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Predicting and retrodicting intelligence between childhood and old age in the 6-Day Sample of the Scottish Mental Survey 1947

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ABSTRACT

In studies of cognitive ageing it is useful and important to know how stable are the individual differences in cognitive ability from childhood to older age, and also to be able to estimate (retrodict) prior cognitive ability differences from those in older age. Here we contribute to these aims with new data from a follow-up study of the 6-Day Sample of the Scottish Mental Survey of 1947 (original N = 1208). The sample had cognitive, educational, social, and occupational data collected almost annually from age 11 to 27 years. Whereas previous long-term follow-up studies of the Scottish mental surveys are based upon group-administered cognitive tests at a mean age of 11 years, the present sample each had an individually-administered revised Binet test. We traced them for vital status in older age, and some agreed to take several mental tests at age 77 years (N = 131). The National Adult Reading Test at age 77 correlated .72 with the Terman–Merrill revision of the Binet Test at age 11. Adding the Moray House Test No. 12 score from age 11 and educational information took the multiple R to .81 between youth and older age. The equivalent multiple R for fluid general intelligence was .57. When the NART from age 77 was the independent variable (retrodictor) along with educational attainment, the multiple R with the Terman–Merrill IQ at age 11 was .75. No previous studies of the stability of intelligence from childhood to old age, or of the power of the NART to retrodict prior intelligence, have had individually-administered IQ data from youth. About two-thirds, at least, of the variation in verbal ability in old age can be captured by cognitive and educational information from youth. Non-verbal ability is less well predicted. A short test of pronunciation—the NART—and brief educational information can capture well over half of the variation in IQ scores obtained 66 years earlier.

1. Introduction

When cognitive data are available from the same individuals in childhood and older age, two types of investigation may be undertaken. First, one can ask how strongly childhood intelligence differences predict intelligence differences in older age, and which variables account for additional variance. This is important in order to understand which factors contribute to people's differences in cognitive ageing. Second, one can ask how strongly vocabulary-type tests—that are often used to estimate peak prior intelligence in older people—estimate (retrodict) measured intelligence from youth. This is important in validating estimates of prior, or premorbid, intelligence, which are valuable in applied and basic work with people who have pathological cognitive decline, such as is found in dementia. The present study does both, using data from the newly-revived 6-Day Sample of the Scottish Mental Survey 1947; an historical summary of the 6-Day Sample is given by Deary, Whalley, and Starr (2009, chapter 1), and the permissions required for the reviving of the study are described by Brett and Deary (2014).

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With regard to predicting intelligence differences in middle and older age from those in youth, there are several studies that have administered the same intelligence-type tests at those far-apart points in the life course (Deary, 2014; Gow et al., 2011; Owens, 1966; Plassman et al., 1995; Schwartzman, Gold, Andres, Arbuckle, & Chaikelson, 1987). These studies are summarised and described in more detail by Deary (2014). An approximate summary would be that about half or less of the variance is stable between age 11 years and about age 70, i.e. the test–retest correlations are about or slightly less than .7. Test–retest correlations are higher between youth and middle age, and lower between childhood and age 90, though still about or greater than .5 (Deary, 2014). There is a search for the factors that contribute to the residual non-stable variance, because it is of considerable interest to discover any modifiable determinants of healthy cognitive ageing. There is evidence that, for example, not having the *APOE* e4 allele, not smoking, and being healthy (not having cardiovascular disease or diabetes, for example) and physically fitter and more active might contribute small amounts to healthier cognitive ageing (Deary et al., 2009; Plassman, Williams, Burke, Holsinger, & Benjamin, 2010). The generally-held view is that there are contributions from all stages of the life course to cognitive differences (Foresight Mental Capital & Wellbeing Project, 2008). Here, we focus on social and educational factors from youth, and we test whether such variables can add to the predictive validity of measured intelligence from youth in explaining cognitive differences in older age.

In a previous report, using a different follow-up sample of the Scottish Mental Survey 1947, we found that education (years of full-time education) contributed some variance in addition to prior cognitive ability in accounting for intelligence differences in older age (Ritchie, Bates, Der, Starr, & Deary, 2013). This was done using only a single, group-based intelligence test in youth. Moreover, the other previous long-term follow-up studies of the stability of intelligence differences based on the Scottish mental surveys (summarised by Deary, 2014) have all used data from the group-based intelligence test (the Moray House Test No. 12) that was administered at age 11 years. The present study is based on a new follow-up study of the 6-Day Sample of the Scottish Mental Survey of 1947. It has the advantage of the sample's having two broad and well-validated tests from age 11—one of which is an individually-administered revised Binet test and is broader in content. A second advantage of this sample is that there are detailed educational and social background and occupational data that were gathered almost yearly from age 11 to age 27, between 1947 and 1963. We have now administered several tests covering important domains of cognitive ability at a mean age of 77 years.

With regard to retrodicting prior intelligence differences from information gathered in middle and older age, and in states of cognitive decline, the tests that are used are based partly on the consistent finding that vocabulary-type cognitive tests hold better in older ages than do tests that require more active, on-the-spot thinking (Park & Bischof, 2013; Salthouse, 2004). This type of 'hold' refers to the fact that mean levels in vocabulary tests do not decline in older age the way that test scores of other cognitive domains—such as non-verbal reasoning, processing speed, and some aspects of memory—decline. This is necessary but not sufficient for vocabulary tests to be useful indicators of prior cognitive ability. There are two types of 'hold' with respect to the longitudinal stability of cognitive test scores as follows: the stability of mean levels and the stability of individual differences (Deary, 2014). Given the former, the latter does not necessarily follow. However, verbal tests also show stronger 'hold' when it comes to stability of individual differences. For example, in a 40-year follow-up study of 260 male Canadian World War II veterans who had taken the Revised Examination M Test of intelligence at conscription and again in older age, the correlations between youthful and older-age verbal and non-verbal scores were .82 and .54, respectively (Schwartzman et al., 1987). Similarly, in a follow-up of 96 freshmen tested on the Army Alpha in 1919 and again in 1961, the youthful versus older-age correlation for the reasoning component was .58, and the correlation for the verbal component was .73. Therefore, verbal tests show higher stability of both mean levels and individual differences.

The concept of estimating prior, or premorbid, intelligence was realised with the development of the National Adult Reading Test (Nelson & Willison, 1991), and subsequent similar tests such as the Wechsler Test of Adult Reading and the Test of Premorbid Functioning. These tests require the participants to pronounce words that are irregular in their grapheme-phoneme associations and/or stress. The idea is that one is unlikely to work out how to pronounce such words if one does not already know how they sound. To date, the NART and WTAR have been retrospectively validated in people with and without dementia (Crawford, Deary, Starr, & Whalley, 2001; Dykiert & Deary, 2013; McGurn et al., 2004); there are correlations between .6 and .7 between NART and WTAR scores in older age and group-administered intelligence test scores obtained at age 11 years. In the present study we focus on social and educational factors from youth, and we test whether such variables can add to the retrospective validity of the NART in estimating prior intelligence as was measured using both individually-administered and group-administered tests.

2. Method

2.1. Participants

The participants are surviving members of the 6-Day Sample of the Scottish Mental Survey of 1947; they were all born in 1936 (Deary, Whalley, & Starr, 2009; MacPherson, 1958; Maxwell, 1969; Scottish Council for Research in Education, 1949). On the 4th of June 1947 the Scottish Council for Research in Education (SCRE) attempted to test every child born in 1936 and attending school in Scotland on the Moray House Test No. 12. They tested 70,805 of a possible 75,252 (Fig. 1). The children born on the first day of the even-numbered months were chosen to form a population-representative sample of the 1936-born population living in Scotland at a mean age of 11 years (MacPherson, 1958). In 1947, they recruited 1208 individuals from a possible 1215. The participants in the 6-Day sample were followed up on a further 14 occasions between 1947 and 1963, by which time they were 27 years old. Data on intelligence, personality, education, health, occupations, and family were gathered. Near to the time of the Scottish Mental Survey 1947 there was a 25-item Sociological Schedule, predominantly completed by head-teachers and school nurses (Scottish Council for Research in Education, 1949, pp. 27–48).