Late Life Potential and Cohort Differences in Mental Abilities

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Abstract

The expression of creative behavior and accomplishment in late life would seem to be contingent upon the maintenance of intellectual functioning into advanced old age. Although average declines in mental abilities with advancing age have been reliably established, there remains controversy as to patterns of individual differences in such decline. Such individual differences may be particularly profound in persons at high ability levels. This paper examines some differences in patterns of decline and in particular considers differential cohort trends over time that may influence the proportion of individuals of advanced age who may remain capable of significant late life accomplishments, and which may impact upon the ability of older individuals to take advantage of recent technological developments. Relevant empirical data from the Seattle longitudinal study are reviewed, some methodological issues are raised, and implications for late life potential are considered.

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Introduction

The expression of creative behavior and accomplishment in late life is necessarily contingent upon the maintenance of a high level of intellectual functioning into advanced old age. Although average declines in mental abilities with advancing age have been reliably established, there remains much controversy as to patterns of individual differences in such decline. Moreover, such individual differences may be particularly profound in persons at high ability levels. In addition, previous research (Schaie, 1983, 1987a; Schaie & Hertzog, 1983) has demonstrated differential cohort trends over time that is likely to influence the proportion of individuals of advanced age who may remain capable of significant late life accomplishments, and which may impact upon the ability of older individuals to take advantage of recent technological developments.

Extensive research on adult intelligence has shown that there have been marked generational shifts in levels of performance on tests of mental abilities (Flynn, 1984; Parker, 1986; Schaie, 1983; Willis, 1985). The usual empirical findings have been that later born cohorts appear to be advantaged when compared with earlier cohorts at the same ages. This phenomenon has been

explained by arguing that increased educational opportunities, improved life styles including nutrition, and the conquest of childhood disease has enabled successive generations to reach ever higher ability asymptotes (cf. Schaie, 1984), similar to the secular trends of improvement for anthropometric and other biological markers (Shock et al., 1984). Although linear trends have been found for some variables, there seems to be contrary evidence, that suggests that such trends may have been time-limited and domain- or even variable-specific.

Recent reports of the performance of high school students on college admission tests such as the S.A.T., suggests that there has been an ebb and flow on such high school measures of mental ability levels. Reexamination of our own data on adults from the Seattle Longitudinal Study (SLS), moreover, suggests that cohort patterns are far from uniform across abilities. That is, positive cohort gradients are not necessarily found for all abilities, and non-linear cohort patterns can not simply be dismissed as sampling aberrations, but may represent complications introduced by countervailing contextual trends that have an impact on mental abilities.

Accurate descriptions of patterns of cohort change in mental ability are important because they provide a foundation for gaining a better understanding of the manner in which productivity and competence shift over time in our society. Such data are also needed to understand how cohort differences in performance can

lead to erroneous conclusions from age-comparative cross-sectional studies (cf. Schaie, 1977, in press; Baltes, Cornelius, & Nesselroade, 1979). Because of the changing demographic composition of the population it is of particular interest to assess differences in performance level at comparable ages for individuals representing eras that are characterized by differential fertility rates (e.g. contrasts of the pre-baby boom, baby boom, and baby-bust generations. Cohort shifts at older ages, moreover, are directly relevant to policy considerations regarding the maintenance of of a competent work force that will contain increasing proportions of older workers as mandatory retirement becomes the relic of a biased past.

Most previous estimates of cohort shifts have resulted from the comparison of no more than two successive cohorts (e.g., Schaie & Strother, 1968; Schaie & Labouvie-Vief, 1973). With the completion of data collection for the fifth wave of the Seattle Longitudinal Study, it is now possible to estimate seven-year cohort shifts that are less sensitive to sampling variations by basing cohort difference estimates over at least four common age levels for seven successive cohorts. The first issue to be addressed in this paper, therefore, is the estimation of cohort trends across and within gender for seven-year birth cohorts with average birth years from 1889 to 1959; virtually the full range of adults now alive. Second, time-lag data will be reported over as many as 5 cohorts, seven years apart from each other, for samples

with average ages (in seven-year intervals) ranging from 25 to 81 years. We will then inquire into some contextual factors that may help us project where these cohort trends may go in the proximal future. Some methodological issues will next be considered. And finally implications will be examined for forecasts of late life potential in future generations.

Method

Subjects

The empirical data brought to bear on the above issues represent the initial tests of 3413 persons (males = 1621; females = 1792) who participated in the five waves of the Seattle Longitudinal Study. All were community-dwelling adults who were randomly selected from each seven-year age stratum of the membership of a metropolitan health maintenance organization. These data were collected in 1956 (ages 22 to 70; N = 500), 1963 (ages 22 to 77; N = 997), 1970 (ages 22 to 84; N = 705), 1977 (ages 22 to 84; N = 612), and 1984 (ages 22 to 84; N = 599). Numbers of participants by cohort and gender are reported in Table 1a. Similar frequencies ordered by chronological age and gender are provided in Table 1b. All participants were in good health when tested, and were representative of the upper 75 per cent of the socio-economic stratum. For the total data base educational levels averaged 13.27 years (range: 4 to 20 years), and occupational status averaged 6.25 on a ten point scale using

census classifications ranging from unskilled labor to professional.

Insert Tables 1a and 1b about here

Measures

Throughout the study, subjects have been assessed with the first five primary mental abilities (Thurstone and Thurstone, 1941; Schaie, 1985), the Test of Behavioral Rigidity (Schaie & Parham, 1975), and a demographic information form.
In this paper our discussion will be limited to four primary abilities: Verbal Meaning, the ability to comprehend words, a measure of recognition vocabulary; Spatial Orientation, the ability to mentally rotate objects in two-dimensional space; Inductive Reasoning, the ability to infer rules from examples that contain regular progressions of information; and Number, the ability to manipulate number concepts, as measures by checking simple addition problems. All measures were standardized to T scores (M = 50, SD = 10) based upon the entire set of study participants.

Procedure

All subjects were tested in small groups in sessions which for the first three waves lasted about two hours, for the fourth wave about three hours, and for the fifth wave in two sessions of 2 1/2 hours each (necessary because multiple markers of the

abilities, and other additional measures had been added).

Method of Analysis

The design of this study is an independent random sampling model, where each cohort at each age is assessed on a separate sample, thus controlling for possible effects of testing, reactivity and experimental mortality (Schaie, 1965, 1973, 1977, in press). Raw cohort differences were obtained by taking the differences between means for each pair of cohorts at all common age levels (four for comparisons of the seven cohorts born between 1896 and 1938, three for those involving cohorts born 1889 and 1945; two for the 1952 cohort, and one for the 1959 cohort). Cohort difference estimates were then obtained by averaging across all estimates to avoid undue weighting in terms of differential sample sizes. Similar estimates were obtained also separately by gender. Cohort gradients were then constructed by cumulating cohort difference estimates across the cohorts available for analysis. One-way ANOVAs examined the significance of time-lags at specific ages from 25 to 81 years.

Results

Cohort Gradients

Differences between successive cohorts as expressed in T score points (1/10 SD) were cumulated from the oldest cohort born in 1889 up to the most recently measured cohort born in 1959 for the four abilities of Verbal Meaning, Spatial Orientation,

Inductive Reasoning and Number and are presented in Figure 1. It will immediately be noted that the gradients differ markedly both in slope and shape. Inductive Reasoning comes closest to showing a linear positive cohort progression. Even here there are departures from linearity, with relatively steep increments up to the 1931 cohort and far slower and decelerating increment thereafter. Nevertheless, the cumulative increment across the currently available population is well in excess of a population standard deviation. The next most substantial pattern of positive increment across successive cohorts is shown by Verbal Meaning. After an initial modest dip this ability rises by about 2/3 SD until the 1924 birth cohort, followed by another modest dip. There is a further rise to an asymptote attained by the 1945 and 1952 cohorts, once again followed by another modest dip. Spatial Orientation also shows a basically positive cohort progression, but with a much flatter and variable profile. This ability reaches an initial asymptote after an 1/3 SD rise for the cohorts from 1910 to 1931. A further rise to a new peak of approximately 1/2 SD above the base cohort occurs in 1938, which is followed by a drop to the earlier asymptote in 1952, but with recovery to the higher level by the most recent cohort.

Insert Figure 1 about here

A very different pattern is shown for Number. Here a peak of about 1/3 SD above base is reached by the 1910 cohort at a level that is maintained through the 1924 cohort. Thereafter an almost linear negative slope is found that continues through the most recent cohort which is approximately 1/4 SD below the 1889 base.

Gender Differences

It might be suspected that some of the irregularities in the cohort patterns described above could be a function of differential representations of men and women in the cohort estimates (see also Table 1a), that would have an effect if cohort by gender interactions occurred over all or part of the cohort range studied. Figure 2 therefore provides cohort gradients estimated separately for men and women for the four abilities of interest.

Insert Figure 2 about here

The most regular pattern represented for the total sample by Inductive Reasoning also pertains separately for women. The implications of the 1959 cohort drop is not clear; it might be sampling fluctuation based on a single sample estimate. The cohort pattern for men is less regular, and seems to represent more of a "stairstep" profile. Nevertheless, it also maintains a clearly positive direction. It is interesting to note that there seems to be a lag effect, with magnitudes of cohort difference for men representing that of women for the previous cohort.

Gender differences in cohort profiles for Verbal Meaning include the attainment of initial asymptotes by the 1910 cohort for females but not until the 1924 cohort for males. Similarly, negative change for the most recent cohorts is observed for females by 1952 but for males only by 1959.

Several interesting gender differences characterize the cohort progression for Spatial Orientation. The early asymptote for the total group actually conceals distinct gender-specific patterns. Positive cohort change continue for men actually to an asymptote attained for the 1924 through 1938 cohorts. For the women however an initial peak is reached for the 1910 cohort with a drop close to base for the 1917 through 1931 cohorts. This is followed by a steep rise in 1938 and 1945, after which point the male and female cohort gradients again converge.

There are also distinct patterns for Number. First of all, note the greater increment from base for the women. A linear positive is observed until a peak is reached for the 1917 cohort. From the on there is successive decrement terminating below base level, interrupted only by a temporary plateau from the 1931 to the 1945 cohort. By contrast, the men reach an asymptote already in 1910. The is followed by a "stairstep" decrement until 1945, followed by modest recovery for the two most recent cohorts.

Time-lag Analyses

The data thus far discussed are based on cohort difference estimates that arise from data that for any set of two cohorts must cover age ranges that differ by at least seven years. For

example, the difference between cohorts born in 1896 and 1903 is computed over the average ages 60 to 81, while the difference between cohorts born in 1903 and 1910 is computed over the average ages from 53 to 74. An alternate manner of studying cohort change is to consider only the data available for successive cohorts at a specific age. This is a time-lag analysis, very similar to that conducted for college aptitude tests, and is relevant to the question whether significant changes have occurred, that would permit the judgment that performance levels at a given age have increased or declined as a function of shifts in population characteristics. Table 2 provides the relevant data from this analysis.

Insert Table 2 about here

Positive cohort trends were found to be statistically significant at or beyond the 5% level of confidence for Verbal Meaning for all ages from 39 to 81 and for Inductive Reasoning for all ages from age 25 to 74. A statistically significant trend was found for Spatial Orientation only at age 25, although all observed cohort differences were in a positive direction. As expected more complex findings occurred for Number. Here statistically significant trends were observed for ages 39 through 53, but significant positive trends were found only at ages 60 and 67. Magnitudes of positive time-lags over a 28 year were as great as .8 SD for Verbal Meaning, .4 SD for Spatial Orientation, and .9

SD for Inductive Reasoning. Because of the curvilinear pattern for Number, maximum negative as well as positive time-lags were small; they amounted to - .4 SD and + .3 SD, respectively.

Because of the specific relevance to the topic under discussion in this paper, trend lines were fitted for those variables showing significant cohort differences at ages 60, 67, 74 and 81. Slope coefficients indicating rate of positive cohort shift over a seven-year interval are given in Table 3.

Insert Table 3 about here

Cohort Gradients for Contextual Variables

The observed differential cohort profiles raise the question whether contextual variables can be identified that have differential impact on the abilities that we have studied and that also show differential cohort profiles. As a first step for such an examination we examined concurrent regressions of the ability variables upon several contextual variables on which data have been collected throughout the longitudinal study (Schaie, 1986b). Table 3 shows the contextual variables that have significant regressions upon the ability measures of interest in this study. Note that the relationship with current contextual variables is greatest for Inductive Reasoning and Verbal Meaning; those abilities that show both the steepest and most linear positive cohort gradients. In both instances, education, income, and multiple occupational exposure are identified as salient

contextual variables. These variables also appear for Number, but only Income accounts for a substantial proportion of variance. In addition, age at first marriage appear of contextual relevance for Verbal Meaning and Education, while age at birth of first child and physical height are relevant to Spatial Orientation.

Insert Table 4 about here

Figure 3 shows cohort patterns for several of the contextual variables. Education and income, show almost linear positive cohort gradients; albeit less steep for education than for the inflation-confounded income measure. An increase of 5 years of schooling was found from the cohort born in 1896 to that born in 1945; with an apparent asymptote reached for that cohort. A linear gradient was observed also for number of changes of living quarters, which increase by an average of 2 for the seven-year interval from the oldest to the most recently born cohort. But just as for the ability measures, there are contextual variables which have much more complex profiles. Frequency of change of occupations, for example, actually declined slightly until the 1938 cohort, but thereafter showed a steep rise. Family status variables also show complex cohort patterns. Thus age at first marriage steadily fell (by a total of 4 years) until the 1931 cohort, but has since risen by a little over 1 year. The age of birth for the first child parallels the marriage pattern only partially. For this variable an initial peak was

attained by the 1910 cohort, the pattern then following that shown for age at first marriage until the 1945 cohort, followed by a steep drop for the most recent cohorts.

Insert Figure 3 about here

Discussion

In trying to understand the data just presented, four different topics need to be covered. The first involves the question as to what meaning and significance is to be assigned to cohort differences in abilities. The second concerns the impact of contextual variables upon these cohort differences. Third we will consider implications for late life potential. And finally, there are some methodological issues to be addressed that hopefully will direct our further research efforts.

Cohort Differences in Abilities

The findings reported here clearly indicate that previous discussions of the impact of cohort differences upon intellectual performance in adults have been too simplistic. It is no longer possible to hold that benign changes in health status, life

styles, and education have a generalized positive effects that will inevitably lead each successive generation to reach an asymptote that is greater than that achieved by its predecessor. Instead, we note that cohort progressions occur at different rates for different abilities, may show gender-specific pattern, and be non-continuous. For some variables positive cohort trends may reverse, even to the point, that over a wide range of cohorts, the most recent cohorts may perform at a level that could be lower than that shown at equivalent ages observed for much older cohorts. It seems to follow that changes in socialization patterns and other environmentally programmed experiences differentially impact cohort progression as well (cf. Schaie, 1984a, 1986a). Nevertheless, it does appear that positive cohort gradients are most likely to be found for those variables that are most directly affected by a steady increase in educational exposure, whether in terms of knowledge acquisition (as would be the case for a crystallized ability such as Verbal Meaning) or in the acquisition of problem solving strategies (as would be true for the fluid variable of Inductive Reasoning). We have previously shown that increasing the familiarity of test stimuli will reduce cohort differences in the face of differential educational exposure (cf. Gonda, Quayhagen, & Schaie, 1981). Similarly, positive cohort differences observed in this study might readily be attributable to differential familiarity with similar test stimuli prior to entry into our study.

It should also be noted that the increment of cohort differences has slowed markedly over the past two decades. Cumulative magnitudes of cohort differences between those now in mid-life and those in early old age is no greater than the amount of training gains demonstrated for older adults who had not experienced age-related decline (Schaie & Willis, 1986; Willis & Schaie, 1986). It seems reasonable than to assume, that much of the cohort-related aspect of the older persons intellectual disadvantage when compared with younger peers could be amenable to compensation by suitable educational interventions.

Some practical consequences arise from the reliably observed upward shift of performance by successive cohorts at given ages. It is instructive to note that the largest gains (see Table 2) occur for the fifties and sixties. These gains are in excess of average estimates of period effects for the past 28 years (Schaie, 1983), and thus imply that past cross-sectional norms may significantly underestimate intellectual performance of individuals at late career stages. Such findings may be particularly important in correcting for the possible misuse of older cross-sectional data in age discrimination litigation and in the development of procedures for lateral career shifts in the latter part of person's work life. On the other hand very little gain across cohorts is observed once the eighties are reached.

Impact of Contextual Variables

Cohort patterns for the contextual variables also fail to show uniform progressions. Those that seem most directly related to the crystallized abilities, education and income, show almost linear positive cohort gradients; albeit less steep for education than for the inflation-confounded income measure. But just as for the ability measures, there are contextual variables which have much more complex profiles. Frequency of occupational change, for example, actually declined slightly until the 1938 cohort, but thereafter showed a steep rise; this in contrast to our other mobility measure, change in living quarters, which showed a rising cohort trend throughout. Family status variables also show complex cohort patterns. Thus age at first marriage steadily fell until the 1931 cohort, and has since been rising, while age of first child attained an initial peak for the 1910 cohort, then followed the pattern for age at first marriage, but showed a steep drop for the most recent cohorts.

Considering the interrelation of ability and contextual variables, it may well be that many of the irregularities in the cohort progression for our ability measures could be better understood by examining shifts in contextual variables occurring over the same time periods (see also Gribbin, Schaie, & Parham, 1980). That is, some of the "stairstep" phenomena seen in ability cohort profile may represent fluctuations in sampling and or general population characteristics on contextual variables that

constrain the distribution of individual differences on mental abilities. A better understanding of these relationships may permit more educated projections for cohort-related shifts in ability structure as well.

Some Methodological Considerations

There are several methodological caveats that need to be mentioned to place our findings into proper context. As is true for most existent longitudinal studies of cognitive functions, those of our data that permit adequate cohort comparisons are currently based on single markers of the latent constructs they represent. We are well aware of the fact that the stability of single markers across cohorts differing widely in age may be less than desirable (cf. Schaie & Hertzog, 1985), and in the most recent wave of the SLS have therefore switched to multiple markers. On the other hand we have recently been able to demonstrate (by means of confirmatory factor analyses) that at least configural invariance pertains for the measures reported on in this paper over the entire adult age range (Schaie, Willis, Jay, & Chipuer, 1987). Nevertheless, it would be important to replicate the cohort shift findings at the latent construct level. At that level it would then become more justifiable to regress ability constructs upon the social structural characteristics for which we have reported concomitant cohort shifts.

Implications for Late Life Potential

There are a number of important inferences, however, that can be drawn at this time for what the cohort shifts in abilities

described here portend for the proximal future. First of all, it is clear that the performance levels of successive cohorts during the young-old life stage (the sixties and early seventies) for certain abilities will continue to increase. On the other hand, there has been a leveling off of gains for more recent cohorts. One consequence of these developments is that age differences in performance between young adults and the young old will at least temporarily be reduced significantly. Using the values for rate of cohort change provided in Table 4 of this paper, we can predict that over the next decade, the proportion of young-old who overlap with the mid-range of young adults on many abilities will increase by from 5 to 10 per cent. Although this may seem a relatively small shift, it is important for several reasons. We have previously documented that until age 60 there is virtually complete overlap for distributions at successive seven-year intervals with that prevailing at age 25 (Schaie, 1987c). It is during the young-old period that we currently see a tendency for that overlap to diminish. The predicted increase in overlap would extend the age range where older persons, in general, would compete on equal terms with their younger peers at least into the early seventies.

Although there has been a trend for ever earlier retirement, there has also been an increasing trend for at least part-time reentry of older persons into the labor force, and there have been an increasing number of individuals (particularly in professional work roles) who have taken advantage of current age discrimination

legislation, to insist on retaining their jobs to later ages. The data provided here, suggest that this trend is likely to increase, and that related litigation will have an even stronger factual basis.

The projected reduction in cohort differences in ability between young and old adults is also likely to result in greater utilization of educational opportunities by older persons, and in conjunction with current shifts in demographic distributions, will lead to greater utilization of educational resources that provide training for second and third careers. Much of the retraining of older workers involves skills that require some of the very abilities that we have been monitoring (cf. Willis & Schaie, 1986). It is fortunate, therefore, that upward shifts in abilities across cohorts appear to occur particularly at those age levels that must be tapped, if we are interested in increasing the age range of high productivity within our population.

In addition to the positive inferences drawn from our data, there are also some negative ones. First, we need to note that the positive cohort shift was no longer apparent once the eighties are reached for any ability other than recognition vocabulary. Apparently, age-related changes do take their toll for most of us in very old age, and environmental interventions at this writing are not too effective to prolong full functioning into quite advanced age. Second, the asymptote reached by recent cohorts in educational attainment, given the substantial correlations of the abilities with education, may suggest that the positive shifts in

potential experienced in early old age by successive cohorts may consequently come to a halt by the end of this century.

Summary

We have examined updated data on cohort differences in the four primary mental abilities of Verbal Meaning, Inductive Reasoning, Spatial Orientation, and Number for seven-year birth cohorts with average birthyears from 1889 to 1959, as well as time-lag data over as many as five period, seven years apart, for mean ages 25 to 81. Our data show differential cohort gradients: Steep positive and linear for Inductive Reasoning, modestly positive with occasional inversions for Verbal Meaning and Spatial Orientation, and curvilinear, but essentially negative for Number. We also noted that there were gender-specific aspects of cohort progressions with men often lagging behind women in magnitude and direction of change. Time-lags at specific ages were particularly significant in the fifties and sixties, and practical implications were considered. Cohort progressions for contextual variables involving income, education, mobility and family formation characteristics, were also examined and suggested as possibly offering a basis for understanding irregularities in the ability cohort gradients and in enhancing projections of cohort trends in mental abilities. We concluded by noting effects of these cohort shifts for late life potential and by raising some methodological cautions.

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Table 1a
First Time Paticipants in the Seattle Longitudinal Study
Classified by Cohort and Gender

Cohort		Wave 1	Wave 2	Wave 3	Wave 4	Wave 5	Total
1889	M	28	39	26	-	-	103
	F	38	39	24	-	-	101
	T	76	78	50	-	-	204
1896	M	35	64	46	28	-	172
	F	37	63	42	31	-	173
	T	72	127	88	59	-	346
1903	M	35	58	42	37	24	196
	F	35	64	49	33	28	209
	T	70	122	91	70	52	405
1910	M	35	62	38	35	39	209
	F	30	81	42	38	37	228
	T	65	143	80	73	76	437
1917	M	36	79	40	35	40	230
	F	35	76	49	38	42	240
	T	71	155	89	73	82	470
1924	M	33	71	44	40	36	224
	F	37	79	43	37	43	239
	T	70	150	87	77	79	463
1931	M	38	52	34	32	33	189
	F	38	70	50	37	33	228
	T	76	122	84	69	66	417
1938	M	-	42	28	37	26	133
	F	-	58	37	36	39	170
	T	-	100	65	73	65	303
1945	M	-	-	31	29	31	91
	F	-	-	40	33	39	112
	T	-	-	71	62	70	203
1952	M	-	-	-	28	27	55
	F	-	-	-	28	28	56
	T	-	-	-	56	55	111
1959	M	-	-	-	-	18	18
	F	-	-	-	-	36	36
	T	-	-	-	-	54	54

Table 1b

First Time Paticipants in the Seattle Longitudinal Study

Classified by Chronological Age and Gender

Mean Age	Males	Females	Total
25	157	200	357
32	169	205	374
39	209	239	448
46	216	225	441
53	210	235	445
60	202	224	426
67	219	230	449
74	161	151	312
81	78	83	161
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Total	1621	1792	3413

Table 2

One-way Analyses of Variance for Cohort Differences at Specific Age Levels from 25 to 81 Years Measured in 1956, 1963, 1970, 1977 and 1984

Age Level	Verbal Meaning			Spatial Orient.			Inductive Reasoning			Number		
	F	d1[a]	d2[b]	F	d1	d2	F	d1	d2	F	d1	d2
25	.62	2.6	1.7	2.48*	3.9	2.9	4.37**	4.7	4.5	1.76	-3.2	-.8
32	1.00	2.5	-.1	1.71	3.0	-.6	2.81*	3.8	3.8	1.75	-3.1	-1.1
39	3.46**	5.0	5.0	.95	2.9	1.4	8.12***	7.3	7.3	4.37**	-5.3	-2.3
46	5.85***	5.7	4.0	2.20	4.0	4.0	6.89***	6.1	4.6	6.82***	-2.9	-2.0
53	10.95***	6.4	5.6	2.23	3.4	2.6	10.21***	6.6	4.9	3.58**	-5.3	-3.7
60	12.19***	8.1	8.1	.86	4.2	3.7	14.69***	8.6	8.6	5.91***	7.3	1.9
67	8.57***	6.2	6.2	1.90	3.9	1.5	10.56***	6.5	4.6	2.41*	4.2	2.0
74	5.43***	4.8	4.8	.48	1.5	1.5	9.08***	4.8	4.6	1.37	2.9	2.9
81	5.60***	5.0	3.0	.61	2.2	1.2	.01	.6	.6	.67	1.1	1.1

Note - Degrees of freedom: 25 = 4,352; 32 = 4,369; 39 = 4,443; 46 = 4,435; 53 = 4,440; 60 = 4,421; 67 = 4,445; 74 = 3,309; 81 = 2,158.

*p < .05, **p < .01, ***p < .001, [a]Difference between lowest and peak level in T score points (1/10 SD); [b]Difference between base and 1984 cohort.

Table 3

Slope Coefficients for Cohort Trends on the Primary Mental Abilities in Late Life (in T-Score Points)

	Mental Ability			
Age Level	Verbal Meaning	Spatial Orient.	Inductive Reasoning	Number
60	1.987		2.021	.471
67	1.615		1.615	.680
74	1.506		1.425	
81	1.425			

[a] Values are listed only for variables with slope coefficients that are significant at or beyond the 5% level of confidence.

Table 4

Beta Weights and Multiple Correlations for Contextual Predictors of Performance Level on Mental Ability Tests[a]

	Mental Ability			
Predictor	Verbal Meaning	Spatial Orient.	Inductive Reasoning	Number
Education	.306		.249	.110
Income	.344	.304	.348	.349
Change of Occupation		.130	.140	.072
Change of Home			.138	
Age at Marriage	-.126		-.197	
Age at 1st child's Birth		-.133		
Height		.143		
Multiple Correlation	.568	.432	.611	.421

[a] Values are listed only for variables with regression coefficients that are significant at or beyond the 5% level of confidence.

Figure Captions

Figure 1. Cumulative cohort differences from 1889 base cohort for the mental abities.

Figure 2. Cumulative cohort differences by gender for the mental abilities.

Figure 3. Cumulative cohort differences from 1889 base cohort for the contextual variables.

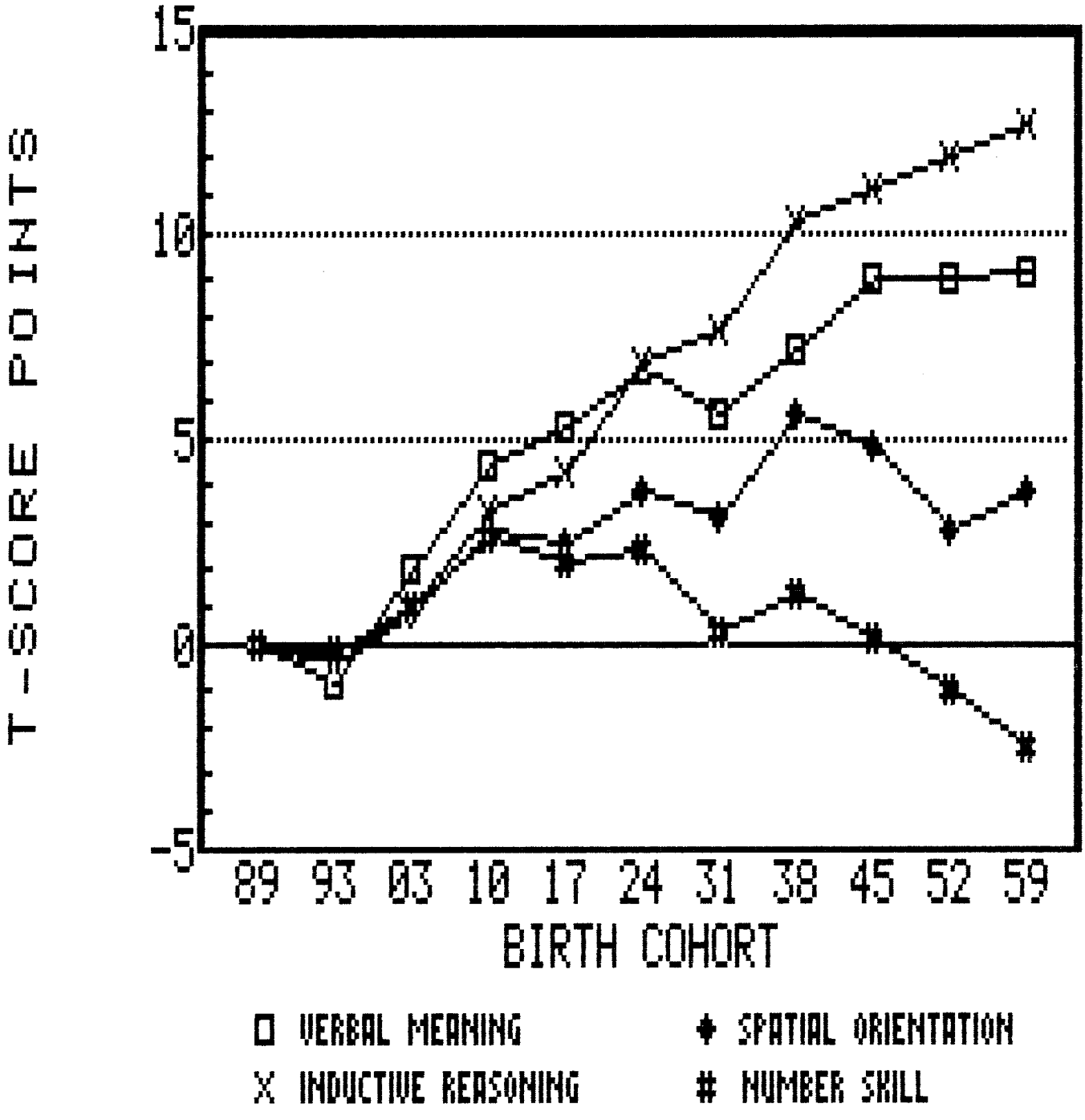

T-SCORE POINTS
15
10
5
0
-5
89 93 03 10 17 24 31 38 45 52 59
BIRTH COHORT
VERBAL MEANING
INDUCTIVE REASONING
SPATIAL ORIENTATION
NUMBER SKILL

FIGURE 1

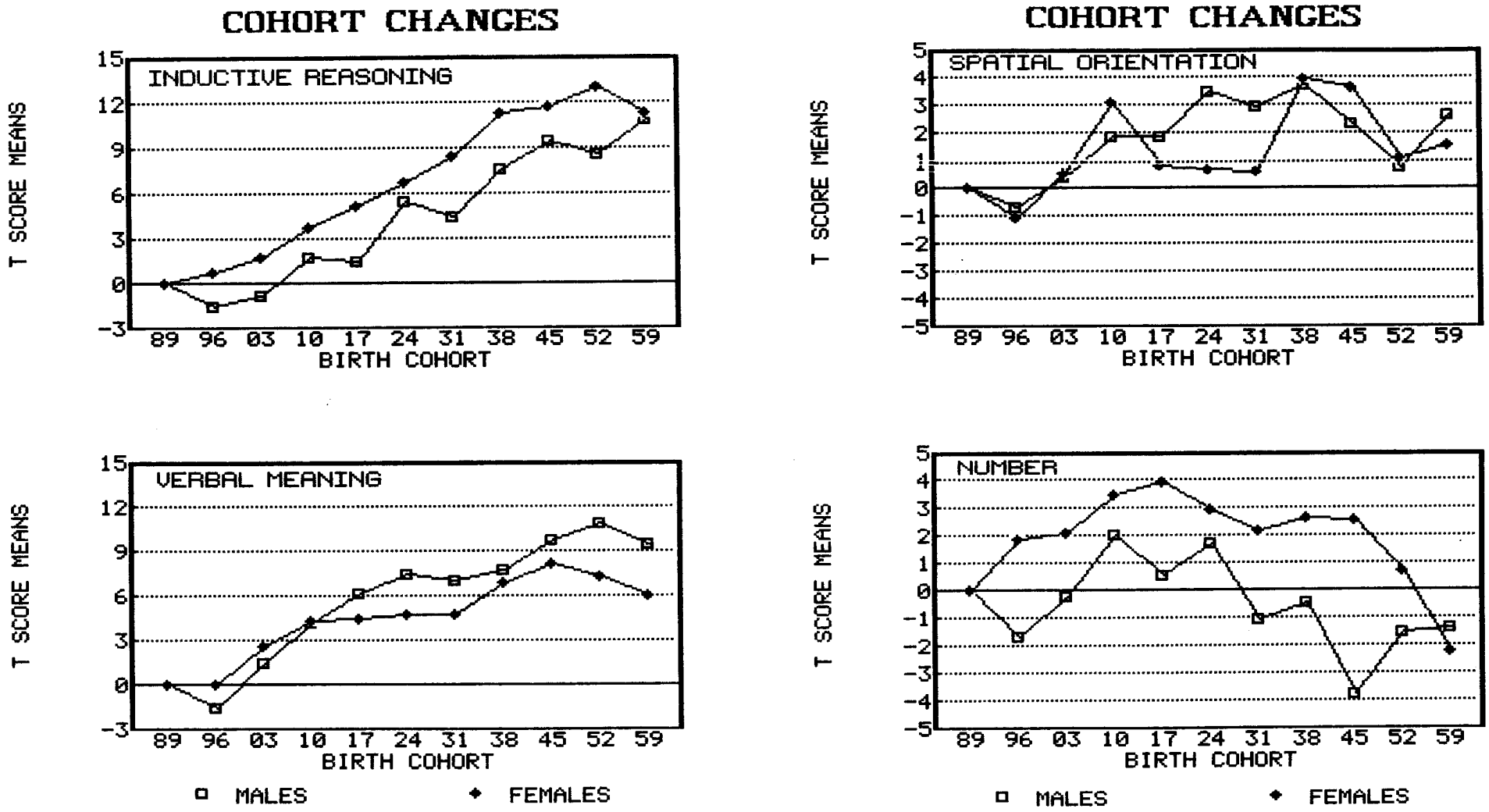
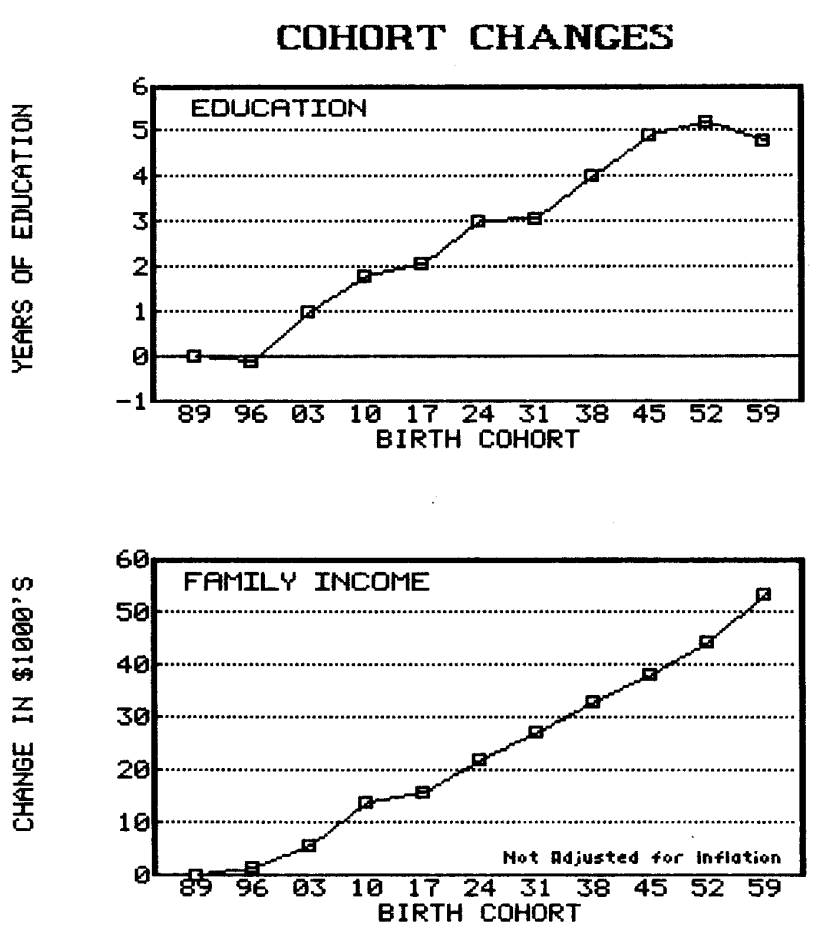
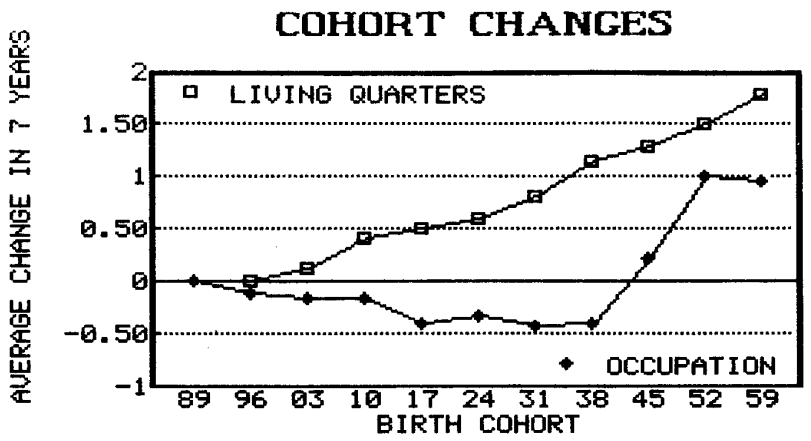

COHORT CHANGES
INDUCTIVE REASONING
T SCORE MEANS
15
12
9
6
3
0
-3
89 96 03 10 17 24 31 38 45 52 59
BIRTH COHORT
COHORT CHANGES
SPATIAL ORIENTATION
T SCORE MEANS
5
4
3
2
1
0
-1
-2
-3
-4
-5
89 96 03 10 17 24 31 38 45 52 59
BIRTH COHORT
VERBAL MEANING
T SCORE MEANS
15
12
9
6
3
0
-3
89 96 03 10 17 24 31 38 45 52 59
BIRTH COHORT
MALES
FEMALES
NUMBER
T SCORE MEANS
5
4
3
2
1
0
-1
-2
-3
-4
-5
89 96 03 10 17 24 31 38 45 52 59
BIRTH COHORT
MALES
FEMALES

FIGURE 2.


COHORT CHANGES
EDUCATION
YEARS OF EDUCATION
6
5
4
3
2
1
0
-1
89 96 03 10 17 24 31 38 45 52 59
BIRTH COHORT

FAMILY INCOME
CHANGE IN $1000'S
60
50
40
30
20
10
0
Not Adjusted for Inflation
89 96 03 10 17 24 31 38 45 52 59
BIRTH COHORT


COHORT CHANGES
LIVING QUARTERS
OCCUPATION
AVERAGE CHANGE IN 7 YEARS
2
1.50
1
0.50
0
-0.50
-1
89 96 03 10 17 24 31 38 45 52 59
BIRTH COHORT

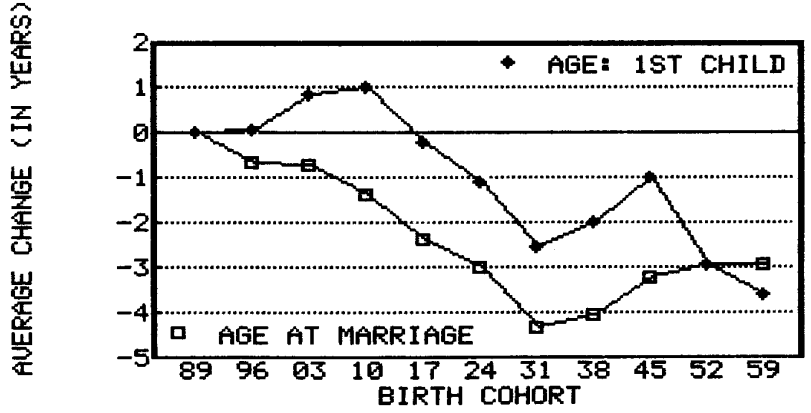

AGE: 1ST CHILD
AGE AT MARRIAGE
AVERAGE CHANGE (IN YEARS)
2
1
0
-1
-2
-3
-4
-5
89 96 03 10 17 24 31 38 45 52 59
BIRTH COHORT

FIGURE 3