000	047	116	173	095	128	057
VII. Spatial Scanning							1.000	124	025	089	305	249
VIII. Selection II								1.000	278	167	363	229
IX. Information Processing, Indeterminate									1.000	150	411	313
X. Deduction										1.000	238	127
XI. General Reasoning											1.000	579
XII. Induction												1.000

Note: All decimal points eliminated for off-diagonal elements.
Ability-task intercorrelations greater than .197 arbitrarily underlined.

Induction, and, to a lesser extent, Verbal Comprehension correlated substantially and consistently with concept attainment and information processing; the other four abilities—Rote Memory, Span Memory, Spatial Scanning, and Deduction—did not. Further, Information Processing—Indeterminate was the information-processing factor that correlated most consistently with other task factors and the cognitive factors, 6 of 11 _r_s ranging between .213 and .431. Presented Concept was the concept-attainment factor to correlate most consistently with task and cognitive ability factors, 5 of 11 _r_s ranging between .213 and .461.

IV
DISCUSSION

Low correlations were found between a set of cognitive abilities, a set of concept-attainment factors and a set of information-processing factors. However, several abilities—Verbal Comprehension, General Reasoning, and Induction—correlated consistently with the concept-attainment and information-processing factors.

The identification of three relatively distinct concept-attainment factors and two information-processing factors with only a few correlations of modest size among these factors was not anticipated. Consider the three concept-attainment factors. Two of these—Selection Concept I and Selection Concept II—resulted from measures of Ss' attaining two concepts in sequence, under identical experimental conditions, that is, in one sitting with identical instructions, materials, etc. Why did two separate factors result? Ss first attained a 2-attribute and then a 3-attribute concept, or a 3-attribute concept and then a 2-attribute concept. They were not informed of this attribute change, which affected the difficulty level of the concept. Apparently, the change in the number of attributes and the ordinal position affected performance in such a manner as to result in separate factors.

The third factor, Presented Concept, resulted from a very different experimental situation. Here the task was for Ss to attain four concepts of two and three attributes in sequence; however, only the minimum amount of information necessary to attain the concept under these conditions was presented. Thus attaining the concept under these conditions was distinctly different from that in which a large array was presented simultaneously and the Ss selected cards successively.

Information processing as defined by eight subtests also yielded two factors, one being based on items of the type where the card definitely was or was not a member of the concept, the other being based on items where insufficient information was presented to determine inclusion in the concept. Identification of the two factors suggests that information processing is not a unitary ability, much the same as concept attainment is not. Further, information processing as defined in this study is not closely related to concept attainment.

The above considerations lead to a further question concerning the nature of concept attainment and information processing, using stimulus material of the type included in the present study. How unique are tasks that result, for example, in three concept-attainment and two information-processing factors ? How many factors would be found if various sequences of 1-, 2-, 3-, 4-, 5-, and 6-attribute concepts were used? These questions remain unanswered; however, the identification of the task factors suggests clearly that concept attainment and information processing are quite different, that these tasks appear to be quite different from the cognitive factors identified in this study.

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