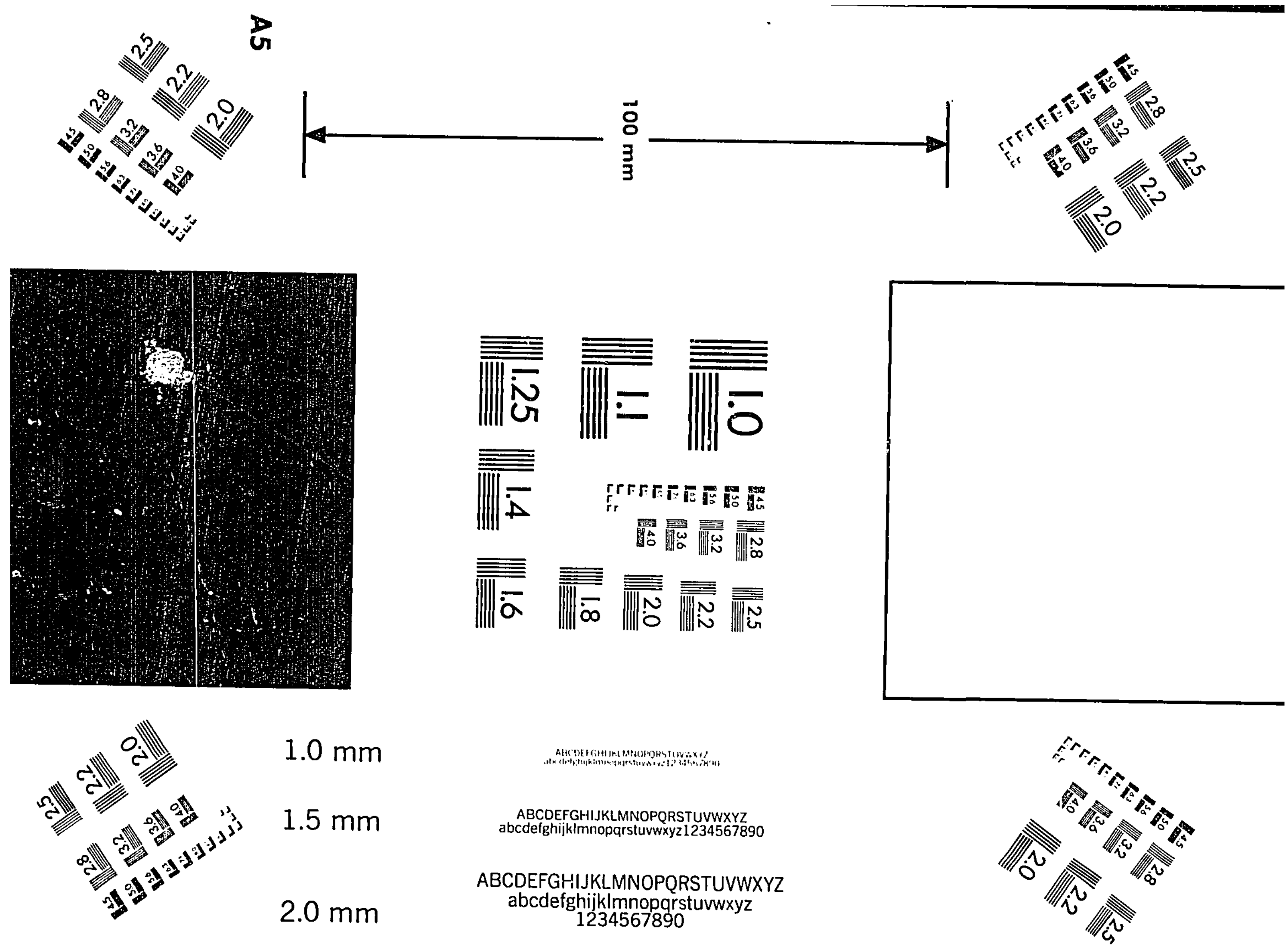
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ABSTRACT

Individual differences in performance on figural analogy tests are usually attributed to quantitative differences in processing parameters rather than to qualitative differences in the formation and use of representations. Yet aptitude-related differences in categorizing standardized figural analogy problems between high and low scorers have been documented which bear close similarities to expert/novice differences in problem representations. Protocol analysis was used to assess problem representations in an attempt to provide converging evidence of aptitude-related qualitative differences. Twenty high and low scorers on one form of the Cognitive Abilities Test (CAT) figural analogy subtest, selected from a large college population, served as subjects. Subjects solved 25 multiple-choice figural analogy problems from a CAT subtest, reviewed problems and described analogy relations, rated problem difficulty, and described their problem solving strategy. Three independent raters assessed relationships attributed to each analogy problem in terms of seven theoretically fundamental relations (rotation, reflection, number, size, shape, shading, and spatial displacement). Preliminary results suggest that formal analyses will reveal strong qualitative differences between high and low scorers. High scorers appear to represent problems in terms of well-constrained, transformational relations, while low scorers focus on looser spatial relations or on shared perceptual characteristics, and are much more idiosyncratic in their representation than are high scorers. (NB)

PROTOCOL ANALYSIS OF APTITUDE DIFFERENCES IN FIGURAL ANALOGY PROBLEM REPRESENTATION

Diane J. Schiano

Paper presented at the Annual Convention of the American Psychological Association, 94th, Washington, DC, August 22-26, 1986.

Protocol Analysis of Aptitude Differences
in Figural Analogy Problem Representation

Abstract

Protocols of high and low scorers on the Cognitive Abilities Test (CAT) figural analogies subtest were compared for qualitative differences in problem representation. While most information-processing models of analogy solution account for individual differences solely in terms of quantitative differences in processing parameters, initial findings provide converging evidence of aptitude-related qualitative differences in problem representation, similar to expert/novice differences in other problem domains. Implications for models of figural analogy problem solution, and for the possibility of training spatial aptitude, will be discussed.

Protocol Analysis of Aptitude Differences
Figural Analogy Problem Representation

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American Psychological Association, 1986

Standardized figural analogy tests comprise spatial problem-solving tasks, performance on which is highly predictive of academic success and commonly viewed as a "knowledge-free" measure of general aptitude (Snow, 1980; Sternberg, 1977). Current information-processing models of figural analogy solution generally assume that all persons initially encode and represent the problems in a similar fashion. Individual differences in performance are attributed to quantitative differences in processing parameters, rather than to qualitative differences in the formation and utilization of representations (Evans, 1968; Mulholland, Pellegrino & Glaser, 1980; Sternberg, 1977). Yet the problem-solving literature suggests that qualitative differences may critically determine individual differences in performance. Qualitative differences in problem representations of differentially skilled solvers have been shown to determine both the ease and the probability of correct solution in a variety of problem domains (e.g., Hayes & Simon, 1976; Newell & Simon, 1972; see also Just & Carpenter, 1985). Novices generally seem to represent problems in terms of shared surface features or loose perceptual similarities, while experts use more abstract, well-constrained transformational relationships, and do so in a more consistent and coherent fashion (e.g., Chi, Feltovich & Glaser, 1981; Larkin, McDermott, Simon & Simon, 1980).

In the domain of figural analogies, theoreticians have posited several types of fundamental relations used in most standardized test problems: rotation, reflection, number, size, shape, shading and spatial displacement, in approximately this order of preference (see Evans, 1968; Whitely & Schneider, 1981). Recent work has shown that when high scorers on figural analogy tests are asked to sort test problems into categories, a structure highly similar to that posited by the theoreticians emerges. Rotation, reflection and number are by far the most frequently cited relations by high scorers. Moreover, their classification schemes are highly consistent and systematic, organized around precise transformational relations. Alternatively, lower scorers tend to organize their categorical structure around perceptual similarities among the figures comprising problem terms; predominantly sorting on the basis of shape and shading characteristics, while some loose spatial displacement relations are also used. In addition, their classification schemes tend to be much more idiosyncatic and much less systematic than those used by high scorers (Schiano, Cooper & Glaser, 1983). Thus, aptitude-related differences in categorizing standardized figural analogy problems bear close similarities to expert/novice differences in problem representations. However, sorting data, while highly suggestive, can nonetheless provide only indirect evidence of representational differences. The purpose of the present experiment was to attempt to provide converging evidence of aptitude-related qualitative differences by assessing problem representations in a more direct fashion, using protocol analysis.

Subjects included twenty high (upper third) and low (lower third) scorers on one form of the CAT figural analogy subtest (see Thorndike & Hagen, 1974), from a large college population.

The CAT subtest was administered under standard conditions, with 10 minutes allotted for the solution of 25 multiple-choice figural analogy problems. Immediately upon completion of this test, subjects were instructed to review each of the 25 problems in turn, and to describe the relation they felt to be expressed by each analogy. They were also asked to rate the difficulty of each problem, and to describe the process by which they came to the choice of each answer they gave on the test.

Three independent raters assessed the relationships attributed to each analogy problem, in terms of the seven theoretically fundamental relations given above. Protocols are currently being coded in terms of the relationship agreed upon by at least two of the three raters. Results will be analyzed in a number of ways, including comparative frequency counts of the various types of relations used by high and low scorers, assessments of difficulty ratings for the two groups for different types of relationships, and an examination of whether primarily "top-down" or "bottom-up" strategies were used by each group to determine answer selection.

While formal analyses are still in progress, initial review of a large sample of the results suggests that strong qualitative differences between high and lower scorers, highly similar to the results of the sorting study, will in fact be found. For example, an overwhelming majority of the high scorers cited solely transformational relations; rotation, reflection and number accounted for more than half of their responses. Conversely, very few of the lower scorers cited these three relations; instead, they focussed on loose spatial displacements, and on shared shape and shading characteristics. Lower scorers were also much more idiosyncratic in their responses than were the high scorers.

Like expert problem solvers in a variety of more obviously "knowledge-dependent" domains, high scorers on standardized figural analogy tests tend to represent problems in terms of well-constrained, transformational relations. Lower scorers, like novices, focus more on loose spatial relations or on shared perceptual characteristics, and are much more idiosyncratic in their representations than high scorers. Such qualitative differences in problem representation suggest that models varying only in the values of processing parameters may not adequately reflect individual differences in figural analogy task performance. Further, they suggest that performance on nonverbal aptitude tests may involve hitherto unsuspected, but perhaps trainable, knowledge components.

References

Chi. M.T.H., Feltovich, P. & Glaser, R. (1981). Categorization and representation of physics problems by experts and novices. Cognitive Science, 5, 121-152.

Evans, T.C. (1968). A program for the solution of geometric analogy intelligence tests questions. In M. Minsky (Ed), Semantic information processing. Cambridge, MA: MIT Press.

Hayes, J.R. & Simon, H.A. (1976). The understanding process: Problem isomorphs. Cognitive Psychology, 8, 165-190.

Just, M.A. & Carpenter, P. (1985). Cogntive co-ordinate systems: Accounts of mental rotation and individual differences in spatial ability. Psychological Review, 92 (2), 137-172.

Larkin, J.H., McDermott, J., Simon, D.P. & Simon, H.A. (1980). Expert and novice performance in solving physics problems. Science, 208, 1335-1342.

Mulholland, T.M., Pellegrino, J.W. & Glaser, R. (1983). Components of geometric analogy solution. Cognitive Psychology, 12, 252-284.

Newell, A. & Simon, H.A. (1972). Human problem solving. Englewood Cliffs, NJ: Prentice-Hall.

Schiano, D.J., Cooper, L.A. & Glaser, R. (1983). Individual differences in the representation of figural analogy problems. Eastern Psychological Association, Philadelphia, PA.

Snow, R.E. (1980). Aptitude processes. In R.E.Snow, P.A.Federico & W.E.Montague (Eds). Aptitude, learning and instruction: Cognitive process analysis of aptitude. Hillsdale, NJ: Erlbaum.

Sternberg, R.J. (1977). Intelligence, information processing and analogical reasoning. Hillsdale, NJ: Erlbaum.

Thorndike, R.L. & Hagen, E. (1974). Technical manual: Cognitive Abilities Test. Boston: Houghton Mifflin.

Whitely, S.E. & Schneider, L.M. (1981). Information structure for geometric analogies: A test theory approach. Applied Psychological Measurement, 5 (3), 303-307.

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