

TRAINING SPACE AND REASONING ABILITIES IN THE ELDERLY

*(Enhancement des capacités intellectuel d'espace et de raisonnement
en personnes de 3eme age)*

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Abstract

This study examined the effects of cognitive training with an elderly sample selected from the Seattle Longitudinal Study. Specifically, the study assessed what components of cognitive performance demonstrated training effects. Subjects were trained on either Spatial Orientation or Inductive Reasoning abilities. Training resulted in a significant increase in accuracy, as reflected by an increase in correct responses and a decrease in commission errors at posttest for both Space and Reasoning groups.

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Training Space and Reasoning Abilities in the Elderly

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Introduction

The purpose of this study was to examine the effects of cognitive training with an elderly sample selected from the Seattle Longitudinal Study (Schaie, 1983). Previous cognitive training research with the elderly focusing on a variety of cognitive abilities (see Willis, 1985, for a review) had indicated significant performance improvement as a function of training. However, prior cognitive training research has not examined the specific nature of the training effects. That is, past work does not inform us as to what specific components of cognitive performance demonstrated training effects. For example, training effects may occur solely due to an increase in the number of items attempted with no improvement in accuracy of performance. Alternatively, training effects may reflect an increase in accuracy as demonstrated by a post-intervention increase in correct responses and/or a decrease in commission errors. One of the objectives of this study, to be reported in this paper, was to examine more specifically the nature of training improvement.

Subjects

Subjects ($N = 229$) were elderly participants ($M = 72.8$ years; Range = 64-95; SD 6.41) from the Seattle Longitudinal Study. There were 97 men and 132 women. Mean educational level was 13.9 years (Range = 6-20; SD = 2.98). Mean family income level was \$19,879 (Range = \$1000-\$33,000; SD = \$8,520). There were no significant sex differences in age, family income, or educational level. All subjects were community-dwelling and had been participants of the Seattle Longitudinal Study since 1970. They had been assessed at least twice prior to the present study, and were community dwelling. Prior to initiation of the study, each subject's physician was contacted and asked to indicate whether the potential subject suffered any known physical or mental disabilities that would interfere with participation in the study; subjects so identified were not included.

Procedure

Subjects were initially contacted via a series of letters and asked to participate. Home visits were made to further explain the study. Approximately 90% of the eligible longitudinal subjects agreed to participate. Given the considerable time required of each participant, subjects were paid \$5 per hour.

The study involved a pretest-treatment-posttest design. Subjects received a five-hour pretest battery involving multiple measures of seven primary abilities. Subjects were assigned to one of two training programs, Space Training ($N = 118$) or Inductive Reasoning Training ($N = 111$), based on their prior longitudinal

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performance on these two abilities. Subjects were assigned to the ability on which they had shown reliable decline over the previous 14 year period. Subjects showing no decline on either ability were assigned randomly to one of the training programs. Subjects exhibiting decline on both abilities were also randomly assigned to one of the training programs.

Both the Space and Reasoning training programs involved 5 one-hour training sessions. The focus of the training sessions was on facilitating subjects' use of cognitive strategies shown in previous research to be associated with space or reasoning ability.

A content analysis of the PMA Space Test identified angles of rotation for the answer choices. Practice problems were then developed to represent the angle rotations identified in the task analysis. Training focused on facilitating mental rotation by helping subjects (1) to develop concrete terms for various angles; (2) to practice with manual rotation of figures prior to mental rotation; (3) practice rotation of drawings of concrete, familiar objects; (4) have subjects generate names for abstract figures; and (5) to teach subjects to focus on two or more features of the figure during rotation. These were similar to strategies previously identified in descriptive research on mental rotation ability (cf. Cooper & Shepard, 1973; Egan, 1981; Kail, Pellegrino, & Carter, 1980).

For Reasoning, pattern description rules used in problem solution were identified. These again follow strategies discussed in the literature (Kotovsky & Simon, 1973; Holzman, Pellegrino, & Glaser, 1982), and include the concepts of identity, next item, skips, and backward next item. Practice problems also involved content other than letters, so that applicability of the rules to other content could be explored. For example, patterns of musical notes and travel schedules were devised based on these rules. Strategies that were encouraged included visual scanning of the series, saying the series aloud to hear the letter pattern, and underlining repeated letters occurring throughout the series.

The five training sessions were conducted individually in the subject's home by a trainer. Subjects were taught through modeling, feedback and practice procedures. Following the training sessions, subjects were posttested on the same five hour battery as at pretest.

Results

Findings are reported here only for the Thurstone PMA Spatial Reasoning test and the PMA Reasoning test (Thurstone, 1948); these are the two measures on which prior longitudinal data are available. For each measure four scores per subjects were derived: Correct (Number of correct responses), Commission (Number of incorrect responses), Omits (Number of correct choices not marked within the pool of items attempted), Attempts (Total number of responses for items attempted). In Figure 1, the raw score points for these four score components are shown for the Reasoning training and Space training groups at pretest (PR) and posttest (PR). The Space training group served as the control (CNT) for assessments of Reasoning training effects, and vice versa.

For Reasoning training, no significant differences between the training and control groups on the four component scores were found at pretest. For the Space training, at pretest the control group was found to have significantly more correct responses ($p < .01$), significantly fewer commission errors ($p < .004$), and significantly fewer omissions ($p < .02$); there were no significant group differences in the number of items attempted. The superior performance of the control group at pretest is due to the greater number of subjects in the Space training group classified as decliners at pretest.

Posttest comparisons of training and control groups indicated significant treatment effects for both abilities. The Reasoning training group demonstrated significantly more correct answers ($p < .02$) at posttest when compared with the control and significantly fewer commission errors ($p < .001$). There were no significant group differences on omissions or total number of items attempted.

With regard to the Space training analyses, it should be recalled that at pretest the control group demonstrated significantly more correct responses and significantly fewer commission errors. At posttest there were no differences between the Space training and control groups on correct responses, commission errors, or omissions. There was a significant increase for both groups in number of items attempted. This finding reflects significant gains for the experimental group. That is, a significantly greater increase in correct responses and a significantly greater reduction in commission and omission errors.

Some difficulty arises, however, in the interpretation of pre-posttest comparison for the three component scores (i.e., corrects, commissions, omissions) because of the increase in the total number of items attempted at posttest for both training and control groups. What needs to be done, therefore, is to examine the relative effects of training adjusted for the increased number of attempted items that might result from practice and/or training. We approached this question by computing net component scores that took into account the increased response rate. That is, we computed the component scores that would be expected solely on the basis of increased attempts and subtracted the expected values from the observed posttest component scores to yield net component gain scores. These are shown in Figure 2. Note that for both Reasoning and Space training groups there were net increases in number of correct responses and net decreases in the number of commission errors significantly greater than for the control group.

Discussion

The data just presented support previous findings that cognitive training procedures can be applied successfully to improve the performance of older adults on specifically targeted mental abilities. In the past there have been some contentions, however, that the improvement observed might be accounted for simply by showing that practice on target-relevant activities will speed up the subjects' response and thereby improve performance. Alternatively it has been argued that training techniques may improve performance by inducing subjects to become less cautious and be more willing to guess; thereby once again increasing response rates.

The present study by analyzing components of training gain permits somewhat more differentiated inferences that can shed light on these issues. First of all, we show that the pattern of componential changes differ across abilities. That is, we can show that the training procedures do increase the number of subjects' responses on Space but not on Reasoning. Hence it must be concluded that the speed-up hypothesis for training gain is quite ability-specific. Secondly, our data show that a possible decrease in cautiousness is also ability-specific; again response omissions decreased significantly only for Space but not for Reasoning. The latter interpretation must be further hedged by our findings with regard to net accuracy scores. Since increased number of responses will confound retest and training effects, it seemed appropriate to obtain net accuracy scores by computing the differences between observed and expected component values when number of attempts was controlled for. Under these circumstances it became clear that the effects for both training conditions involved increases in correct responses and decreases in commission errors that were significantly greater than those shown for the controls. On the other hand there were no changes in omission errors that could be attributed to training effects.

Conclusions

A program of individual cognitive training for both Inductive Reasoning and Space abilities, resulted in a significant performance gains. Examination of the components of this gains showed that it could be attributed primarily to an increase in response accuracy. The increased accuracy is reflected both by an increase in correct responses and the decrease in commission errors at posttest. Consequently, the results of this study serve to rebut past criticisms of cognitive training studies that imply that training gains are due primarily to interventions that increase subjects' speed of performance. In fact, it was found in the present study that speed of response was enhanced only for the Space training group while accuracy was improved for both groups.

References

- Cooper, L. B., & Shepard, R. N. (1973). Chronometric studies of rotation of mental images. In W. G. Chase (Ed.), Visual information processing. New York: Academic Press.
- Egan, D. E. (1981). An analysis of spatial orientation test performance. Intelligence, 5, 85-100.
- Holzman, T. B., Pellegrino, J. W., & Glaser, R. (1982). Cognitive dimensions of numerical rule induction. Journal of Educational Psychology, 74, 360-373.
- Kail, R., Pellegrino, J., & Carter, P. (1980). Developmental changes in mental rotation. Journal of Experimental Child Psychology, 39, 102-116.
- Kotovsky, K., & Simon, H. A. (1973). Empirical tests of a theory of human acquisition of concepts for sequential patterns. Cognitive Psychology, 4, 399-424.
- Schaie, K. W. (1983). The Seattle Longitudinal Study: A 21-year exploration of psychometric intelligence in adulthood. In K. W. Schaie (Ed.), Longitudinal studies of adult psychological development (pp. 64-135). New York: Guilford.
- Thurstone, L. L. (1948). Primary mental abilities. Chicago: University of Chicago Press.
- Willis, S. L. (1985). Towards an educational psychology of the adult learner: Cognitive and intellectual bases. In J. E. Birren & K. W. Schaie (Eds.), Handbook of the psychology of aging (pp. 818-847). 2nd ed. New York: Van Nostrand Reinhold.