



## The Flynn effect and population aging<sup>☆</sup>



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### ABSTRACT

Although lifespan changes in cognitive performance and Flynn effects have both been well documented, there has been little scientific focus to date on the net effect of these forces on cognition at the population level. Two major questions moving beyond this finding guided this study: (1) Does the Flynn effect indeed continue in the 2000s for older adults in a UK dataset (considering immediate recall, delayed recall, and verbal fluency)? (2) What are the net effects of population aging and cohort replacement on average cognitive level in the population for the abilities under consideration?

First, in line with the Flynn effect, we demonstrated continued cognitive improvements among successive cohorts of older adults. Second, projections based on different scenarios for cognitive cohort changes as well as demographic trends show that if the Flynn effect observed in recent years continues, it would offset the corresponding age-related cognitive decline for the cognitive abilities studied. In fact, if observed cohort effects should continue, our projections show improvements in cognitive functioning on a population level until 2042—in spite of population aging.

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### 1. Introduction

There is a clear longitudinal evidence that fluid intelligence declines over the adult life span, starting in people's mid-twenties and becoming more prominent during later midlife (e.g., Park, Nisbett, & Hedden, 1999; Schaie & Hofer, 2001; Verhaegen & Salthouse, 1997). However, fluid intelligence has a high and growing importance for individuals' social, professional, and health-related functioning, and adults aged 50+

are particularly at risk of decline (Maitland, Intrieri, Schaie, & Willis, 2000; OECD, 2006; Schmidt & Hunter, 2004; Verhaegen & Salthouse, 1997).

Based on a lifespan perspective on aging, levels and trajectories of cognitive aging are not considered as pre-determined but rather as an outcome of continuous interactions between genetic predispositions, contextual influences, and individual decisions, which very likely are different for each successive birth cohort (cf. Baltes, Lindenberger, & Staudinger, 2006). In this respect, numerous individual-level studies have documented tremendous cognitive plasticity in the sense that cognitive performance has been improved using training interventions of different kinds (e.g., Hertzog, Kramer, Wilson, & Lindenberger, 2008; Mårtensson et al., 2012). Also, there is evidence supporting performance differences at age 70 and less steep cognitive declines between 50 and 80 years of age favoring younger cohorts (e.g., Gerstorf, Ram, Hoppmann, Willis, & Schaie, 2011). Later-born cohorts have also been found to develop higher levels of fluid intelligence in youth and early adulthood: the so-called Flynn effect (Colom, Ma Lluís-Font, & Andrés-Pueyo, 2005; Flynn, 1987, 2012; Lynn, 2009; Neisser,

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1997; te Nijenhuis, Cho, Murphy, & Lee, 2012; te Nijenhuis, Murphy, & van Eeden, 2011; Teasdale & Owen, 2000; Tuddenham, 1948). For instance, based on evidence from the Wechsler Intelligence Scale for Children (WISC) tests (Flynn & Weiss, 2007), young Americans have gained about 22 IQ points over the 70 years between 1932 and 2002 (where 15 IQ points represent a standard deviation). This is also relevant for older ages, as cognitive abilities at younger ages strongly influence cognitive functioning in prime-age and senior adulthood (Deary, Whiteman, Starr, Whalley, & Fox, 2004; Richards, Shipley, Fuhrer, & Wadsworth, 2004; Snowdon et al., 1996; Whalley et al., 2000).

We need to consider, however, that lifespan trajectories of specific cognitive abilities (as compared to general cognitive ability *g*) may differ (Flynn & Weiss, 2007; Sundet, Barlaug, & Torjussen, 2004; te Nijenhuis, *in press*). In the present study, we will focus on the two indicators of memory functioning (immediate and delayed recall) and one of executive functioning (verbal fluency). For memory tests, which are not part of usual IQ tests, higher performance levels have been found for later born cohorts by Rönnlund and Nilsson (2009) who used cohort-sequential analyses to compare measures of recall and recognition memory as well as fluency over 15 years. Baxendale (2010) also demonstrated positive cohort effects in terms of learning and recall of both verbal and nonverbal materials over a 22-year period in the UK.

very rarely, however, is this individual-level perspective combined with a population-level approach. This is the gap that the present paper aims to fill. Demographers predict that much of global population growth will occur among the 50+ age group, and that this growth will occur first in richer countries (UN, 2011). This in turn calls into question whether aging societies will be able to maintain economic productivity levels, or even increase them (OECD, 2006). Fortunately, there is also evidence that we are living not only longer but also healthier lives. According to one study, current 70-year-olds are as healthy as the 60-year-olds were when comparing the middle with the end of the 20th century (Vaupel, 2010). The present study addresses how such demographic trends affect cognition in the 50+ population, taking into account cohort effects in cognitive aging.

Estimating the size of inter-cohort cognitive performance change of older adults gains particular relevance as the 50+ share of the total UK population is scheduled to increase from 33% in 2000 to 40% in 2040 (UN, 2011, medium variant scenario). Further, the prevalence of poor cognitive health is concentrated among seniors; raising the potential health implications of improvements for these age groups (Williams, Plassman, Burke, & Benjamin, 2010).

The first question we studied was whether or not the Flynn effect would continue to be seen in the older part of the population (in the UK) in tests of immediate and delayed recall as well as verbal fluency. The second aim was to identify the net effect of demographic change (both population aging and cohort replacement) on the average level of cognition at the population level by using projections.

To understand whether levels of cognitive performance on a population level are increasing or decreasing over historical time, we need to assess (i) the impact of older age structures (with increasing population shares of older age groups) and (ii) cohort replacement (as cohorts die out, they are replaced by

later-born cohorts with potentially different characteristics). To do this, we need to run population-based projections of cognitive performance, using a model that is calibrated with assumptions on the input factors (cohort variation over the life cycle, lifespan trajectories of cognitive performance, population aging and cohort replacement)—in one joint projection model.

### 1.1. The Flynn effect for cohorts currently aged 50 +

The evidence for the Flynn effect is based predominantly on the performance of younger individuals, usually children and students. There is much less evidence for cognitive change among individuals over the age of 50, although some studies do focus on older adults. Substantial improvements in four cognitive measures of Swedes aged 62 to 78 have been identified for tests of verbal, memory, speed, and fluency. Cohorts born from 1926 to 1948 have been found to perform considerably better on all cognitive measures than those born from 1900 to 1925 (Finkel, Reynolds, McArdle, & Pedersen, 2007). Further evidence in support of a Flynn effect from the Betula project in Northern Sweden has been provided by Rönnlund and Nilsson (2008). Evidence from the Seattle Longitudinal Study corroborates and extends earlier findings by documenting differences in the level of cognitive aging of up to 0.50 SD at age 70. Comparing cohorts born from 1914 to 1948 with those born from 1886 to 1913, less steep rates of cognitive aging for most abilities between 50 and 80 years were found, favoring the later-born cohorts (Gerstorf et al., 2011). Zelinski and Kennison (2007) studied reasoning, memory, spatial and verbal abilities in two cohorts from the Long Beach Longitudinal Survey in California born 16 years apart. Individuals were assessed at ages 55 to 87, and comparisons were made between those born in 1893–1923 and those born in 1908–1940. An increase in levels of cognitive functioning between cohorts was found, with those born later performing considerably better on all measures tested. The effect was considerable. The level of cognitive performance of younger cohorts was at the level of those 15 years younger in the previous cohort. Cohort improvements and stronger cohort effects were found particularly for fluid abilities (including memory) rather than crystallized abilities (see also studies by Horn & Cattell, 1966; Raven, 2000). Evidence suggests further that from 1993 to 1998 there was a decrease in the share of cognitively disabled among older Americans (Freedman, Aykan, & Martin, 2001).

Some studies have, however, identified a cognitive stagnation or even a reversal of the Flynn effect among the young. These include analyses from Denmark and Norway (for example, Sundet et al., 2004; Teasdale & Owen, 2007), where later-born cohorts' test performances have only been as good as or slightly worse than those of their predecessors. In Australia, teenagers aged 13–14 have been found to display a small but statistically significant fall in numeracy over the period 1964–2003, and in both literacy and numeracy over the period 1975–1998 (Leigh & Ryan, 2011). Further, analysis of results on two Piagetian tests of formal operations in England (school grades 8 and 9) showed that school performance worsened from 1976 to 2004 for both girls and boys (Shayer, Ginsburg, & Coe, 2007).

The stalled or reversed Flynn effect could reflect worsening cognition levels among successive cohorts in some countries, which might subsequently decrease cognitive

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