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AUTHOR	Muir-Broaddus, Jacqueline; Coyle, Thomas
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ABSTRACT

Group differences based on giftedness and achievement were examined in acquisition and generalization of a strategy for solving verbal and figural analogies. The strategy involved making a sentence that captured the relationship between a pair of words and then applying that sentence to a third item. A total of 162 high-achieving gifted, underachieving gifted, high-achieving nongifted, and average-achieving nongifted children in seventh and eighth grades were assessed on their performance at baseline, training, proximal transfer, and distal transfer. The strategy training improved performance, raising correct responses (out of 10) from 6.2 to 6.9. Each of the four groups differed significantly in analogy solving accuracy. Group differences in performance were paralleled by group differences in strategy use. The high-achieving gifted were more spontaneously, frequently, and successfully strategic, and were the only group to increase performance at distal transfer. The underachieving gifted showed qualitative deficits in their strategic functioning. (Eight references) (JDD)

Effects of Giftedness and Achievement on the Training and Transfer of a Strategy for Solving Analogies

Jacqueline Muir-Broaddus, Departments of Psychology and Education, Southwestern University, Georgetown, TX 78626, and Thomas Coyle, Department of Psychology, Florida Atlantic University, Boca Raton, FL 33431.

Abstract

Group differences according to giftedness and achievement were examined for the acquisition and generalization of a strategy. 162 seventh and eighth grade high achieving gifted, underachieving gifted, high achieving nongifted, and average achieving nongifted children orally solved verbal and figural analogies. Performance at baseline, training, and proximal and distal transfer was assessed according to response accuracy and strategy use. The high achieving gifted were more spontaneously, frequently, and successfully strategic, as well as the only group to increase performance at distal transfer. The underachieving gifted showed qualitative deficits in their strategic functioning by comparison.

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Introduction

It has been suggested that gifted children may be characterized according to their ability to spontaneously generate, learn, or generalize problem solving strategies. Another possible key characteristic of giftedness is creativity, referring in part to a capacity for original and divergent thinking (Renzulli, 1988). Although research on the question of a strategic advantage has produced mixed results (Borkowski & Peck, 1986), the most marked differences between gifted and nongifted children in this domain have been found in studies of generalization, particularly those where the conceptual distance between the training and transfer task is greatest (ie, Scruggs, Mastropieri, Jorgensen, & Monson, 1986). One reason for this may be that the ability to recognize commonalities between two distinct tasks, and then to independently apply known strategies across these two domains, may reflect the insightful, flexible, and "creative" use of divergent thought processes. In short, the distal generalization of strategies may reflect creativity in the cognitive domain, and as such is worthy of exploration as a possible processing advantage of gifted children.

Just as strategy use and generalization are theoretically important sources of the gifted advantage, they are also promising as explanations for some of the underachievement observed in this group. That is, it is possible that strategy use, especially distal generalization, would distinguish the individuals with psychometrically defined high potential who achieve (high achieving gifted) from those who fail to reach this predicted potential (underachieving gifted).

The reason for this prediction lies in the fundamental incongruity between the way that giftedness is defined and the expectations made of the children so labelled. In practice, the label "gifted" is reserved for those children who excel on measures that primarily tap convergent processes, such as intelligence tests, and thus who are superior synthesizers (Sternberg, 1986). In the classroom and the world beyond, however, these same children are expected to excel in concept formation and to be original and creative thinkers, both reflecting divergent processes. Given this incongruity, one would expect there to be a subset of children who meet the psychometric criteria for the gifted label, but who lack the creativity and insight to meet the challenges of a gifted curriculum. Thus, it seems likely that distal generalization, a task that captures these more divergent skills, would differentiate these two gifted achievement groups.

A training and transfer experiment was designed to test these hypotheses. Specifically, it was expected that all groups would profit from a trained strategy in terms of increased strategy use and improved performance at training and proximal transfer (transfer within the same content domain). However, it was predicted that only the high achieving gifted group would independently transfer the trained strategy to the novel content domain (distal transfer), with a concomitant improvement in task performance.

Method

162 seventh and eighth graders were selected and assigned to one of four groups according to intelligence scores (WISC-R or Stanford-Binet for gifted; Otis-Lennon, Slosson, or Cognitive Abilities test for nongifted), achievement scores in language and math (Scholastic Aptitude Test), school grades in language and math, academic program (gifted, advanced, or regular classes), and teacher opinion. Group characteristics are summarized below.

Group Means, Standard Deviations, and Ranges for IQ, Total Language and Math SAT Percentiles, and School Grades in Language and Math

Group	N	IQ	SAT	Grades
High Achieving	55	136.88	97.31	3.74
Gifted		(7.34)	(1.98)	(.30)
		127-164	92-99	3.0-4.0
Underachieving	26	134.32	84.23	2.38
Gifted		(5.98)	9.56	(.57)
		127-147	54-94	1.0-3.0
High Achieving	47	118.03	91.07	3.67
Nongifted		(5.82)	(6.18)	(.35)
		107-127	77-99	3.0-4.0
Average Achieving	34	106.64	60.06	2.32
Nongifted		(6.88)	(12.72)	(.52)
		92-120	31-80	1.0-3.0

Experimental Design

This training and transfer experiment was conducted and analyzed as a 2 (gifted classification: gifted vs nongifted) x 2 (academic achievement: high vs average achieving) x 2 (analogy type: verbal vs figural) x 5 (phase: baseline 1 vs baseline 2 vs training vs proximal transfer vs distal transfer) factorial design, with repeated measures on the phase factor. Each phase included one 10-item set of verbal or figural analogies.

Materials

Three sets of 10 verbal analogies and 3 sets of 10 figural analogies served as stimuli. The problems were multiple choice, with 4 alternatives provided. The majority of the verbal items were selected from "Barron's How to Prepare for the Miller Analogies Test" (Sternberg, 1981), and the figural items from Feuerstein's (1979) Learning Potential Assessment Device.

Each participant was assigned to one of two orders of presentation of the two analogy types across the 5 phases: either figural, verbal, verbal, verbal, figural, or verbal, figural, figural, figural, verbal. Thus, for any one subject the same analogy type (verbal or figural) always appeared at both baseline 1 and distal transfer, and the same analogy type always appeared at baseline 2, training, and proximal transfer. Accordingly, performance at distal transfer were assessed in comparison with baseline 1, and performance at training and proximal transfer were assessed in comparison with baseline 2. The order of presentation for each of the 3 verbal and 3 figural 10-item lists was counterbalanced across phases and groups.

Procedure

Two sessions of individual testing were spaced 2 days apart. Session 1 included the baseline & training phases (30 min), and session 2 included the proximal & distal transfer phases (15 min).

Session 1 began with training and practice in the overt verbalization of all thoughts during problem solving. Following practice with sample items, the children completed baseline 1 & 2. They were then given training and practice in the use of the "make a sentence" strategy. Training was specific to the analogy type in the 2nd baseline trial. The strategy was to make a sentence that captured the relationship between the 1st pair of words (figures), and then to apply that sentence to the 3rd item. Subjects then solved a set of analogies in the trained domain.

Session 2 began with a set of 10 analogies in the trained domain in order to test for proximal transfer. This was followed by a final set of analogies in the never-trained domain in order to test for the distal transfer of the trained strategy.

Measures

Performance was assessed in terms of the number of analogies solved correctly out of 10 at each of the 5 phases.

Strategy use was assessed from the audio recordings of subject verbalizations during task performance. Most group differences were noted in 3 of the 6 strategy types analyzed. Strategies include the "good sentence" (identification of the appropriate relationship and application of it to the 3rd term), the "poor sentence" (misidentification or misapplication of the relationship), and "quick response" (< 5 s with no strategy).

Results

The data were analyzed using mixed-design analyses of variance and Newman-Keuls tests. (See accompanying summary).

1. The trained strategy was a good one. Mean percent accuracy was 86% following a "good sentence," 62% following a "quick response," and 47% following a "poor sentence" strategy.

2. Strategy training improved performance. The number of correct responses (out of 10) was greater at training (6.9) than at baseline (6.2). Significant increases over baseline were 7% at training, 4% at proximal transfer, and 5% at distal transfer. These increases were paralleled by greater use of the "good sentence" strategy (compared to baseline) at each of training (57% > 33%), proximal (48% > 33%), & distal transfer (37% > 28%).

3. Each of the 4 groups differed significantly in analogy solving accuracy. The mean number correct was 7.4 for the high achieving gifted, 6.7 for the underachieving gifted, 6.0 for the high achieving nongifted, and 5.2 for the average nongifted.

4. Group differences in performance were paralleled by group differences in strategy use. "Good sentence" use decreased across the four groups, with the high achieving gifted (53%) > high nongifted (37%) > average nongifted (21%). The underachieving gifted (44%) exceeded only the average nongifted (21%) in "good sentence" use. Furthermore, only for the high achieving gifted did "good sentence" (53%) use exceed "poor sentence" (27%) use. For the underachieving gifted (44%, 38%) and high nongifted (37%, 35%), "good" and "poor" sentence use did not differ significantly. For the average achieving group, by comparison,

"quick response" (38%) was the most common strategy.

5. The groups differed significantly in accuracy following the decision NOT to use the strategy. That is, when a "quick response" approach was used, the high achieving gifted (72%) solved more analogies correctly than the underachieving gifted (57%) or average nongifted (50%) groups. The high nongifted did not differ significantly from any other group (63%).

6. Increased use of the "good sentence" strategy was not accompanied by increased success for all groups. Whereas "good sentence" use increased over baseline at training and proximal transfer for all 4 groups and at distal transfer for all but the average nongifted, this was accompanied by an increase in correct responses only for the high achieving nongifted group at training, and only for the high achieving gifted at distal transfer. (An explanation for this latter finding is provided in #7). The underachieving gifted & average nongifted did not improve significantly at training, proximal, or distal transfer.

A word of interpretation here concerning the above findings. Within the context of resource theory, one explanation for this utilization deficiency (Miller, 1990) is group differences in the efficiency of strategic functioning. Specifically, inefficient strategy implementation may have consumed more of the available resources on the part of the two lower achieving groups, leaving too few resources to improve performance (see Bjorklund & Harnishfeger, 1987). Indeed, simultaneously implementing a strategy, solving an analogy, and verbalizing thought processes is notably effortful.

7. The high achieving gifted children showed greater increases in spontaneous strategy use and task performance before training than any other group. The high achieving gifted exceeded only the average nongifted in correct responses at baseline 1, but by baseline 2 the high achieving gifted exceeded all other groups. In addition, only the high achieving gifted significantly improved between baseline 2 (7.2) and baseline 1 (6.6). In terms of "good sentence" strategy use, the high achieving gifted exceeded all others at baseline.

Note: The spontaneous improvement of the high achieving gifted may account for the anomalous finding in #6. Recall that their performance increases at training and proximal transfer did not reach significance, whereas those at distal transfer did. Given that the training & proximal transfer effects were compared with baseline 2, and distal transfer with baseline 1, it may be that this spontaneous improvement obscured the effects of training.

8. The underachieving gifted were deficient in the frequency and quality of strategy implementation after training compared to the high achieving gifted. At training, the high achievers (70%) exceeded the underachievers (59%) in "good sentence" use; at proximal transfer the underachievers (36%) exceeded the high achievers (25%) in "poor sentence" use; and at distal transfer the high achieving gifted (49%) exceeded the high nongifted (37%) in "good sentence" use, whereas the underachievers did not (43%).

9. The high achieving gifted excelled at distal transfer compared to all other groups. They were the only ones to solve more analogies at distal transfer (7.5) than at baseline (6.6).

Discussion

These results reveal an advantage on the part of the high achieving gifted children in terms of both quantity and quality of strategy use. They were more spontaneously strategic before training, and after training they were more frequently and successfully strategic compared to all other groups. They were also more accurate following the decision not to use a strategy, and the only group to improve performance at distal transfer.

The underachieving gifted children, by contrast, were deficient in strategic functioning despite having similar IQs as their high achieving gifted peers. In fact, they tended to "look" like the high achieving nongifted in their overall pattern of performance. Specifically, the underachieving gifted were less likely than the high achieving gifted to spontaneously acquire an effective strategy, and when they did evidence sentence strategy use they were no more likely to exhibit a good rendition of it than a poor one. Accordingly, although the underachieving gifted children successfully acquired and transfered the "good sentence" strategy, there were no accompanying improvements in performance for this group.

These findings suggest that distal strategy generalization may be characteristic of gifted cognition, perhaps because it captures some form of "analytic creativity". If so, the extent to which the failure of the underachieving gifted children to achieve distal transfer reflects strategy deficits, or the extent to which it reflects the misclassification of a subset of under-achieving gifted children who meet the psychometric, but not the behavioral, criteria for the gifted label, remains to be seen.

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Summary of Reported Analyses of Variance

All ps values are less than .05 unless otherwise stated.

Performance: Number of Correct Responses out of 10

1. Main effect of gifted classification, $F(1,130) = 62.47$.
2. Main effect of academic achievement, $F(1,130) = 15.73$.
3. Main effect of phase, $F(4,520) = 7.22$.
4. Gifted classification x academic achievement x phase, $F(4,520) = 1.45$, $p = .22$.

Percent Accuracy Following Use of the Three Primary Strategies

5. Main effect of gifted classification, $F(1,125) = 14.38$.
6. Main effect of academic achievement, $F(1,125) = 8.88$.
7. Main effect of strategy type, $F(2,250) = 149.52$.
8. Strategy type x academic achievement, $F(2,250) = 4.96$.

Strategy Use: Percent Use of Each Category of Strategy

9. Pnase x category, $F(20,2480) = 23.02$.
10. Category x gifted classification x academic achievement, $F(5,620) = 6.35$.
11. Phase x category x gifted classification x academic achievement, $F(20,2480) = 2.23$.