AGING AND COGNITION

Mental Processes, Self-Awareness and Interventions

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9 Current Issues in Cognitive Training Research

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As a relatively new research area within psychogerontology, cognitive training studies have generated considerable interest and discussion. To date, a number of studies have demonstrated that behavioral interventions are effective in significantly improving, on average, the community dwelling elderly's performance in a variety of cognitive domains, including face-name memory (Yesavage, Lapp & Sheikh, 1989), problem solving tasks (Denney, 1982), and fluid intelligence abilities (Willis, 1987). However, there remains considerable debate regarding the interpretation of these findings and their implications for our understanding of intellectual development in later adulthood (Donaldson, 1981; Kliegl & Baltes, 1987; Willis, 1987). In this chapter, we will examine five issues of current concern in the cognitive training literature. We will begin by reviewing some empirical data related to each issue and then consider the implications of the issue for our broader understanding of adult cognition in old age.

Two Research Programs on Cognitive Training

In discussing these five questions, we will refer primarily to two programs of research on cognitive training. The designs of these research programs are shown in Figure 9.1. The first data base is from the Adult Development and Aging project (ADEPT) begun by Paul Baltes and Willis in 1976 (Baltes & Willis, 1982; Willis, Blieszner & Baltes, 1981; Willis & Nesselroade, in press). Over 500 subjects have participated in 5 studies focusing on the modifiability of fluid intellectual performance. Three studies involved training of cognitive strategies related to the fluid abilities of Figural Relations or Inductive Reasoning. The remaining two studies involved practice (without feedback on performance and with no strategy training), on Figural Relations and Inductive Reasoning abilities (Hofland, 1981; Hofland, Willis & Baltes, 1981). Each study involved a pretest-treatment-posttest, control group design. Following the pretest, cognitive strategy training subjects participated in 5 one-hour training sessions focusing on cognitive strategies related to the target ability. Posttests were conducted one-week, one-month and six-months following training to examine maintenance of training effects. In 1986-87, a seven-year follow-up was conducted to examine long-term training effects (Willis & Nesselroade, in press).

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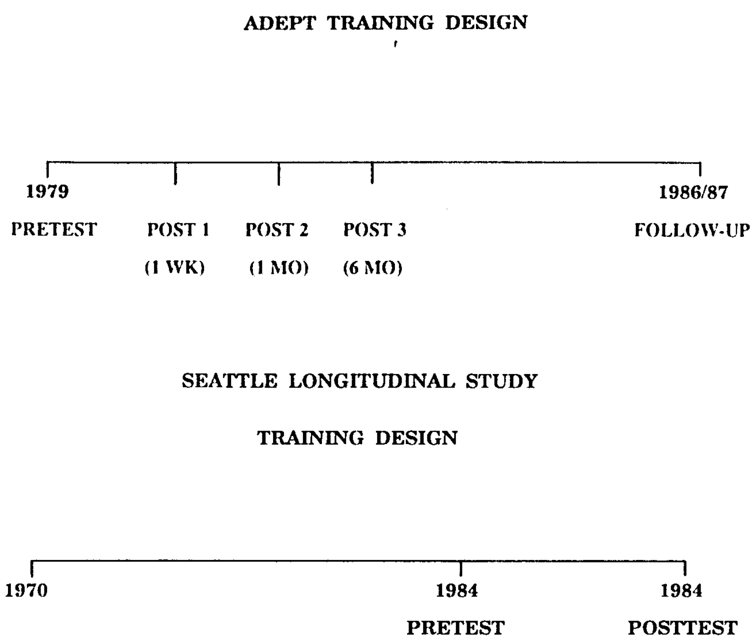

Figure 9.1. Design of the Adult Development and Enrichment Project (ADEPT) training studies (top), and training phase of the Seattle Longitudinal Study (bottom).

The second research program is part of the Seattle Longitudinal Study (SLS). Although the SLS was begun in 1956 (Schaie, 1983), the training phase of the study started in 1984 (Schaie & Willis, 1986; Willis & Schaie, 1986). Longitudinal data on older SLS subjects were examined over the fourteen-year period (1970-84) prior to training. Subjects' performance on two abilities, Inductive Reasoning and Spatial Orientation, was classified as having remained stable or having declined over the fourteen-year interval. In 1984, subjects received cognitive training on either Inductive Reasoning or Spatial Orientation. Subjects classified as having declined on only one of the abilities received training on that ability. Subjects classified as having remained stable or having decline on both abilities were randomly assigned to one of the training programs. Subjects received five one-hour training sessions, individually conducted in their homes. A posttest followed training.

Description of Cognitive Training Procedures

The development of the training materials and the format of the training sessions was similar for each of the abilities trained, although the cognitive strategies emphasized in training and the training tasks differed by ability. We will briefly describe the Spatial Orientation training program to illustrate these procedures. Spatial Orientation ability involves speed and accuracy in mentally rotating abstract drawings in two-dimensional space. We employ Spatial Orientation ability in tasks, such as reading road maps or interpreting floor plans. In a test assessing this ability, the subject is shown a target drawing and must identify which of six drawings could be rotated to look like the target (Thurstone & Thurstone, 1949). The six drawings are at 45, 90, 135, 180, 225, 270, and 315 degree angles, and some are mirror images of the target.

Several cognitive strategies that facilitate spatial orientation performance were identified via a review of the research literature (Cooper & Shepard, 1973; Egan, 1981; Kail, Pellegrino, & Carter, 1980). The following strategies were emphasized in training: 1) Progression from manual to mental rotation. Poor performers frequently physically turn the page to view the stimuli at various angles, rather than mentally rotating each drawing. Physical rotation is inefficient in that it take time; also since the subject often forgets what the target object looks like, he/she may repeat the physical rotation multiple times. The training procedures progress from activities in which physical rotation is permitted to those requiring mental rotation. 2) Progression from familiar to abstract stimuli. Training exercises in the early sessions involve stimuli that are familiar and meaningful to the subject. For example, subjects are asked whether they know their right hand from their left hand, and then perform an exercise in which they identify left versus right hands drawn at various angles. Use of familiar stimuli reduces the memory load during mental rotation, and also facilitates our demonstration of the use of other cognitive strategies (e.g., focusing on features of the stimulus) described below. Later training exercises involve more abstract stimuli. 3) Use of verbal labels for abstract stimuli. Subjects are encouraged to generate verbal labels for abstract stimuli. The verbal label is generated by the subject, rather than the trainer. Again, use of verbal labels reduces the memory load during mental rotation, and helps the subject identify key features of the stimulus to attend to during mental rotation. 4) Attending to key features of the target stimulus. Proficient performers attend to two or more features of a figure and determine the spatial position of these features, compared to their position on the target stimulus. During training, subjects are taught to identify key features and to attend to these features during mental rotation. 5) Use of common names for angle rotations. Many older subjects, particularly women, have not had geometry as part of their formal education, and are unfamiliar with the terms for the degrees of rotation (e.g., 45, 180). In training, these angles of rotation are discussed with reference to the face of a clock (e.g., 3 o'clock position), or the portion of a pie (e.g., quarter of a pie). These strategies are emphasized in the training exercises included in the training material.

The training program for each ability involved 5 one-hour training sessions, conducted in small groups or individually. A training booklet involving several training exercises has been developed for each of the five training sessions. The training exercises emphasize the cognitive strategies discussed above. Each exercise begins with several exemplar problems for which the trainer models use of the cognitive strategies to solve the problem. Then the subject practices using the strategies to solve several additional problems in the exercise; the trainer gives feedback regarding correctness of the answer and proper use of the strategies.

Data from the ADEPT and SLS training studies are beginning to permit us to examine a number of issues related to training. The longitudinal data from the SLS study allows us to examine antecedents of training and to evaluate training effects within a developmental perspective. The ADEPT follow-up study conducted in 1986-87 is beginning to provide data on the long-term effects of training.

QUESTION I: Have Most Older Adults Declined on Fluid Abilities? Therefore, Does Training Involve Simply the Remediation of Pre-existing Cognitive Performance Levels ?

Since virtually all training studies have focused on cognitive processes and abilities that show early normative patterns of decline, there has often been the assumption that training improvement reflects primarily a remediation or reactivation of previous cognitive skill levels. However, our data indicate that the asssumption that training involves solely the reactivation of *pre-existing* skills is too simplistic and is not completely accurate.

Two issues must be considered: 1) Not all older adults have suffered age-related decline. For subjects experiencing no prior cognitive decline, training gain represents improvement beyond prior performance levels, not a reactivation of prior skill level; 2) The behavioral changes associated with training effects are not a simple reversal of the behaviors associated with age-related decline. That is, training gain is not a mirror-image of the behavioral change associated with decline.

Data from the SLS training study deal with these two issues (Schaie & Willis, 1986; Willis, 1987; Willis, in press). SLS subjects' performance over the fourteen year period prior to training was classified as having remained stable or having declined for spatial and reasoning abilities (Figure 9.2). Only 22% of the subjects had declined on both abilities; 47% had not declined on either ablity; approximately 15% had declined on one of the abilities but not on the other. These data indicate that there are wide individual differences in the timing and rate of age-related decline, even when considering fluid abilities.

These data should not be interpretted as evidence against the reality of age-related decline, but only to demonstrate the importance of individual differences in the timing of decline (Schaie, 1990). If training researchers studied only subjects 80 years of age and older, then they could accurately assume that most of their subjects had experienced some age-related decline. However, training subjects are generally the *young-old*, that age period in which there are the widest individual differences in patterns of decline.

Figure 9.3 shows performance patterns (i.e., total number of items answered correctly) for stable and decline subjects trained on Inductive Reasoning (Willis, in press). In 1970, fourteen years prior to training, stable and decline subjects were performing at the same level on reasoning ability. In 1984 prior to training, the performance of subjects who had declined was significantly below that of subjects showing no prior decline (stables). Training resulted in significant performance gain for both stable and decline subjects. However, the nature of training effect is *qualitatively different* for the two groups (Willis, in press). For decliners, training was

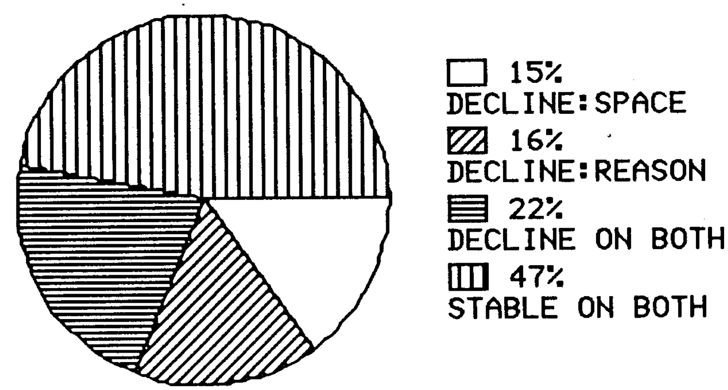

Figure 9.2. Proportion of Seattle Longitudinal Study training subjects whose performance on Inductive Reasoning and Spatial Orientation abilities were classified as having remained stable or having declined over the 1970-1984 interval prior to training.

effective in returning their performance to the 1970 score level; that is, after training decline subjects were answering correctly, on average, the same number of problems as they had in 1970. On the other hand, for stable subjects training reflects *improvement* in performance beyond their 1970 level; stable subjects were answering correctly, on average, substantially more problems than they had in 1970.

Examination of the raw mean scores for stable and decline groups at various occasions before and after training, as shown in Figure 9.3, provides little information on the nature of these changes in performance. Does training result in a simple reversal of age-related decline? It is accurate to say that there is a reversal of the change on the test score. After training, the average score for decliners is comparable to their 1970 score level (Figure 9.3). However, our analyses suggest that the nature of the behavioral changes associated with age-related decline are not identical to the behavioral changes associated with training. On the left-hand side of Figure 9.4, the bars show the magnitude of age-related change in Inductive Reasoning over the fourteen years (1970-84) prior to training for stable and decline subjects; the bars on the right-hand side of the figure shows the pre-posttest training gain for the two groups. The shading of each bar shows that part of the total change score associated with a change in accuracy and that part associated with a change in speed of problem

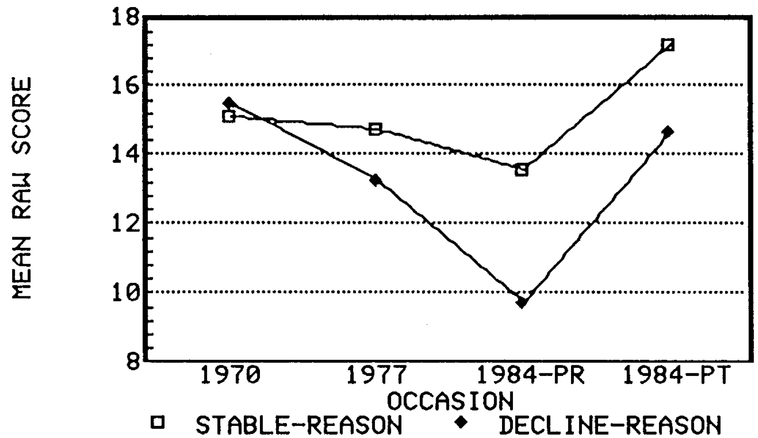

Figure 9.3. Mean scores on Inductive Reasoning ability for Seattle Longitudinal Study training subjects classified as stable and decline. Scores are shown at four occasions: Prior to training (1970, 1977); at pretest (1984-PR); and at posttest (1984-PT).

solving[1]. A change in accuracy reflects a change in the proportion of attempted items that were answered correctly (Willis & Schaie, 1988). The change in speed reflects that part of the total change score that is associated with a change in the number of items attempted and that cannot be attributed to a change in accuracy.

There was an age-related decline of approximately seven points for decliners over the fourteen years prior to training (left-hand side of Figure 9.4); approximately half of the decline reflects a drop in accuracy with the remaining half associated with a decline in speed of problem solving. That is, as they decline, subjects attempt fewer problems and are less accurate in the problems they do attempt. However, the training gain for

[1]The total change score (e.g., 1984 rights minus 1970 rights) can be partitioned into that part associated with change in accuracy and the remaining part resulting from a decline/gain in problem solving speed (e.g., decline/gain in number of attempted items). The accuracy change score was derived by first computing the expected score at time two (e.g., 1984), if accuracy had remained at the time one level (e.g., 1970). The expected score was computed by multiplying the time two (1984) attempts by the time one accuracy rate (e.g., 1970 rights divided by 1970 attempts). The accuracy change score equals the observed time two (e.g., 1984) score minus the expected score. A speed change score was computed by subtracting the accuracy change score from the raw change score.

decliners (right-hand side of Figure 9.4) resulted primarily from an increase in accuracy. In contrast to the pattern of change associated with age-related decline involving both a drop in accuracy and speed of problem solving, most of the training improvement is a gain in accuracy. Thus, although the magnitude of the mean change scores associated with age-related decline and training gain are comparable, the nature of the behavioral changes differs for the two phenomena (see also training effects for Spatial Orientation ability, Willis & Schaie, 1988).

What is the nature of behavioral change for the stable subjects? Since the magnitude of age-related change from 1970-84 is negligible, we will focus on the nature of the training gain for stable subjects. First, stable subjects answered substantially more problems correctly than they did in 1970; that is, their test score after training was higher than their score in 1970, on average (Figure 9.3). Second, and more importantly, they were performing at a higher level of accuracy after training than they did in 1970 (right-hand side of Figure 9.4). Most of the training gain was associated with increased accuracy rather than increased speed of problem solving (Figure 9.4). Thus, training effects for stable subjects involved not only an improvement in level of performance beyond their 1970 score, but also increased accuracy.

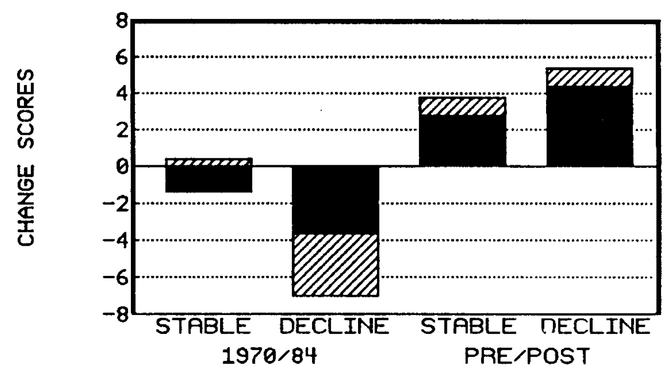

Figure 9.4. Changes in accuracy and speed of problem solving on Inductive Reasoning ability for Seattle Longitudinal Study training subjects classified as stable and decline. Change scores are shown: Prior to training (1970-1984); and Pre-posttest change.

QUESTION II: Are Training Effects Narrow? Should Training Transfer Be Expected to Occur at the Level of Second-order Latent Constructs, Such as Gf?

Perhaps one of the most debated issues in cognitive training research is the issue of training transfer. Some have suggested that training effects are narrow and reflect little more than "teaching the test" (Donaldson, 1981).

The issue of training transfer must be considered from the perspective of Cattell's (1971) hierarchical model of fluid and crystallized intelligence. At the lowest level of the hierarchy, cognitive functioning must be assessed through behavioral observations, sometimes called tests. Test scores can be dimensionalized into common and unique variance. Unique variance is specific to a particular measure, reflecting the specific content or format of a test. The common variance of a test is that portion of the variance that is common or shared with other tests that measure the same ability. The common variance shared among tests measuring the same ability is represented within the hierarchical model as a first-order latent construct, better known as a primary mental ability (PMA).

First-order constructs can also be partitioned into that related to unique and common variance. The common variance shared among first-order constructs is represented as a second-order construct. Second-order latent constructs such as fluid and crystallized intelligence reflect the variance shared among primary abilities (first-order constructs).

Now, at what level should one expect to find training effects? Since we have targeted our training efforts at a specific primary ability, we maintain that training effects should be found at the level of first-order latent constructs, and indeed, this is the level at which training effects have been reported (Schaie, Willis, Hertzog & Schulenberg, 1987; Willis & Schaie, 1986). Training effects at the level of a first-order construct (i.e., at level of a primary mental ability) are broader than "teaching the test." If training only involves "teaching the test," then training effects should be specific to one test. However, if training impacts the common variance shared by all tests of an ability, then training effects should be demonstrated at the primary ability, or first-order construct level.

Some of our colleagues (Donaldson, 1981; Hayslip, 1989b) have argued that training effects at the level of first-order constructs are too narrow. They maintain that training on one primary ability should result in transfer to other abilities - this would result in transfer at the level of a second-order construct (e.g., Gf). However, this argument appears in conflict with current research on cognitive processes. It is well documented that the cognitive components or processes associated with a particular cognitive ability or skill are quite specific and are distinct from the processes associated with another skill or ability. Therefore, since our training programs have emphasized components and strategies specific to a given ability, there is little reason to expect that training focusing on the components associated with one ability (e.g., inductive reasoning) should result in improvement on another ability (e.g., spatial orientation).

QUESTION III: Are Interventions Focusing on Performance Factors as Effective as Cognitive Strategy Training ?

There is no question but that cognitive functioning is influenced by both cognitive factors and performance factors. The question then arises whether interventions directed at performance factors are as effective as cognitive strategy training in improving intellectual behavior.

Let's begin with definitions of cognitive versus performance factors. We will take what some will consider a rather narrow view of cognition, for the purposes of this discussion. Cognitive factors are limited to those *intellectual* components, skills and processes that are said to underlie a particular ability or intellectual dimension; they are considered intrinsic to the ability. For example, cognitive strategies such as mediators and mnemonics are intrinsic or specific to memory ability (Poon, 1985); utilization of salient rule patterns is associated with inductive reasoning ability (Kotovsky & Simon, 1973); mental rotation skill is specific to spatial orientation ability (Cooper & Shepard, 1973).

In contrast, performance factors influence performance on one or more abilities or skills, but are not considered to be an intellectual component or process specific to the ability (Denney, 1980; Willis & Baltes, 1981; Willis, Cornelius, Blow & Baltes, 1983). Performance factors that have been studied include general response speed, affective dimensions (e.g., anxiety, morale, depression), motivational factors (e.g., achievement motivation, intrinsic/extrinsic reinforcement), and attitudinal factors (self efficacy, locus of control). Since affective and attitudinal factors, such as self efficacy, do involve thoughts, they have sometimes been described as cognitions, thus complicating the use of the term "cognitive." In addition, the distinction has recently been made between general and task- or domain-specific attitudinal and affective factors, such as intellectual self efficacy and health self efficacy (Lachman, 1986). Such context- or domain-specific attitudes or beliefs are considered to be specific to a particular ability or cognitive dimension. However, we consider these attitudinal and affective factors, both general and domain-specific, to influence mental ability *performance*, but not to be intrinsic intellectual components or processes underlying a particular ability in the same manner as mnemonics or cognitive strategies.

A number of studies have examined the relative effectiveness of interventions focusing on performance factors versus cognitive strategy training. Our interpretation of findings from these studies is that treatment conditions focusing solely on performance factors are generally not as effective as those involving training on cognitive strategies specific to the ability. Support for this position is based on both correlational and experimental data.

First, although the correlations between performance factors, including domain-specific control beliefs, and fluid ability performance are often found to be statistically significant, given large enough sample sizes, the correlations are typically modest (compared with the magnitude of intercorrelations among ability factors), generally in the range of .20 to .40 (Lachman & Leff, 1989; Willis, 1988). The correlations between fluid abilities and anxiety measures are even more modest (Hayslip, 1989b). Moreover, domain-specific control beliefs have not shown to be significant predictors of age-related change in fluid or crystallized intelligence dimensions in old age (Lachman & Leff, 1989; Willis & Jay, 1990).

Second, most experimental studies have reported modest or no effect on ability functioning of treatments focusing solely on performance factors. No significant improvement in cognitive performance was reported for interventions focusing solely on the performance factors of monetary reinforcement (Denney, 1980; Hoyer, Labouvie, & Baltes, 1973), noncontingent social reinforcement (Mergler & Hoyer, 1981), additional planning time (Denney, 1980), social contact (Willis et al, 1983), or morale (Yesavage, 1983).

Hayslip (1989a, 1989b) has recently argued that treatments focusing on performance factors, such as anxiety reduction procedures, are as effective as cognitive strategy training. However, the Hayslip research (1989b) suffers from a number of limitations that affect interpretation of the findings. First, subjects in the anxiety reduction condition also received practice on the cognitive strategy training materials, confounding the two treatments. Second, Hayslip's claim of a training effect for the stress innoculation group was demonstrated only immediately after training; greater durability of training effects was shown for the cognitive strategy training than for the stress innoculation. Third, Hayslip found no reduction in anxiety level following the stress innoculation procedure, bringing into question whether changes in cognitive performance could be attributed to the stress reduction intervention. Indeed, in a number of instances a negative relationship was found between cognitive gain and reduction in anxiety (Hayslip, 1989b).

A major limitation of much of the previous research on interventions focusing on performance factors has been the lack of a direct test of the intervention's effectiveness. That is, in many studies, change on the target variable (e.g., anxiety, morale, self efficacy) has not been directly assessed. However, if improvement in cognitive functioning is to be attributed to the performance factor, then change in the performance factor needs to be demonstrated, and a relationship needs to be shown between change in the cognitive ability and change in the performance factor. To Hayslip's credit, he did examine pre-posttest change in anxiety, but found little relationship between change in anxiety and in cognitive performance.

Some of the most systematic experimental research on the effect of performance factors on memory performance has been conducted by Yesavage and colleagues (Yesavage, 1983; Yesavage, Lapp & Sheikh, 1989). In a number of studies, Yesavage has examined the effect on face-name memory recall of various non-cognitive treatments (e.g., imagery enhancement, relaxation, morale) alone and in combination with specific training on mnemonic strategies. While performance factor interventions alone have had modest or no effect on face-name recall, these treatments do appear to be useful when administered *in combination* with specific mnemonic strategy training. Such interventions appear to boost or enhance the effectiveness of the strategy training in some instances. Thus, based on the Yesavage research, it appears that combinatorial training involving treatments focusing both on cognitive strategies specific to the ability and on domain-specific performance factors may yield the maximum improvement in cognitive functioning.

As a final note, Yesavage's most recent research also suggests that there appear to be wide individual differences in the effectiveness of treatment on a particular performance factor. For example, only subjects high in anxiety were found to benefit from a combination of relaxation and strategy training. Thus, combinatorial training programs may need to be "tailored" to the specific needs of the individual in order to maximize the effects.

QUESTION IV: Is Practice as Effective as Cognitive Strategy Training in Improving Cognitive Performance ?

Some have maintained that older subjects can generate their own strategies if given the opportunity to practice, and that cognitive strategy training produces no greater effects than practice alone. Teaching of cognitive strategies may even be confusing to the subject. This perspective is based largely on the assumption that intervention involves the activation of *pre-existing* cognitive skills.

It is certainly true that almost any exposure of elderly subjects to cognitive problem solving tasks results in some improvement (Hofland et al., 1981). Even practice associated with pre- and posttesting raises performance on a variety of measures for both training and control groups. On the one hand, such practice effects are encouraging, since it supports the notion of plasticity in intellectual performance in old age. On the other hand, it forces the researcher to examine more carefully what are the specific benefits from particular types of intervention (e.g,. practice versus cognitive strategy training conditions).

We must begin by differentiating between procedures employed in cognitive strategy training and those traditionally involved in practice. A practice condition traditionally has involved the subject attempting to solve a number of problem solving tasks without feedback regarding the correctness of the response and with no instruction on strategies or techniques that are useful in solving the problem. Furthermore, the difficulty level of tasks included in a practice condition have traditionally been randomly ordered, so that the problems did not proceed from simple to more complex tasks.

In comparing the effects of cognitive strategy training versus practice, it is important to consider not only the increase in number of correct items, but also level of accuracy (Willis, in press). As a function of practice, subjects can speed up their behavior, thereby attempting more problems and increasing the number of problems answered correctly. However, an increase in the number of correct answers does not necessarily reflect an increase in accuracy. Accuracy level may increase, decrease or remain constant, even though there is a significant increase in number of correct answers.

We have found cognitive strategy training to be particularly effective in increasing level of accuracy in both the ADEPT and SLS studies. Accuracy is important for both theoretical and practical reasons. Increased accuracy suggests that the older adults are utilizing the cognitive strategies emphasized during training. We believe that subjects' utilization of these strategies and the resulting increase in accuracy are important to the maintenance of cognitive training effects. Accuracy is also very important to the older adult from a practical perspective. Mistakes or errors due to incompetence or carelessness can be very costly, even deadly, to the older adult. Many older adults recognize this and much of their efforts are devoted to maintaining a high level of accuracy, even if it involves avoiding activities where there is potential for error.

Therefore, training that demonstrates potential for increased accuracy is particularly important in old age.

In our ADEPT research, we have compared level of accuracy for cognitive strategy training and practice conditions on the fluid ability of Figural Relations. Figure 9.5 shows the proportion of problems answered correctly under strategy training versus practice conditions on Figural Relations ability. After 5 strategy training sessions, 69% of the items attempted were answered correctly. In contrast, after 5 practice sessions only 50% of items were answered correctly. Even after 10 practice sessions, the accuracy level (53%) was below that for the cognitive strategy training group after five training sessions.

In recent research by Baltes and colleagues (Baltes, Kliegl & Dittmann-Kohli, 1988), cognitive strategy training was also found to result in higher levels of accuracy on Inductive Reasoning ability than a practice condition involving the same number of hours of practice as cognitive training. However, there was no difference in accuracy between the strategy training and practice conditions on the Figural Relations ability. However, it was noted that the Baltes et al. sample was a more advantaged sample than the ADEPT subjects, and scored about one-half standard deviation above the ADEPT sample at pretest. For more advantaged subjects, such as in the Baltes et al. study, a practice condition may be effective for some less complex abilities, such as Figural Relations. Some Figural Relations problems have been shown to be able to be solved by a visual inspection of the stimulus (e.g., the gestalt), rather than by logical reasoning strategies.

Several recent studies (Baltes, Sowarka, & Kliegl, 1989; Blackburn, Papalia-Finlay, Foye & Serlin, 1988; Hayslip, 1989a) have employed a different type of self-instruction or practice condition than that traditionally included in the literature on practice effects. We believe that comparisons reported in these studies between self-guided practice and cognitive strategy training need to be interpretted with considerable caution. In all of these studies the practice condition involved use of an adaptation of the ADEPT cognitive strategy training materials, but with little or no trainer direction. Thus, the nature of the practice materials was qualitatively different from the types of materials traditionally employed in a practice condition. That is, the cognitive strategy training materials were designed similar to programmed instructional materials. The training problems were sequentially ordered to introduce the subject to cognitive strategies and problem solution rules in a systemmatic manner. Problems within the materials were ordered in terms of difficulty level. Thus, it would be expected that advantaged subjects would be able to engage in self instruction as they progressed through the materials, as has been demonstrated with other programmed instructional materials. Furthermore, in two of the studies (Blackburn et al., 1988; Hayslip, 1989a), subjects were given the answers to practice problems, thus giving them feedback regarding the correctness of their responses; traditionally, no feedback on problems has been given under practice conditions. This type of self guided instruction condition

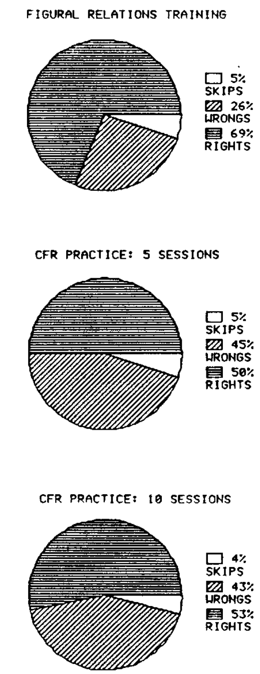

Figure 9.5. Proportion of attempted Figural Relations ability test items that were correct, wrong, or omitted. Figures are shown for: Training subjects after five training sessions; Practice subjects after five practice sessions; and Practice subjects after ten practice sessions.

represents a midpoint in a continuum from cognitive strategy training and the traditional practice condition. While findings from these studies contribute to our understanding of the antecedents of cognitive functioning, we consider this self guided instructional condition to provide much more support to the subject than is provided in the traditional practice condition, and results of the studies need to be interpreted accordingly.

QUESTION V: Are There Long-term Effects for Cognitive Training?

The durability of training effects over time is an important issue when examining the implications of training within a developmental perspective. The concern is not only that significant improvement in older adults cognitive performance can be demonstrated immediately after training, but whether training interventions are durable and have implications for patterns of longterm cognitive development. In the first phase of cognitive training research, the maintenance of training effects was assessed one week, one month, and six months after training. In several studies in our own laboratory and that of others, training effects were found to be maintained six months following training (Willis et al, 1981; Willis, 1987).

As it has become possible to follow training subjects for multiple years after initial training, we have begun to examine the longterm impact of training on subjects' subsequent cognitive development. We have recently reported findings from a seven-year follow-up of ADEPT subjects trained on the fluid ability of Figural Relations (Willis & Nesselroade, in press). Subjects received initial training in 1979, with subsequent booster training sessions in 1981 and 1986. Significant training effects at each of the three occasions indicated that subjects were able to continue to profit from cognitive interventions as they advanced from young-old to old-old age. Moreover, training subjects even into their late seventies and early eighties continue to perform at a level significantly above their baseline level (prior to training). Examination of subjects' performance at the individual level, indicated that 64% of the training group's performance was consistently above baseline, compared to 33% of the control group. Thus, findings from our follow-up studies suggest that during the late seventies and eighties, during a period in which widespread cognitive decline would be expected, multi-phased cognitive interventions are effective in maintaining older adults' level of performance significantly above their baseline performance, seven years previously.

Summary and Discussion

In this chapter we have discussed five issues of concern in current research on cognitive training in elderly samples. Perhaps the most notable outcome of the training research to date has been the repeated demonstration of plasticity in older adults' cognitive functioning. Plasticity in cognitive functioning has been exhibited not only by the numerous studies reporting significant improvement in older adults' performance via brief behavioral interventions, but also by studies showing that for some healthy older adults' reliable declines in cognitive performance can be remediated through cognitive training.

Findings from training research have provided a new and broader framework in which to consider the average or normative levels of performance reported in single occasions studies of cognitive aging. Based on the findings of training research, one can expect that one half to two-third of the subjects in a descriptive (single occasion) study are capable of performing at a statistically significantly higher level than they exhibit at a single occasion of measurement. Our studies suggest that many healthy older adults' can perform at a level one-half to three-quarters of a standard deviation above their average or normative level of performance.

At the same time, some words of caution and reservation are needed. First, the research on cognitive training has focused largely on relatively healthy older adults, living independently in the community. Participants have typically been the young-old, rather than the old-old and very old, since the young-old are more likely to volunteer for almost any type of behavioral research. There has been less cognitive training research with institutionalized or cognitively impaired elderly; these populations are more likely to include the old-old and very-old. However, fortunately interest in this type of research is growing, given the changing demographics of our society, and the need to foster the maintenance of independence into advanced age.

Second, the number of cognitive abilities and processes that have been subjected to training interventions is relatively limited. To date the abilities that have received the most intensive study are those that longitudinal research indicates show the earliest onset of decline (e.g., fluid abilities). Further research is needed on abilities and skills, such as crystallized intelligence, that tends to remain intact until advanced old age. Such research is important for theoretical and applied reasons. From the perspective of developmental theory, it is important to compare the relative range of plasticity in intact as well as more vulnerable cognitive dimensions. Interestingly, it may prove more difficult to enhance performance on more intact abilities to the degree exhibited for abilities showing earlier decline. Although there have been virtually no direct training studies of crystallized abilities, several studies have shown smaller retest or practice effects for intact abilities such as vocabulary than for fluid abilities (Baltes et al., 1988; Willis et al., 1981). From an applied perspective, fostering the maintenance and enhancement of intact abilities and skills may be particularly useful in order to compensate for irreversible loss in other cognitive domains due to neurological impairment.

Three themes for future research emerge from the discussion of the five issues considered in this chapter. First, future training research must give greater attention to individual differences. Many previous training studies have reported effects in terms of mean scores, with standard deviations serving as the only indication of variability in training effects. However, our own research has demonstrated the importance of distinguishing between training as the remediation of decline, versus training as the improvement of the performance of subjects experiencing no previous decline. Furthermore, recent research on performance variables (e.g., anxiety, self efficacy) affecting cognitive functioning suggests that future training research needs to target interventions specifically to the strengths or deficits of the individual. To be maximally effective, training procedures need to be "tailored" to the individual. Furthermore, study of individual differences is important in furthering our understanding of the antecedents of cognitive change and of the predictors of training effectiveness. For example, more study is needed of the relationship between chronic disease and the medications prescribed for these diseases and cognitive change and responsiveness to training interventions.

The second theme to emerge focuses on further study of the nature of the behavioral changes reflected in training and practice effects. We have begun to examine training effects reflecting changes in accuracy versus speed of problem solving. Baltes and colleagues (Baltes et al., 1988) have examined the relationship between item difficulty level and training effects. However, further research is needed to examine the nature of the behavioral changes occuring in training for subjects who have declined verus those who have not declined. The nature of behavioral change occurring under different treatment conditions also needs further study.

Finally, the effects of training interventions need to be examined within the ongoing development and aging of the individual. That is, training effects need to be examined within a lifespan perspective. Our recent follow-up studies of ADEPT training research suggest that training and intermittent booster sessions are effective in sustaining higher levels of functioning even into advanced old age. We believe that it is the examination of training interventions from a lifespan framework that will provide the most fruitful information on the utility of training for fostering and enhancing the quality of life for older individuals and thereby for society at large.

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