MORTALITY SELECTION AND COHORT DIFFERENCES IN PATTERNS OF COGNITIVE AGING

This paper focuses on the problem of unmeasured heterogeneity in cohort-specific aging functions resulting from mortality selection. We assume that as a biological, neurological, or cognitive process, *normal aging* can be defined as all those time-dependent irreversible changes that lead to progressive loss of functional capacity after a point of maturity. Of course there is a great deal of heterogeneity in a population, but from this perspective these changes in the conditions of "human frailty" (such as declining respiratory function, hearing, vision and cognitive function) are to some extent intrinsic within the organism rather than brought about by the outside environment, and they occur in a pattern that is characteristic of all members of a given species.

Normal aging is not a disease process, but it eventually produces both functional decline and increased susceptibility to illness and death from specific diseases. Signs of normal aging, such as short-term memory lapses, wrinkled skin, and gray hair are, thus, not symptoms of disease and need not result in greater susceptibility to death. But with advanced age also comes weakened ability to fight off such diseases of cancer and infections, even as there is cognitive decline that reduces memory, speed of processing and the like. One of the important components of population aging is declining mortality rates. When advances are made in curing or forestalling the diseases that tend to result in death to older people, then this means that an even larger proportion of people survive into advanced old age. Thus, while one may forestall physical functional decline, and the susceptibility to illness and death from specific diseases, there may be no counterpart happening in the area of cognitive functioning. The question for the student of the future of cognitive aging is whether changes in cognitive function will continue in old age as our current models predict, or will we be able to develop parallel remedies that will cure or forestall cognitive functional decline?

This paper addresses the question of whether cohort differences exist in patterns of cognitive aging. The demographic literature concerned with cohort effects on cognitive functioning has focused primarily on differences between cohorts in levels (or intercepts) of performance. By contrast, the developmental literature has phrased the issue of cohort variation in terms of the existence (or lack thereof) of "simple age-graded nomothetic and universal patterns of behavioral development. Our analysis shows that both of these issues may be investigated within the framework of growth models by explicitly examining the differences between two sets of models – one that posits *intra-individual change* across all cohorts to follow the same overall age-based trajectory and one that posits potential differences in intercepts and slopes across cohorts.

Using data from the Health and Retirement Study we examine the possibility of cohort effects on estimates of functions that describe normal cognitive aging. An examination of cohort-specific slopes and intercepts in latent growth curve models of aging functions suggests the existence of significant differences, net of schooling, in cohort-specific intercepts in functions describing normal cognitive aging. Perhaps the most plausible explanation of the pattern of inter-cohort differences in intercepts observed is the phenomenon of *mortality selection*. A given birth cohort can be thought of as a collection of subpopulations defined by longevity, and cohorts differ substantially in their representation of these subpopulations. Membership in these subpopulations is not easily discernable prior to death; however an individual's current age serves as a lower bound. As a result, given stable (or at least proportional) age-specific mortality rates, heterogeneity in longevity decreases with age, meaning that at a given time earlier-born cohorts are less heterogeneous with respect to expected age at death than are the later-borns. Thus, when comparing groups of different ages, one must realize that the younger group contains individuals whose longevity is lower than the lower bound (age) of the older group.

If the variable of interest, in this case cognitive functioning, is positively related to longevity, then the younger group will necessarily have a lower age-standardized mean than that of the older group, net of any "real" cohort differences. Mortality is obviously selective and to the extent that selectivity is linked to factors associated with levels of cognitive performance, then mortality selection is a potential explanation for the above findings. Indeed it might be the case that such performance-linked selectivity in survivorship might be masking a "true" cohort effect that favors more recent born cohorts. Therefore a strong argument can be made that differential age-specific mortality rates should be taken into account when examining age differences in cognitive performance, or when comparing cohorts in patterns of age-related within-cohort change.

Our paper examines the relationship between mortality patterns and age-related trajectories of performance using the HRS cognitive measures. For each of several birth cohort groups from the AHEAD subsample—those born 1890-1908, 1909-1913, 1914-1918, and 1919-1923—we examine mean levels for different patterns of mortality, adjusted for differences in schooling. There is a clear difference in cognitive performance between members of a given cohort (in this case a group of cohorts) who are nearer to death in any wave of the study relative to those who prove themselves to have greater longevity. Whatever factors are selective with respect to mortality in these data, they appear to be associated with level of cognitive performance. These results illustrate the phenomena of *mortality selection* with respect to cognitive performance and strongly suggest that this process is one explanation of the pattern of inter-cohort differences in intercepts reported in the above analysis. Given this pattern of cognitive scores among groups defined by patterns of mortality, and given that heterogeneity in longevity decreases with age, the later-born cohorts, as a whole, have lower mean levels of cognitive performance, than does the subset of these cohorts that will survive to the ages represented by the earlier-born cohorts. These results suggest that comparisons of age

differences in cognitive performance, particularly when undertaken cross-sectionally, should take age-specific mortality rates into account. We note, however, that if the phenomenon of interest declines with age but is positively related to longevity, then the bias introduced by ignoring mortality selection is conservative. That is, under such circumstances, ignoring mortality selection results in an underestimate of age-related decline.

One solution to this is to account for cohort differences in longevity by controlling statistically for inter-cohort differences in expected age at death. The objective of this analysis is to account for heterogeneity in cohort experiences in variables linked to survivorship, at least at the cohort level. We know of no research that has attempted to control for individual differences on expected longevity, although the examination of the history of panel respondents who have experienced mortality—which eventually will include all respondents in the HRS—represents an appropriate strategy for analyzing cognitive change in what may be a more informative time metric. Preliminary results suggest that statistical adjustments for processes of mortality selection, produce interpretable patterns of cognitive aging and reinforce the conclusions advanced earlier, that cohort-specific free-intercepts models appears to reflect a better assessment of the aging function than the more conventional "age-based" or "convergence" models that are common in the growth modeling literature, which assume there are no cohort differences in processes of cognitive aging.