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DEVELOPMENT AND MODIFIABILITY OF ADULT INTELLECTUAL PERFORMANCE: AN EXAMINATION OF COGNITIVE INTERVENTION IN LATER ADULTHOOD

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Introduction

Traditionally, differential and cognitive approaches have emphasized different dimensions of adult intelligence. Differential psychology has sought to represent intellectual functioning in terms of structural models of human abilities (Cattell, 1971; Guilford, 1967). Much of the emphasis in this approach has been on idividual differences in intellectual ability. In contrast, cognitive psychology has focused on identifying the cognitive processes and strategies involved in intellectual functioning (Newell and Simon, 1972; Sternberg, 1977). It has been suggested that cognitive psychology provides a more dynamic approach to the study of intelligence in that the focus is on the processing of information, whereas psychometric ability factors represent static products of cognition.

In one sense, however, both approaches have tended to assume a somewhat static view of adult intelligence. That is, much theory and research associated with each position has involved assumptions regarding stability in adult intellectual performance. Thus, the focus in both approaches has been primarily on the normative or average level of intellectual functioning rather than on an examination of the full range of intraindividual variability in adult intellectual performance (Baltes and Willis, 1977, Willis and Baltes, 1980). However, it will be suggested in this paper that there may be considerable plasticity in intellectual performance, particularly in later adulthood; thus, potential as well as average levels of functioning must be examined.

Several trends have contributed to such assumptions regarding stability in adult intelligence. In differential psychology the notion regarding the static nature of intelligence (Baltes and Willis, 1979; Brown and French, 1979). Within cognitive psychology the importance of a predictive vs. diagnostic (learning) approach to intellectual assessment is gaining attention (Brown and French, 1979; Resnick, 1979). The traditional emphasis on prediction appeared to involve a static perspective of intelligence, such that the individual's current level of functioning (based on prior learning and assessed by standard intelligence tests) was considered to provide an accurate reflection of future learning potential. In contrast, those advocating a diagnostic approach suggest that current level of functioning may not provide an accurate prediction of the individual's potential zone of intellectual development, if prior learning opportunity has been limited (e.g., environmental deficits, learning disability). In this case, a learning or diagnostic approach involving an examination of the range of plasticity in intellectual functioning within a short-term experimental, assessment or interventive context would be useful. Such an approach emphasizes intraindividual variability rather than a normative (average) level of intellectual functioning. A learning or diagnostic approach has been most forcefully articulated (within cognitive psychology) by those working in the area of mental retardation (Brown and French, 1979). In addition, these researchers are engaged in a series of training studies examining the range of modifiability of intellectual performance in learning disabled and retarded populations (Belmont and Butterfield, 1977; Brown, 1978).

Similar concerns regarding intellectual variability within a psychometric or differential approach to intelligence have been associated most notably with the recent revival of a life-span perspective. Within a life-span approach, developmental change and plasticity are examined across the total life span rather than primarily in childhood or adolescence. Two lines of recent research have examined individual variability in intellectual functioning in adulthood. The first and more extensive line of research, illustrated primarily by the work of Schaie (1979), has focused on the use of cohort-sequential methodology in the longitudinal study of adult intelligence. In contrast to cross-sectional findings suggesting a peak in intellectual functioning in childhood or adolescence, longitudinal research suggests continued intellectual development for some abilities into young adulthood, such that in current cohorts of healthy, well-educated adults a peak in intellectual functioning may not be reached until early middle age. Moreover, much less pervasive decline in old age has been reported than for cross-sectional samples. In addition, comparisons of earlier and later adult cohorts at the same chronological age indicate that more recent cohorts performed at a higher level for some abilities than did earlier cohorts at the same age. Such cohort-differences research suggest that the lower level of intellectual performance of current older adult cohorts may be partially attributable to cohort-related obsolescence as a function of socio-cultural change. Thus, the curof stability appears to have been closely related to assumptions regarding the nature of ability factors. Those taking a casual, rather than descriptive, view of the nature of factors have tended to ascribe trait-like characteristics to such ability factors. Cattell (1971) has referred to factors as "source traits," and Guilford (1967) has described a factor as "an underlying latent variable along which individuals differ" (p. 41). Based on a biological perspective of traits as enduring characteristics (e.g., eye color, race) of the individual, there was the tendency to make similar trait-like assumptions regarding ability factors, such that considerable stability in intellectual performance was expected.

Within cognitive psychology, stability notions have been related to the concern with identifying a set of elementary information processes (Newell and Simon, 1972; Sternberg, 1977). These processes were considered elementary in the sense that within a given theory they were the fundamental units of analysis. The elemental nature of these processes appears to have led to assumptions regarding their stability. Moreover, some have suggested that information processes may be a direct reflection of neural efficiency in functioning, again implying the elemental, stable character of such processes (Jensen, 1978; Ertl, 1971).

In addition, both differential and cognitive approaches have placed heavy emphasis on predictability (Anastasi, 1976; Sternberg, 1977). Within the psychometric approach, the concern was on development of measures which could predict individual differences in performance in academic or occupational settings, whereas in cognitive psychology the goal was to design models of sufficient generality to predict or simulate the manner in which information was processed across a variety of content and task domains. To achieve such predictive power, models were developed which focused on normative or average levels of intellectual functioning and assumed considerable stability in intellectual performance.

Finally, stability assumptions regarding adult intelligence have resulted, in part, from the traditional emphasis within developmental psychology on the earlier portion of the life span (Labouvie and Chandler, 1978; Baltes and Willis, 1979). That is, many models of adult intelligence have evolved from child-oriented theories of intelligence, such that intelligence was seen as developing in childhood and adolescence, followed by a period of considerable stability through most of adulthood and a sharp decline in old age. Thus, most developmental change in intelligence was assumed to occur in childhood with relatively little important developmental variability through the remainder of the life span.

However, within both differential and cognitive psychology there appears to be a movement toward reexamination of a normative or average approach to intellectual functioning and of assumptions rent elderly may be at a disadvantage in many academic-related contexts, such as testing situations. As a function of such obsolescence, older adults' average level of intellectual performance as assessed in standardized testing contexts may not provide an accurate reflection of their potential zone of intellectual functioning. In this case, a learning approach may be useful in examining the range of plasticity (variability) in older adults' intellectual performance.

An Examination of Intellectual Plasticity (Variability) in Later Adulthood

In this paper two studies will be reported briefly which are part of an ongoing research program aimed at examining the modifiability of intellectual performance in later adulthood through a cognitive training paradigm.[1] A series of short-term longitudinal training studies focusing on several abilities representing fluid intelligence are being conducted. Within the Cattell-Horn theory of fluid-crystallized intelligence, fluid intelligence is conceived as one of two general dimensions of intelligence, involving stable trait-like properties and exhibiting a normative pattern of decline in later adulthood (Horn and Cattell, 1967; Cattell, 1971). Our training research seeks to examine the range of variability which can be experimentally produced for component abilities representing such a trait-like dimension of intelligence and, thus, to assess the modifiability of normative decline in fluid intellectual performance in the elderly.

In the first study to be reported, the range of variability in intellectual performance as a function of practice (retest) effects was examined. Such a study explored intellectual modifiability under minimal intervention conditions; subjects participated in multiple retest sessions with no instruction on cognitive strategies and no feedback regarding correctness of response. In the second study, subjects received training on cognitive strategies required in solution of the target fluid ability tasks. Training effectiveness was assessed with regard to both durability (maintenance) of training effects and transfer to a theory-based pattern of ability measures.

Research on retest-practice effects. Thirty older subjects ($\bar{X}$ age = 69.2 years, SD = 5.18) participated in eight one-hour retest sessions (Hofland, Willis, and Baltes, Note 1). At each retest session, subjects were administered under standard testing conditions two measures, representing the two fluid abilities of Figural Relations and Induction respectively. The Culture Fair test (Scale 2, Power Matrices Scale 3; Cattell and Cattell, 1957) was identified from previous research (Cattell, 1971) to represent the Figural Relations ability; the Induction ability was marked by an Induction Composite test including Letter Sets (Ekstrom, French, Harman, and Derman, 1976) Number Series and Letter Series (Thur-

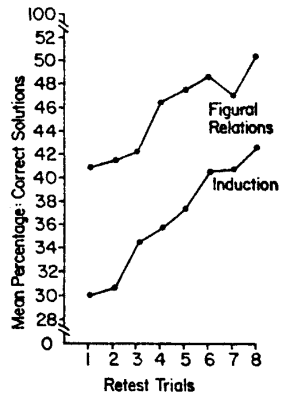

Figure 1

stone, 1962) tests. No external feedback regarding correctness of responses was given during the retest sessions.

The mean percentage of correct solutions for each measure was computed for each of the eight retest sessions and is shown graphically in Figure 1. A one-factor analysis of variance with repeated measurement across the eight trials was performed on the raw scores for each of the two retest measures. Significant performance gains ($p < .001$) were found across the eight trials for each of the two measures (Figural Relations: $F = 16.81$, $df = 7,203$; Induction: $F = 26.42$, $df = 1.29$). Total improvement in mean scores on both measures was roughly equivalent to one standard deviation. With regard to the performance pattern across the eight sessions, subjects exhibited small, steady gains between consecutive trials. Separate trend analyses for the two measures indicated that only a linear component was significant ($p < .001$). No apparent performance asymptote was reached.

Training research. Modifiability of fluid intellectual performance in the elderly has also been examined as a function of a series of short-term longitudinal training studies each focusing on one target fluid ability. In one such study (Willis, Blieszner, and Baltes, Note 2) involving the target ability of Figural Relations, training effectiveness was assessed by comparing posttest performance of randomly assigned experimental and control groups (Total N = 58, X age = 69.8, SD = 5.7). Experimental subjects participated in five one-hour training sessions focusing on cognitive strategies identified in task analyses to be involved in solution of Figural Relation-type problems. The two criteria for assessing training effectiveness were durability (Maintenance) of training effects over three posttest occasions

(1 week, 1 month, 6 months) and transfer (generalizability) of training across a broad battery of seven fluid and crystallized measures. With regard to training transfer, a hierarchical theory-based pattern of trasnsfer was predicted with the largest training effects occurring for the three near transfer measures representing the target fluid ability: ADEPT Figural Relations (Plemons et al., 1978), Culture Fair (Cattell and Cattell, 1957), Raven (Raven, 1962). Less or no training effects were predicted for two levels of far transfer, involving far fluid transfer to the fluid ability of Induction and far nonfluid transfer to Crystallized Intelligence and Perceptual Speed. Induction was represented by two measures: ADEPT Induction (Blieszner, Willis, and Baltes, Note 3) and Induction Composite (Ekstrom et al., 1976; Thurstone, 1962) tests. Crystallized Intelligence was marked by a Vocabulary measures (Ekstrom et al., 1976) and Perceptual Speed by the Identical Pictures test (Ekstrom et al., 1976).

The entire data matrix (across treatments and occasions) for each of the seven posttest measures was standardized using the control group's score on that measure at Posttest 1 as the standardization base with a mean of 50 and standard deviation of 10. This standardization procedure was employed to provide a common baseline of performance on each measure to which all other data points for that measure could be compared and to eliminate scale level differences between measures, thus facilitating comparison of transfer effects across measures. A graphic summary of the training and control groups' standardized mean scores for the seven transfer measures averaged across the three posttest occasions, is shown in Figure 2. Mean scores of the training group were larger than the control's scores for all seven measures at each of the three posttests. The pattern of training transfer is represented by the relative difference between the standardized mean scores for the training and control groups for each measure. Note that the difference between mean scores for training and control groups appears larger for the three near, Figural Relations, measures than for the four far (fluid and nonfluid) measures.

An overall analysis as a general assessment of training effects was performed across all measures and occasions, using standardized scores. That is, a 2 (Treatment: Training, Control) x 3 (Occasion: Posttests 1, 2, 3) x 7 (Measures) analysis of covariance with repeated measures was conducted using the pretest score on the ADEPT Figural Relations test as the covariate. There was no significant difference beteen training and control groups at pretest. This analysis resulted in a significant Treatment main effect (F [1, 54] = 11.81, $p < .001$), and a significant treatment x Meassure interaction (F [6,336] = 2.25, $p < .05$) suggesting a differential treatment effects across the seven transfer measures as predicted. A significant Occasion main effect (F [2,112] = 12,00, $p < .001$) was obtained and interpreted as suggesting retest effects common to

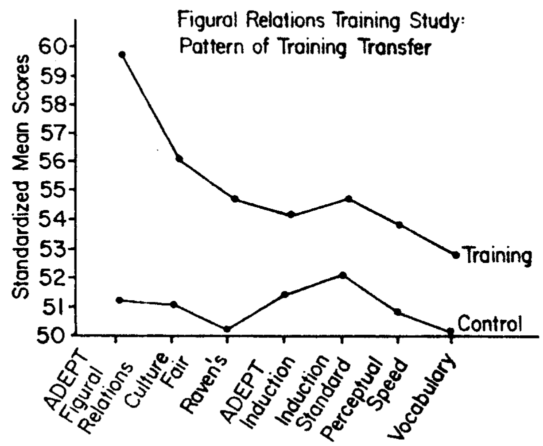

Figure 2

both training and control groups. A significant Measure main effect (F [6,336] = 3.43, p < .05) occurred as a function of differential training and retest effects by measure, given the standardization procedure.

Follow-up analyses via the Tukey WSD conducted separately by measure indicated that training and control groups differed significantly on each of the three near tranfer measures across posttests: ADEPT Figural Relations (p = .000), Culture Fair (p = .008), Raven's (p = .018). No significant differences between training and control were found for the four far transfer measures separately: ADEPT Induction (p = .151), Induction Composite (p = .16), Vocabulary (p = .138) and Perceptual Speed (p = .122). However, increasing the statistical power by using a repeated measures analysis of covariance on just the four far transfer measures resulted in a significant Treatment main effect (F [1,54] = 4.15, p = .047) for the four far transfer measures.

Discussion

Training research in later adulthood. Findings from both the retest and training studies suggest considerable variability in intraindividual intellectual performance in later adulthood. In the retest study significant performance increments were found for each of two measures, representing Figural Relations and Induction abilities. Such retest effects occurred under a minimal interventive practice condition in which subjects received no training or feedback, thus, suggesting subjects possessed or were able to generate on their own cognitive strategies and/or test-taking skills useful in improving their performance. In the Figural Relations training study a pattern of differential training transfer was found with significant training and transfer effects being established and maintained for the three near transfer measures. Such training effects for the three measures represent a broad continuum of training transfer within the target ability. Moreover, these training effects were maintained over a six-month period.

Data from the training study also suggests that transfer effects extended, although to a lesser degree, beyond the target ability. The training group's scores on all four far transfer measures at all post-test occasions were larger than those for the control. In our view, such an effect on far transfer measures is less likely to result from ability-specific improvement. Rather it may reflect generalized, non-ability-specific transfer attributable to situational or ability-extraneous factors (e.g., increases motivation, anxiety reduction) which were accrued as a function of the training treatment but are not intrinsic to performance on the target ability per se. Such non-ability-specific transfer would affect performance on a wide variety of ability measures and would show a general effect across the far transfer measures as was found. The likelihood of non-ability-specific transfer occurring may be greater for educationally and/or test-disadvantaged populations, such as the elderly. Considerable retest effects were also found in the training study. They were differentiated from ability-specific training effects as being general such that retest effects occurred for <u>both</u> experimental and control groups and did not follow the predicted pattern of differential transfer.

Such training research would appear to have important implications for theories of adult intelligence. Most current models of adult intelligence, both within the psychometric and cognitive approach, focus on the normative or average pattern of intellectual aging and do not address the potential for plasticity in intellectual functioning in middle and later adulthood. While most intelligence models in childhood and young adulthood have also focused on normative patterns of development, cognitive training research has examined the range of modifiability of intellectual performance during these age periods. This training research has contributed to more comprehensive models of intellectual development early in the life span. Such training research is needed to supplement current theories of normative adult intellectual development. It is suggested that comprehensive theories of intelligence including both potential and normative dimensions of functioning may be particularly important in adulthood, in light of recent cohort research examining the potential impact of socio-cultural change on adult intelligence.

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Footnote

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