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An Historical Framework for Cohort Differences in Intelligence

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This article reviews key issues regarding the controversy on the direction and magnitude of cohort differences in intelligence. Data from the Seattle Longitudinal Study (SLS) illustrate why differences must be studied across multiple cohorts and multiple chronological ages. Differential cohort patterns for multiple dimensions of intelligence are described. A conceptual framework is suggested for the identification of historical influences important for developmental study of cohort differences.

We begin with a review of several aspects of the controversy regarding gain or decline of intellectual abilities in successive cohorts over the past century (Alwin, 1991; Flynn, 1999; Wilson & Gove, 1999) and a discussion of what have been proposed as key issues in the study of cohort differences. We then use Seattle Longitudinal Study (SLS) data to illustrate how the recent debate has been too narrow due to the limited range of birth cohorts examined and because cohort differences are often studied nondevelopmentally by considering only a single chronological age. We also discuss key issues in a methodology for studying factors associated with cohort differences or gains. We then propose a conceptual framework for the developmental study of cohort differences, applying Bronfenbrenner's (1986) concepts of the ChronoSystem and MesoSystem.

We consider several factors (possible mechanisms) enhanced or delimited by macrosocial events that may account for cohort gains in intellectual functioning. Exemplary data from the SLS are provided on cohort differences in the areas of education attainment and practice. The SLS data provided here focuses primarily on 3 particular birth cohorts, which are approximately 30 years apart, from the total of 13 birth cohorts studied in the SLS, following Flynn's (1987) definition of *generational differences*. Moreover, the two most recent cohorts are roughly com-

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parable in birth years to the cohorts cited by Flynn (1987) in his articles documenting IQ gains in 14 nations.

Our work on cohort differences in cognitive abilities in the SLS (Schaie, 1986, 1990, 1996a, 1996b, 2005) was markedly influenced by the writing of Raymond Kuhlen (1940) and Matilda White Riley (e.g., Riley, Johnson, & Foner, 1972). These authors argued early on that the individual life course needed to be understood within the context of a changing society. Over the past 2 decades, the senior author of this article has organized and edited a series of volumes (e.g., Schaie & Achenbaum, 1993; Schaie & Elder, in press) that has tried to make the connection between macrosocietal phenomena and individual aging. With respect to intelligence, the first effort within this context appeared in a chapter by Willis (1989). What we now wish to accomplish is to review the cohort differences we have previously observed within a broader historical framework that includes the consideration of exemplar mechanisms chosen from the areas of education and work.

THE DEBATE ON COHORT GAINS

Over the past 2 decades there has been an intensive debate regarding nature and directionality of cohort differences in intellectual functioning. This debate was in part stimulated by reports of decline in scholastic aptitude test (SAT) scores. A number of explanations for declining SAT scores have been suggested, including a marked increase in the proportion of students taking the SAT (Hanford, 1991) and increase social diversity and perturbations. In support of the SAT data, Alwin (1991) reported a decline in education-adjusted verbal test performance from the General Social Surveys that "confirms systematic declines in verbal test scores in cohorts born in the post-World War II era, but reveals a trend beginning much earlier" (p. 635). In a replication Glenn (1994) reported support for Alwin's findings. However, Wilson and Gove (1999) questioned the Alwin and Glenn findings and argued that their analyses confused cohort effects with aging, treating the relationship between age and verbal ability as linear rather than curvilinear.

On the other hand, an extensive literature largely stimulated by the analyses of Flynn (1984, 1987, 1999; see also Dickens & Flynn, 2001) has argued that massive IQ gains on the order of 5 to 25 points have occurred in a single generation; data from 14 nations have been cited in support of this position (Flynn, 1987). Flynn and colleagues reported that the largest cohort differences in intellectual functioning have been found for what are commonly known as *fluid abilities*. Less or no cohort gains have been found for acculturated skills acquired through schooling and commonly known as *crystallized intelligence*. Of concern to the study and theory of life-span development is the fact that these assertions were based almost exclusively on differences found between two particular cohorts differing approximately 30 years in age—the massive cohort gains are reported for the post-World War II cohort with most data cited pertaining to those born in the 1950s. Although data from a number of western cultures including Japan are cited, the data are largely limited to these two birth cohorts. From a U.S. perspective, it is immediately evident that these cohorts represent the Baby Boomers and their parent generation, sometime referred to as the Depression cohorts.

From a life-span perspective, the question arises whether the findings of massive IQ gains represent a phenomenon unique to a specific historical period and to the post-World War II cohort or whether they are indicative of a long-term societal or evolutionary change. The data reported by Flynn and others are insufficient to address this question given the limited range of cohorts examined. To give them full credit, one would have to assume that cohort differences remain stable across the life span. That is, the assumption is made that differences at the ages under examination were caused by differences in heritability and/or environmental impact that occurred prior to the age at which a particular cohort was measured. Flynn (1999), we assume, was the first to question the tenability of such assumptions. Hence, it is necessary to examine not only a range of multiple ages for each cohort to be compared to obtain more stable estimates of cohort differences but also to be able to examine deviations in linearity among the cohorts to be compared. Most current studies of cohort differences primarily address differences in level of performance between two generations and do not permit examination of the more interesting question of generational differences in rate of cognitive change—or of interindividual differences in intraindividual change.

CRITERIA FOR EXAMINING COHORT DIFFERENCES

The literature on IQ gain in the post-World War II cohort proposes four criteria for evaluating the data (Flynn, 1987; Jensen, A. R., personal communication): (a) Comprehensive or representative samples are required to avoid sample bias; (b) the tests must contain the same items across cohorts and trends should be reported in raw score metric; (c) assessment of cohort gains should emphasize fluid ability measures or what have been called *culture reduced measures*, rather than crystallized measures that were assumed to reflect cohort differences in what could be learned though schooling; and (d) use of mature study participants who are assumed to have reached their peak level of intellectual performance.

As research in the SLS and other cohort-sequential studies have shown, each of these criteria is problematic. A randomly drawn sample of a cohort from a population frame at one point in time may no longer be representative of that population at a subsequent draw from the same cohort if one uses a nonreplacement sampling strategy. On the other hand, sampling with replacement may be problematic if the population frame changes over time. In psychological studies, contrary to practices of demographers, the criterion may properly shift to whether the full range of the phenomenon studies has been included in the sample.

With regard to the second criterion, use of the same assessment measure across cohorts, there is the problem of the aging of tests. That is, the same test items may not mark the construct equally well in all cohorts; content becomes obsolete. Also, the difficulty level of specific test items may shift markedly across cohorts and time. Single markers of a construct are, therefore, ill suited for cohort studies unless the status of the cohort on the latent construct has been determined so that differential weighting methods can be applied.

The third criterion proposing to focus on fluid measures is based on assumptions regarding the distinction between the antecedents of fluid and crystallized measures that are generally no longer supported in the research literature (cf. Baltes, Staudinger, & Lindenberger, 1999; Li et al., 2004). Although Cattell (1963) originally assumed that fluid measures were not impacted by culture and were more directly based on genetic and neurophysiological influences, there is a large body of literature indicating that fluid abilities (as measured by psychometric tests) as well as crystallized abilities are significantly impacted by environmental influences. Hence, performance on psychometric markers of fluid ability can be improved through educational procedures, although their basic information-processing components might not be affected. Thus, a test of the proposition that fluid abilities would offer a stronger test of cohort gains than would gains in crystallized abilities would require definition of *fluid intelligence* in terms of more basic markers of information processing (cf. Li et al., 2004).

Finally, there is the criterion of using mature participants who have peaked intellectually. In early debate on IQ gain, it was proposed that cohort differences could be due to the post-World War II cohort peaking intellectually at an earlier age than the prior cohort (Flynn, 1987, 1999). However, as we report in a later section on the SLS's findings, the opposite actually occurs. There is strong suggestive evidence that current cohorts may be peaking at later ages or maintaining their peak level of functioning until a later chronological age (Schaie, 2005).

Some Methodological Issues in Cohort Analysis

The issue of the lack of comparable chronological ages across cohorts is, in particular, a critical one in evaluating cohort differences and a criterion that has been seriously abused in prior studies. For example, U.S. data covering the age range from 2 to 75 years are cited as strong support for massive IQ gains (Flynn, 1987). The negative cohort effects on verbal ability reported by Alwin (1991) may be due to confusing cohort effects with aging, treating the relationship between age and verbal ability as linear rather than curvilinear (Wilson & Gove, 1999).

Some of the approaches used in the analysis of cohort differences suffer from problems similar to those faced in the cross-sectional study of age differences. That is, the direct comparison of different cohorts at one point in time confounds cohort with age effects, whereas comparison of cohorts at the same age but different points in time confound cohort and period effects (cf. Ryder, 1965; Schaie, 1965; Wilson & Gove, 1999). It is necessary, therefore, to make specific assumptions about the confound in one's design. In the study of adult intelligence, it would seem that a Cohort × Age design is most reasonable because it contrasts the intracohort differences over time with the intercohort differences across specified age ranges (Baltes, 1968; Baltes, Cornelius, & Nesselroade, 1979; Schaie & Baltes, 1975). Such a design requires the availability of successive random samples over broad age ranges from a well-defined sampling frame. It also seems appropriate to assume that cohort differences should persist across wide age ranges, whereas period effects are likely to show their impact differentially by life stage. Hence, it might not seem unreasonable to model the contribution of period effects as the Cohort × Age interaction (also see Schaie, 1986, 2005).

If one wishes to address the impact of period effects directly, however, it would be necessary to redefine period in terms of some measures of event density or of specific historic periods. Such measures would be uncorrelated with calendar time; hence, they could be modeled in an unconfounded manner directly with age and cohort effects, as well as their interactions (see Schaie, 1986).

In addition to shifts in mean level of performance at comparable ages, it would also be desirable to consider differences in trajectories within cohorts across age for successive cohorts. When cohort comparisons are made over trajectories in advanced age, it would seem necessary to also consider shifts in the linear form across cohorts.

Major shifts in performance level across cohorts are likely to lag behind societal transitions, such as changes in access to the educational system, and dramatic changes following major societal upheaval (cf. Schaie & Elder, in press). Although it is convenient to define cohorts in relatively brief time intervals, it may be necessary to examine differences between cohorts that are separated for longer periods in time, particularly when the separation includes major societal shifts.

COHORT DIFFERENCES IN THE SLS

Cohort differences in level of performance were first studied in the SLS by means of cohort-sequential designs as part of the analyses associated with its third wave (Schaie, 1996a; Schaie, Labouvie, & Buech, 1973; also see Willis, 1989). Data on rate of change across successive cohorts have been reported previously (Schaie, 1995, 2000, 2005). Generational differences in biologically related individuals were also investigated as part of our family studies (e.g., Schaie, 2005; Schaie, Plomin, Willis, Gruber-Baldini, & Dutta, 1992).

Because of the sequential design of data collections in the SLS, we have repeatedly recruited samples randomly drawn from successive birth cohorts and tested them at comparable ages (Schaie, 1996b, 2005). Hence, it has been possible to compute cohort differences in performance level of successive cohorts averaged over several ages and thus to determine cumulative cohort trends for various mental abilities. In the following sections, we describe the design of the SLS and summarize our findings on cohort differences in intelligence.

Design of the SLS

The data of major relevance for the study of cohort effects come from seven cross-sectional data collections that occurred from 1956 to 1998 in 7-year intervals. The first data collection (1956) covered the range from ages 22 to 70, the second (1963) from ages 22 to 77, and all other data collections (1970–1998) from ages 22 to 84. The database includes thirteen 7-year birth cohorts that have been followed over time, covering the range of median birth years from 1889 to 1973 (see Table 1 for a schematic of the study design).

TABLE 1
Design of the SLS Database

Cohort	*Median Birth Year/Range*	*Age at Testing*						
		1956	*1963*	*1970*	*1977*	*1984*	*1991*	*1998*
1	1889 1892–1898	67	74	81	88	95		
2	1896 1893–1899	60	67	74	81	88	95	
3	1903 1900–1906	53	60	67	74	81	88	95
4	1910 1907–1913	46	53	60	67	74	81	88
5	1917 1914–1920	39	46	53	60	67	74	81
6	1924 1921–1927	32	39	46	53	60	67	74
7	1931 1928–1934	25	32	39	46	53	60	67
8	1938 1935–1941		25	32	39	46	53	60
9	1945 1942–1948			25	32	39	46	53
10	1952 1949–1955				25	32	39	46
11	1959 1956–1962					25	32	39
12	1966 1963–1969						25	32
13	1973 1970–1976							25

Cohort Differences in Intelligence

It is possible from data such as ours to estimate cohort differences in level of performance between any two cohorts by comparing the performance of successive cohorts over the age ranges for which both cohorts have been observed. The cohort effects estimated in this manner will, of course, be confounded with period effects, but if a series of cohort differences are computed across the same time period, each estimate will be equally affected. In our case it is possible to generate twelve cohort differences for thirteen 7-year birth cohorts with mean birth years from 1889 to 1973.

To obtain the most stable estimates available, the average level difference between any two cohorts is defined as the average of unweighted mean differences at all ages in which observations are available for these two cohorts. A cohort difference (*Cd*) is therefore obtained by the formula:

$$Cd_i = (\sum_j^1 (M_{ij+1} - M_{ij})) / a,$$

where M_{ij} is the unweighted mean for Cohort *i* at age *j*, and where *a* indicates the number of common ages for which observations are available for each cohort pair. Given the seven waves of the SLS, this means that cohort differences for those cohorts entering the study at an early stage can be compared at as many as six different ages, whereas the most recently entered cohort can be compared only at the one age at which it was measured.

Applying the aforementioned method we estimated average cohort differences at all available ages between all adjacent cohort pairs from 1989 to 1973 (e.g., $C_2 - C_1$; $C_3 - C_2$; . . . $C_{13} - C_{12}$). The cumulative cohort differences were then computed over the 84-year time frame (Schaie, 2005). The results are charted in Figure 1. The horizontal bars indicate the cohorts basic to Flynn's (1987) argument.

The Flynn Effect Cohorts

We first describe the nature of cohort differences based on the SLS data for the cohorts most commonly discussed with regard to the Flynn effect. Second, we describe the nature of cohort differences when observed across the 13 cohorts included in the SLS. The post-World War II cohorts relevant to Flynn effect data are the SLS birth cohorts 1945 and 1952 (Flynn, 1987). The earlier cohort to whom the post-World War II cohorts are compared include the SLS birth cohorts of 1931 and 1938. With respect to the purest measures of both fluid and crystallized intelligence, the trends in the SLS data broadly support the Flynn effect. There is an increase on the order of approximately ½ *SD* for fluid intelligence as measured by inductive reasoning from birth cohort 1931 to birth cohort 1952. Indeed inductive reasoning shows the strongest positive linear trend of any ability examined

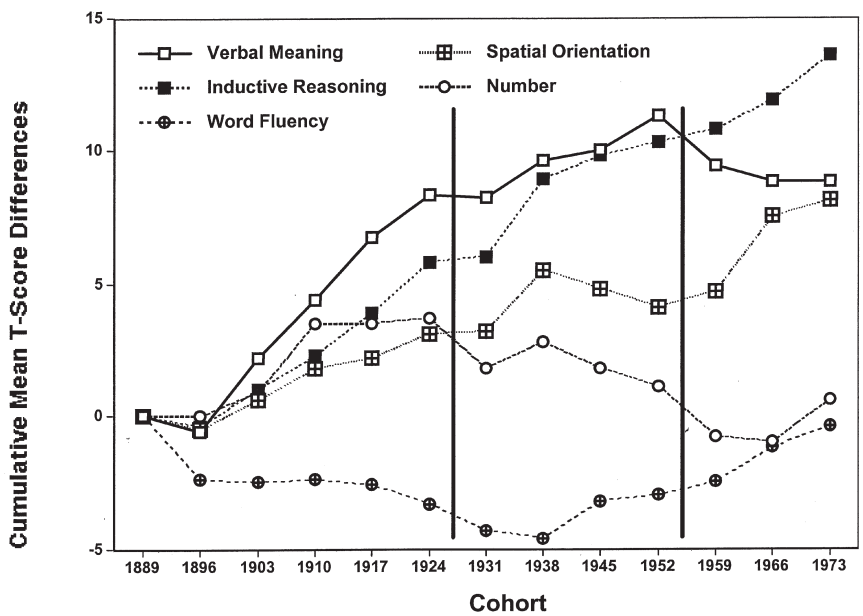

FIGURE 1 Cumulative cohort differences for the Primary Mental Abilities in the Seattle Longitudinal Study. *Note.* From *Developmental Influences on Adult Intelligence: The Seattle Longitudinal Study* (p. 144), by K. W. Schaie, 2005, New York: Oxford University Press. Reprinted with permission.

within the SLS study for these cohorts. In contrast, cohort differences over the same cohorts are more modest for the two crystallized abilities of verbal and number ability and even for the fluid ability of spatial orientation. In fact, number ability exhibits a negative trend, which, as we show, is much more pronounced when examined across a broader range of cohorts.

Cohort Differences Across 13 Cohorts

When five distinct cognitive abilities are examined across 13 rather than 4 cohorts, it becomes clear that there are both positive and negative cohort trends. In contrast to the conclusions that would be drawn from data cited for the Flynn effect, these data indicate that there are systematic and substantial positive advances in cohort level for both crystallized ability (verbal meaning) and fluid abilities (spatial orientation and inductive reasoning). Indeed, the cohort differences (1889–1952) for verbal ability are of equivalent magnitude to that for inductive reasoning until the 1959 cohort, which is when the gradient began to decline for verbal meaning. Moreover, although considerable attention has been given to the massive IQ gains for the post-World War II 1950 cohorts, the SLS data suggest that the magnitude of cohort gains (at least for verbal meaning and inductive reasoning) were much greater for the cohorts born in the early 1900s than for the cohorts cited in the Flynn effect.

On the other hand, quite different patterns of cohort differences are observed for number and word fluency. Number ability shows positive cohort differences up to about the 1910 cohort. But then there is a plateau followed by a negative shift that indicates a successive lowering of performance level. The 1924 cohort exceed both earlier and later born cohorts; the youngest cohorts are, therefore, currently at a disadvantage when compared with the older cohorts. Word fluency, by contrast, shows a concave pattern. A negative cohort trend prevails until the 1938 cohort, but improvement occurs for subsequent cohorts. For this ability, then, earlier cohorts have a slight advantage over the later born ones; but beginning with the cohort born in 1945, there are also successive positive cohort differences for this ability.

Cohort Differences in Rate of Age-Related Change

To understand cohort differences fully, it is necessary not only to attend to level differences between cohorts but also to chart the trajectory (slope) of performance differences within cohorts. The appropriate data to be used for comparison of the trajectories of different cohort come from successive independent random samples of each of the three cohorts. These data are thus unbiased with respect to attrition and/or retest effects. Their use, moreover, is appropriate in the context of cohort studies because cohorts represent interindividual difference patterns.

To illustrate cohort differences in rate of age-related change, we selected three specific cohorts. These three cohorts were chosen to illustrate adults of the same chronological ages living at very different historical periods. Moreover Cohorts 6 and 10 include the cohorts compared in data cited for the Flynn effect. Cohort 2 (median birth year = 1896; Table 1) had entered early old age at the time our study began in 1956. This cohort reached young adulthood during World War I and also experienced the Depression during young adulthood and early middle age. Women of this cohort gained the right to vote as young adults. This cohort experienced World War II and the Korean War during middle age. Historical events such as the Civil Rights movement, travel to the moon, and the Great Society were experienced in young-old age. The second illustrative cohort (Cohort 6, median birth year = 1924) was born shortly after the Depression and were young adults during World War II, with many men in this cohort serving in the military in World War II and some also in the Korean War. Cohort 6 experienced the Civil Rights movement, travel to the moon, and the Great Society in their 30s and the Vietnam War and Watergate while in middle age. Cohort 6 represents the parents of the Baby Boomers. Finally, Cohort 10 (median birth year = 1952) represents the Baby Boomers, who first entered our study as young adults and whom we followed into middle age. The Baby Boomers were born shortly after World War II, experienced the Civil Rights movement and travel to the moon as children and the Vietnam War and Watergate as young adults. Furthermore, selecting these three cohorts allows a comparison of Cohorts 2 and 6 in old age and Cohort 6 and 10 during midlife. Figure 2 gives examples of trajectories for these three cohorts for verbal meaning (a measure of crystallized intelligence) and inductive reasoning (a measure of fluid intelligence).

The trajectories for the three sample cohorts, first of all, reflect the overall cohort differences in level, but they also demonstrate that the trajectories differ by ability as well as by life stage. Thus, in midlife, there is little difference between Cohorts 6 and 10 on verbal meaning but a modest systematic gain for Cohort 10

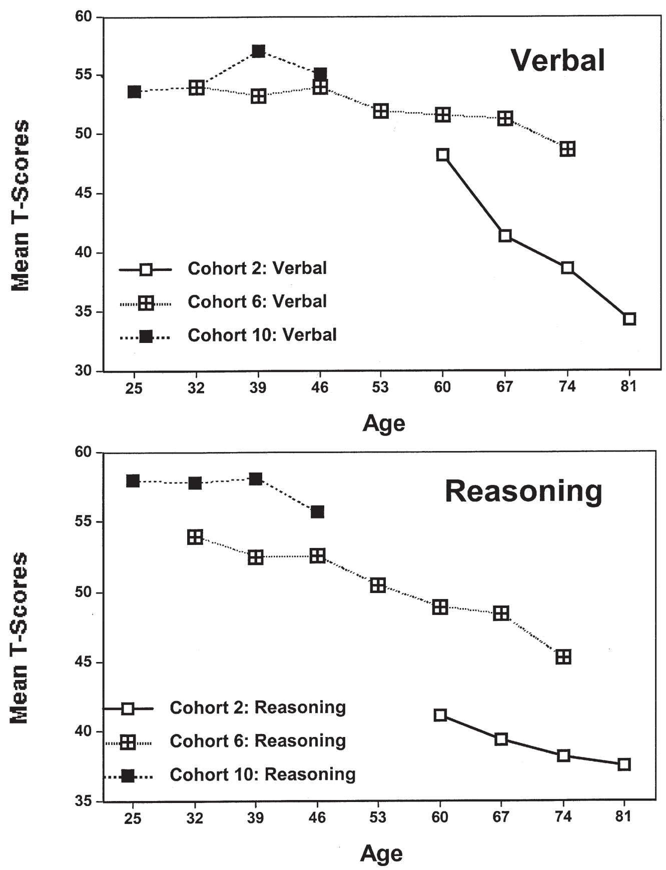

FIGURE 2 Within-cohort trajectories for the Abilities of Verbal Meaning and Reasoning (from independent random-sample data).

on inductive reasoning. Far more substantial differences in level are found in old age between Cohorts 2 and 6, but now there is also a substantial difference in slope, particularly for verbal meaning, favoring the later born cohort.

In summary, when cohort differences are examined over a broader historical period and a wider range of cohorts, the phenomenon of cohort gain in intellectual performance becomes more complex than described by the Flynn effect. Both fluid and crystallized abilities have exhibited significant positive gains, particularly in the early 1900 birth cohorts. The magnitude of cohort gain appears to have been greater in the early 1900s than that cited for the post-World War II cohorts. In addition, positive, negative, and curvilinear cohort trends have been observed. Moreover, cohort trends vary for different abilities within the same historical period. For example, over the Baby Boomer cohorts (1945–1966), there has been a positive linear trend for inductive reasoning, a negative trend for number, and a plateau for verbal ability. These differential cohort trends within the same historical period raise the possibility that various abilities may be impacted by different factors or that the same factor (e.g., education) may have variable impact on different abilities.

Cohort Gains in Educational Level

Some investigators have argued that the most parsimonious explanation for cohort differences in intelligence might be found in profound changes in educational processes and structures that have occurred over the past century (e.g., Alwin & McCammon, 2001). And, indeed, our own studies show marked increase in educational attainment for subsequent cohorts, resulting in an average increase of 5½ years over the period studied, with a greater increase of 1 year for men (see Figure 3). Again, the horizontal bars indicate the cohorts that can be compared with those studied by Flynn (1987).

Although the SLS sample has the advantage in level of education, the magnitude of total cohort gain in years of education found in the SLS (birth cohorts 1889–1973) is quite comparable to that reported for national representative samples. Hauser and Featherman (1976) reported a total increase in the average length of schooling of about 4 years from birth years 1897 to 1951 based on 1973 Occupational Changes in a Generation (OCG) survey data; they noted that a gain of 4 years is likely an underestimate because members of the youngest cohort (birth cohort 1951) have probably not completed their education in 1973. Intergenerational differences between successive generations, approximately 20 to 30 years apart, range from 2 to 4 years. Hauser and Featherman (1976) noted that intergenerational differences in schooling peaked among men born shortly after World War I and that a deceleration has occurred across more recent cohorts. A similar trend is shown in the SLS data in Figure 3.

The changes in educational structures and processes, however, are embedded in historical events and sociocultural transformations. Thus, much of the increase

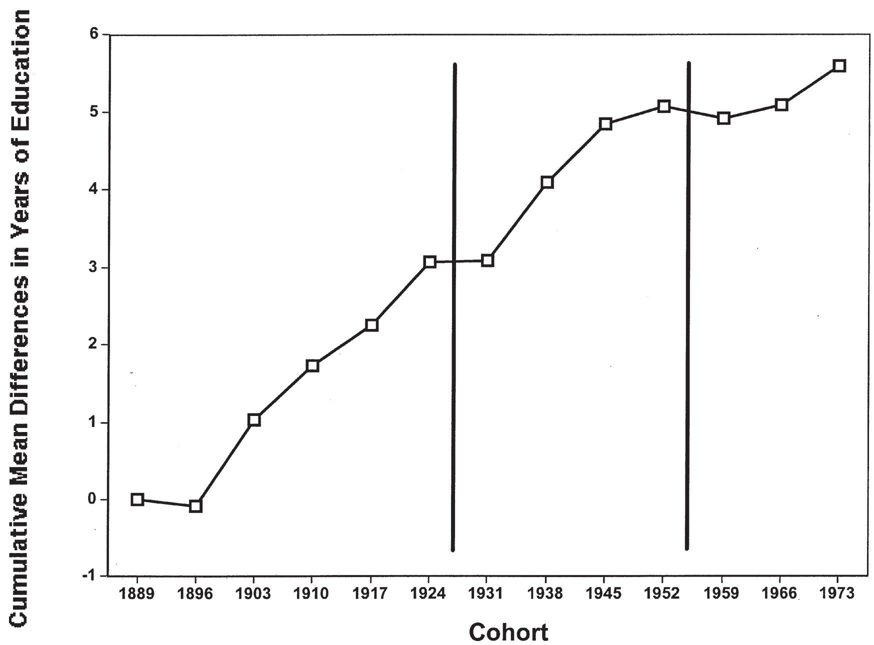

FIGURE 3 Cumulative cohort differences in level of educational attainment by gender in the Seattle Longitudinal Study. *Note.* From *Developmental Influences on Adult Intelligence: The Seattle Longitudinal Study* (p. 150), by K. W. Schaie, 2005, New York: Oxford University Press. Reprinted with permission.

in educational level that occurred in men post-World War II may be directly attributable to the GI Bill (cf. Elder, Gimbel, & Ivie, 1991; Laub & Sampson, in press; Sampson & Laub, 1996). Likewise, social insurance relieving the need of families to provide for the elderly (Gratton, 1993), changes in societal attitudes toward the importance of education for children (Vinovskis, in press), or anti-poverty programs (Huston, Mistry, Bos, Low, & Shim, in press) may underlie changes in educational process. Hence, we now describe the historical framework that we hope will enrich our understanding of cohort differences in intelligence.

INFLUENCES ON COHORT DIFFERENCES IN INTELLIGENCE: A CONCEPTUAL FRAMEWORK

From the life-span developmental psychology viewpoint we are interested in identifying those influences in the historical cultural context that might impact cohort differences in both the mean level and trajectory of mental abilities across adulthood. In Table 2 we propose a conceptual framework adapted from Bronfenbrenner's

TABLE 2
Conceptual Framework for the Study of Development in Historical Contexts

Developmental Phase	*MesoSystem Contexts of the Individual*	*ExoSystem Contexts of Significant Others*	*ChronoSystem Single-Domain Transitions & Life Course or Cumulative Events*
Childhood	(1) Family (2) Academic (3) Leisure/social (4) Media	(1) Parents (2) Extended family & friends	(1) Single-domain transitions, normative, & nonnormative (2) Life course/cumulative events (economic, political, social, etc.)
Adolescence	(1) Family (2) Academic (3) Work (4) Leisure/social (5) Media	(1) Parents (2) Extended family, friends, & colleagues	(1) Single-domain transitions, normative, & nonnormative (2) Life course/cumulative events (economic, political, social, etc.)
Young adulthood	(1) Family (2) Academic (3) Work (4) Leisure/social (5) Media	(1) Parents (2) Spouse or significant other (3) Extended family, friends, & colleagues	(1) Single-domain transitions, normative, & nonnormative (2) Life course/cumulative events (economic, political, social, etc.)
Middle age	(1) Family (2) Academic (3) Work (4) Leisure/social (5) Media	(1) Parents (2) Spouse or significant other (3) Extended family, friends, & colleagues	(1) Single-domain transitions, normative, & nonnormative (2) Life course/cumulative events (economic, political, social, etc.)
Young–old age	(1) Family (2) Academic (3) Work (4) Leisure/social (5) Media	(1) Parents (2) Spouse or significant other (3) Extended family, friends, & colleagues	(1) Single-domain transitions, normative, & nonnormative (2) Life course/cumulative events (economic, political, social, etc.)
Old–old age	(1) Family (2) Academic (3) Work (4) Leisure/social (5) Media	(1) Spouse or significant other (2) Extended family, friends, & colleagues	(1) Single-domain transitions, normative, & nonnormative (2) Life course/cumulative events (economic, political, social, etc.)

conceptual framework (1986; Bronfenbrenner & Crouter, 1983) for studying the major domains of influence that would provide possible mechanisms for cohort differences in intellectual performance. Although Bronfenbrenner's model is typically presented as a series of concentric circles, our framework is presented as a matrix. This conceptual structure is necessary to make explicit multiple systems of influence at different developmental phases (childhood, adolescence, young adulthood, middle age, and old age) across the life span. At the core of our framework are the physical and psychological characteristics of the individual.

Three Environmental Systems

The framework includes three systems of influence at each developmental phase: ChronoSystem, Exosystem, and MesoSystem. In Bronfenbrenner's model, after the family, the nearest and most direct environmental system, the MesoSystem, is given first and primary consideration among the extrafamilial systems. However, the ordering of environmental systems is reversed in our framework, given our primary concern with the impact of broad sociocultural events on cohort differences. Thus, we first consider the ChronoSystem, which is concerned with the changes and continuities over time in environments that impact the individual's development. Two dimensions of the ChronoSystem are considered. First, the simplest form of ChronoSystem focuses on domain-specific life transitions. Two types of transitions have been distinguished in the psychological and sociological literatures (Baltes, 1979; Riley et al., 1972): normative (school entry, puberty, work entry, marriage, child bearing, and retirement) and nonnormative (death or severe illness, divorce, and winning the lottery). These transitions are usually specific to a particular life domain (e.g., marriage or work) although there may be spillover to other domains. Also, these transitions are usually defined by a circumscribed relatively brief time period during which they occur. In contrast, a second dimension of the ChronoSystem deals with cumulative effects of an entire sequence of transitions or events occurring over a more extended time period in the individual's life (e.g., war, depression, and technological advances). The impact of such historical or sociocultural life-course events on individual development has been an important focus of the work of social psychologists such as Elder (1974), Stewart (2003), and, to some extent, Helson and Moane (1987). However, the developmental outcomes of interest in the prior work have primarily been factors such as well being and stability and success in work and marriage, rather than intellectual performance. Of critical importance is the expectation that the relative impact of these long-term historical or sociocultural events will vary depending on the developmental phase of the individual. Thus, the same historical event may result in very different outcomes for different cohorts experiencing the event at different developmental phases.

The ExoSystem deals with environments that are not directly experienced by the individual but are important environments for significant others, such as the target individual's parents, spouse, or friends. Such environments external to the developing individual are referred to as ExoSystems. As Kahn and Antonucci's (1980) model of convoys of social support suggest, the significant others in the individual's life would be expected to change across the life course, progressing from parents to spouses and extended family, friends, and colleagues. The external environments in the ExoSystem that impact individual development would thus vary across the life course as the significant others change. In the child literature, the parents' work environment has been shown to impact child-rearing practices (Kohn & Schooler, 1983), occupational aspirations of adolescents (Mortimer & Kumka, 1982), and curricular activities (Morgan, Alwin, & Griffin, 1979).

In Bronfenbrenner's model (1986), the ExoSystem appears to focus primarily on the concurrent environments of significant others (e.g., parent's work environment) that may impact the developing individual. However, in our framework, we also include transitions occurring across the adult lives of significant others that may influence the individual. For example, the father's educational or occupational status experienced as a young adult and occurring in a particular historical period have been studied as influences on subsequent intellectual functioning of the offspring (Hauser & Featherman, 1976).

The MesoSystem involves the principal contexts or environments in which individual development takes place. Given the focus on childhood, the family is considered the primary context of development in Bronfenbrenner's model. However, in our framework, we include the family as one of the facets of the environments within the MesoSystem. Other environments experienced directly by the individual include work, leisure/social context, and, more recently, media or technology-based contexts. The relative impact of these various environments is expected to vary across the life course and to interact with the personal characteristics of the individual.

It is assumed that long-term cumulative events primarily impact individual development indirectly as mediated by environmental factors in the MesoSystem and ExoSystem and interact with the personal characteristics (e.g., personality, attitudes, and life styles) of the individual who is a member of the cohort under investigation.

HISTORICAL INFLUENCES ON CHRONOSYSTEM AND EXOSYSTEM MODELS

In this section, we selectively review how the environments represented in the ChronoSystem and ExoSystem vary by historical period and, hence, across cohorts. We focus our discussion on the SLS Cohorts 2, 6, and 10 as previously described.

Clearly, there is a wide range of contexts (health and medical care, nutrition, technology, etc.) that impact intellectual functioning and possible cohort differences in intellectual performance. However, for illustrative purposes, we focus primarily on environments that are associated with educational attainment.

ChronoSystem Models

In Table 2, the ChronoSystem component includes both single-domain transitions and cumulative life course transitions and events; we provide illustrations primarily from the latter because these are most likely to reflect historical change. Although the most common measure of educational attainment is quantitative—the total number of years of schooling—education involves both quantitative and qualitative aspects. Quantitative measures reflected in total years of schooling include the age range over which schooling is experienced and the density of the educational experience (school days/school year). Qualitative indicators focus on educational practice, including curriculum and pedagogy. We begin by discussing the impact of historical changes in legislation and in public funding of education on quantitative indices of educational attainment.

Legislation on Child Labor and Compulsory Schooling

Two major forms of legislation originating in the early 1900s contributed to significant differences in educational attainment between Cohort 2 (born 1896) and Cohort 6 (born 1924). A series of child labor laws were passed from 1900 to the 1920s, which prohibited paid employment of young children in the increasing number of factories resulting from industrialization and the growth of urban areas (Hogan, 1978). Child labor, both paid employment and work in the home, was an important source of income for recent immigrant families to the United States. Thus, decisions regarding the schooling of children often rested on the economic needs of the family, particularly for recent immigrants. Children who were employed earned 36% of the income for their families in Chicago in 1884 (Hogan, 1978; Illinois Bureau of Labor Statistics, 1884). Eighty percent of families in which children under age 16 were employed were dependent on the child's income for support. The effects of the child labor laws on the proportion of immigrant children attending school were quite dramatic, particularly for the adolescent years. The proportion of immigrant children aged 14 to 15 attending school increased from 55% in 1910 to 94% in 1930; the increase for children aged 16 to 17 was 13% and 50% in 1910 and 1930, respectively. The SLS's Cohort 2 would be represented by the 1910 data, whereas Cohort 6 would be represented by the 1930 data.

State legislation on the length of the school year and compulsory school attendance passed during the same period impacted not only the proportion of children in school but the intensity of the educational experience. The average length of the school year increased by almost 2 months from Cohort 2 to Cohort 10 (U.S. Department of Education, National Center for Education Statistics, 2002). The average length of the school year for Cohort 2 was 140 days compared with 170 days and 180 days for Cohorts 6 and 10, respectively. Moreover, compulsory school attendance legislation increased the average daily attendance of various cohorts. Daily attendance was approximately 65% for Cohort 2 compared with 85% and 90% for Cohorts 6 and 10, respectively (U.S. Department of Education, National Center for Education Statistics, 2002).

Time-Specific Federal Funding for Education

The GI bill. In several historical periods, federal funding was provided and targeted to selected groups in the United States. Because these targeted groups often represented particular birth cohorts, the cohort differences in educational attainment can be shown to be partially due to these economic interventions in educational funding. One of the most prominent examples are the postwar rehabilitation programs for veterans, known as the GI Bills (Nam, 1964; Sampson & Laub, 1996).

Further educational training was provided through GI Bills for veterans of World War II, the Korean War, and the Vietnam War. Study of the effects of the GI Bills on World War II veterans is of particular interest, because a greater proportion of the U.S. male population was involved in World War II than in the Korean or Vietnam wars. The SLS's Cohort 6 would have been particularly affected by the GI Bill associated with World War II. The effects of the GI Bill on postsecondary education were most pronounced. Almost 50% of all veterans of World War II and the Korean War used the benefits for education and training, and 82% of those veterans who had attended college before the war made use of GI benefits to continue their education. Approximately 33% of veterans whose college work was interrupted by military service finished college or went on to graduate or professional school. For veterans who had just completed high school or had barely started college, 20% went on to get a college degree and a larger proportion took at least some college courses. In comparison, only 10% of those who were working at the time of military service acquired at least an academic year of schooling after the war. Sampson and Laub (1996) reported that GI Bill training as well as in-service schooling enhanced subsequent occupational status, job stability, and economic well being, independent of childhood differences and socioeconomic background. The benefits of the GI Bill were larger for younger veterans and for those who had some evidence of delinquency in military service records.

Moreover, the dramatic numbers of veterans on college campuses after World War II and the Korean War significantly altered academic protocol and curriculum. In 1947 7 of 10 men enrolled in college or universities were veterans of World War II. Similarly, in 1956 25% of all male college students were veterans of the Korean War (Nam, 1964). These veterans not only challenged prewar assumptions of who could benefit from a college education but also challenged the very definition of what higher education should offer. Feeling as though the war had delayed their entry into adult life, veterans demanded that education be streamlined and that the curriculum be geared to real life, in contrast to the more traditional emphasis in higher education on liberal arts and humanities. These veterans impressed academic with the view that the main duty of the university was to train individuals for adult participation in the modern world and to be the vehicle toward a secure job in a large corporation (Vinocour, 1947).

National Defense Education Act. In 1957 the Soviet Union launched Sputnik. The national panic generated by this event resulted in Congress passing a federal-aid-to-education bill, known as The National Defense Education Act of 1958. A major provision of the law involving a $15 million grant was the provision of funds to identify talented students and encourage them to pursue higher education. In the 1957–1958 term alone, congress proposed over 80 laws to establish programs that would seek out bright students and provide them with financial support for schooling. This focus on talented youth and the provision of educational funds to the gifted would have impacted primarily the SLS's Cohort 10 (born 1952.)

Historical Change in Educational Curriculum and Pedagogy

Progressive movement. There have also been historical shifts in educational pedagogy and curriculum that differentiate the schooling of the SLS's cohorts. A marked shift in educational philosophy between Cohort 2 and Cohort 6 was the Progressive movement in education, which peaked in the 1920s and whose most noted proponent was John Dewey (Emirbayer, 1992). The goal of the movement was development of a *demographic character* equipped for responsible citizenship. This new citizen was to be developed from the *melting pot* represented in the United States during the early 1900s as a result of large number of immigrants and the movement of the population from rural to urban areas and the growth of industrial centers such as Boston.

The Progressive movement advocated what today seem to be contradictory initiatives (Emirbayer, 1992). On the one hand, due to the increased number of pupils resulting from child labor laws and compulsory school attendance, the educational practices of standardized testing and tracking of students was introduced. Standardized testing was viewed as a more scientific way to determine children's likely occupational attainment and to allocate them into different educational channels (Ackerman, 1995). On the other hand, the Progressive movement also advocated movement away from teacher-directed lecture and rote recitation to increased student–teacher interaction, group exercises, and critical reflection. The Progressive movement also involved the introduction of the kindergarten, manual and vocational education, and evening classes for adults.

Historical change in the educational curriculum. Further support for extensive historical changes in curricula taught at different ages is shown in the recent work of Blair and colleagues (Blair, Gamson, Thorne, & Baker, in press). Findings of this research are particularly relevant to the prior discussion of Flynn IQ effects, in which the claim is made that IQ gain for the post-World War II cohorts has been primarily in the fluid abilities. Blair and colleagues documented cohort differences in the age at which students were introduced to visuospatial skills such as those traditionally taught in geometry. An 1894 college textbook included a problem that required the student to draw and cut out a two-dimensional triangle and to fold the triangle to develop a three-dimensional polyhedron. By 1955 (the SLS's Cohort 10) this type of problem was included in a seventh-grade textbook. By 1971 the same concept was being taught to third graders, and by 1991 a first-grade textbook included a simplified version of the concept.

ExoSystem Models

Primary focus in this article has been on the ChronoSystem, documenting historical change in the cumulative life course environments of various cohorts. However, we now turn briefly to the ExoSystem to illustrate its importance to understanding cohort differences in intellectual functioning. First, we note that the three illustrative SLS cohorts (Cohorts 2, 6, and 10) discussed herein represent three successive generations, separated by approximately 30 years. Thus, Cohort 6 could represent the children of Cohort 2; likewise, Cohort 10 could represent children of Cohort 6. Thus, the ChronoSystem environments that we have discussed for a given cohort could be considered as the ExoSystem environment for a preceding cohort. For example, the discussion of the effect of the GI Bill on educational attainment of Cohort 6 could be construed as an ExoSystem environment for Cohort 10. Cohort 10, as children of Cohort 6, indirectly experienced the effects of increased educational attainment of their fathers.

Fathers' background and educational attainment of the children. There have been a number of studies examining key social background variables associated with final educational attainment (cf. Alwin & Thornton, 1984). Of relevance for this article is the fact that a number of these social background variables pertain to the parent's characteristics and thus would be considered in our framework in ExoSystem models. Hauser and Featherman (1976) utilized data from the OCG surveys (Blau & Duncan, 1967) to examine key social background variables associated with educational attainment of male birth cohorts from 1897 to 1951. Among the social background variables studied were father's education, father's occupation, number of siblings, broken family, farm background, and Southern birth—many of these variables clearly pertain to the environment of the father as well as the subject of interest. These background variables account for 30% to 37% of the variance in educational attainment of males of various cohorts. Father's education was relatively more important than any other background variable in all groups examined. The mean level of fathers' education had increased from about 7 years to almost 11 years. Each of the following variables accounted for about 25% of a year gain in level of educational attainment: 1 year of father's schooling, 10 points of father's occupation status, and additional sibling. The variables of being raised on a farm and being born in the South also had a substantial effect. On average a farm background cost men 1 full year of schooling, and Southern birth cost .4 to .8 years of schooling. All of these social background variables have shown change over the birth cohorts studied. Both father's education and occupation status have increased across cohorts, whereas the number of siblings has decreased. Particularly dramatic are the cohort differences in individuals raised on a farm. Among the 1897 cohort, 40% were raised on farms compared to 10% of the 1951 cohort.

In summary, the proportion of variance in educational attainment explained by the social background variables has declined from .35 to .28. The declining influence of social background reflects changes both in the variance of the social background characteristics and in their effects on schooling. In addition, primarily as a consequence of the secular rise in educational attainment, successive cohorts of young persons have distributions of social background variables that are gradually becoming more favorable to high levels of schools, as evidenced by increases in parent's educational and their occupational levels.

SUMMARY AND CONCLUSIONS

We began this article by briefly reviewing the controversy on the direction of cohort differences in intelligence. To do so, we attended to methodological issues concerning the need to consider both differences in level and in trajectories of cohorts to be compared. We also suggested that designs are needed that control for either age or period effects and that it is necessary to assess cohort differences over multiple ages. In general, our findings agree with the Flynn effect for some but not all intellectual abilities. We pointed out, however, that cohort differences in intelligence were even more dramatic for cohorts born prior to those studied by Flynn, but they have diminished in subsequent cohorts.

Some assumptions for cohort analysis were questioned: First, given the existing psychometric ability measures, it is unlikely that fluid abilities would provide stronger tests of cohort effects than those provided by crystallized measures. Advances in cognitive science would suggest, in any event, that a test of cohort differences in fluid abilities should be conducted using measures of more basic levels of information processing. Second, the notion that one should measure cohort differences in mature persons implies that ages of peak performance remain constant across cohorts (not true) or, when samples ranging widely in age are utilized, assumes that there are no adult age changes. Third, failure to study differences in intracohort trajectories can lead to the serious misapprehension that rates of aging remain constant although levels of performance differ across cohorts. Yet, changes in rates of aging in intellectual performance have serious societal consequences for the nature of the workforce, the stability of pension systems, and the nature of the health care system required to serve a growing elderly population that differs markedly from earlier cohorts.

We identified the life stage at which certain historical events impacted different SLS cohorts to trace the course of three selected cohorts: those becoming adults during World War I and reaching old age in the 1950s, those becoming adults during World War II and who reached old age in the 1990s, and those who became adults in the 1970s and who are currently in late midlife.

These cohorts experienced rather divergent life courses. Perhaps the largest difference between our Cohorts 2 and 6 is the dramatic increase in educational attainment, which is accompanied by marked cohort differences at comparable ages for both verbal ability and inductive reasoning skills. The gains in intellectual performance for successive cohorts continue on to Cohort 10. But here we see other impacts of changes in the educational system and in the advances in electronic devices actually leading to negative cohort differences in numerical ability. Another major change for the latter cohort is the increase of women in the workforce, accompanied by an increase in their educational levels (now similar to their male peers). We also noted dramatic changes in the level of occupational pursuits, associated with structural changes in the labor market, but also requiring acquisition of educational skills commonly associated with upward socioeconomic mobility.

We then provided a conceptual model for the developmental study of cohort differences in an historical context. The model employs Bronfenbrenner's (1986) analysis of environmental systems that influence development. Our scheme, however, places this scheme within a life-span framework. We argued that historical influences of the ExoSystem (single domain and cumulative life-course transitions) exerts a dominant influence on individuals (and cohorts) in the expression of the their individual characteristics such as intelligence. We examined historical events that have shaped the nature of our educational system, which we see as the major mechanism for understanding cohort differences in intellectual performance.

Beyond the direct influence of the historical context we also suggested that there is mediation through the ExoSystem (influences of societal context mediated through their impact on significant others). Here we pointed out that the historical influences that directly impacted our Cohort 2 indirectly impacted Cohort 6 (their children) and Cohort 10 (their grandchildren). In turn the direct experiences of Cohort 6 influenced members of Cohort 10 indirectly.

The analysis of cohort effects in the SLS, although rich in within-nation longitudinal and cohort-comparative sampling, is, of course, restricted in the scope of cross-national comparisons. Its focus is specific to historical contexts affecting the United States. However, despite this restriction, the data, because of their extensive comparative and longitudinal findings within one study, have far-reaching implications for interpretations of the so-called Flynn effect.

Our analysis of the historical influences on education suggests that cohort differences in intellectual abilities are shaped largely by changes in educational attainment and educational process and by changes in the labor market that are shaped by sociopolitical developments. We discussed the specific effects of the GI Bill and the National Defense Education Act, along with changes in curriculum, and the impact of compulsory education and the prohibition of child labor. All of these events are, of course, embedded in other political and cultural changes; to analyze these changes is beyond the scope of this article. Nevertheless, this is a program of analysis and research that is exciting and necessary. A final caution: As Riley (1972) taught us, changes in the characteristics of populations will, in turn, change the social structures that have produced these changes; hence, we experience an interactive process that requires continuous monitoring and study.

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