PATTERNS OF AGE-RELATED IQ CHANGES FROM THE WAIS TO WAIS-III AFTER ADJUSTING FOR THE FLYNN EFFECT

A Thesis

Presented to

The Faculty of the Department

of Psychology

University of Houston

In Partial Fulfillment

Of the Requirements for the Degree of

Master of Arts

By

Kristina A. Agbayani

December, 2011

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Kristina A. Agbayani

APPROVED:

Merrill C. Hiscock, Ph.D.
Committee Chair

Paul J. Massman, Ph.D.

Andrea B. Burridge, Ph.D.
Department of Educational Psychology

John W. Roberts, Ph.D.
Dean, College of Liberal Arts and Social Sciences
Department of English

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Abstract

Previous studies have found that the Flynn effect accounts for at least 48%, and as much as 100%, of the difference between norms for 20- and 70-year-olds on the Wechsler intelligence tests (Dickinson & Hiscock, 2010). The purposes of the current study are 1) to obtain a true aging effect (TAE) for each of the 11 subtests of the Wechsler intelligence tests by comparing norms for different age groups and adjusting them for the Flynn effect, and 2) to compare three methods of calculating the age group difference (AGD), Flynn effect difference (FED), and TAE for a cohort across successive revisions of the Wechsler test. Results are consistent with previous findings of a large contribution of the Flynn effect to age differences in norms for the Wechsler IQ tests. Moreover, IQ was found to be relatively stable, on average, across various age groups. In order to most accurately determine age-group differences in IQ, methods involving direct assessment of the Flynn effect from the subtest norms are preferable to the use of Flynn effect estimates from the publisher’s validity samples.

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Patterns of Age-Related IQ Changes from the WAIS to WAIS-III after Adjustment for the Flynn Effect

Many physiological and cognitive changes occur in the brain as an individual gets older. Of the numerous physiological changes, one example is the gradual decrease in brain volume with age (Mueller et al., 1998). Moreover, as one ages, neuronal loss occurs and there is a reduction in dendritic arborization (Katzman, 1997). Accompanying the aforementioned physiological alterations are cognitive changes or decline; however, not all cognitive processes decline equally and at the same rate across the life span. Various research design methods are employed to study age-related changes. Of these, cross-sectional and longitudinal designs are the most common. Each design has its relative advantages and disadvantages, and each design highlights different aspects of the population and individual change (Hofer & Sliwinski, 2006).

One explanation for cognitive ability differences between age groups is that they reflect the Flynn effect, or intergenerational rise in intelligence quotient (IQ). Flynn's (1984) hallmark study compared American subjects' mean performance on different combinations of two IQ tests (Stanford-Binet and Wechsler tests) that differed with respect to the years on which they were normed. The results of this study showed an American IQ gain of approximately 3 IQ points per decade, or over 15 points between the years 1932 and 1978. Flynn (1987) conducted further studies of this phenomenon in fourteen other countries and found similar IQ gains ranging from five to twenty-five points within a generation.

Flynn's (1984, 1987) findings of a generational rise in IQ as measured through cognitive ability tests led to various speculations about what may have led to such changes. Dickens and Flynn (2001a, 2001b) attributed these widespread changes more to differences in environmental rather than biological factors; they attributed the strength and magnitude of the environmental influence on IQ to “multiplier effects”. Individual multipliers pertain to the interaction between one’s genes and environment. Essentially, people who are advantaged with respect to a specific trait will have that advantage amplified by “attracting” a superior environment for that trait (Flynn, 2006a). Flynn (2006a) illustrated the individual multiplier in terms of IQ with the example of a cyclic pattern in which a genetically-based performance advantage leads to an environment where more homework is completed which, in turn, leads to an enhanced performance advantage that again leads to an enriched environment. In short, an individual’s genetic predisposition for some skill interacts with his or her environment, which leads to a greater improvement and individual advantage in that particular skill.

Moreover, Dickens and Flynn (2001b) proposed a social multiplier effect in which a society-wide emphasis on specific skills leads to a general increase in individual ability which raises the average ability level, which in turn raises individual ability in an interactive pattern. Specifically, Flynn (2006a) noted that the intelligence and IQ changes were first seen as a result of industrialization, a social multiplier, in the various countries studied. Moreover, Flynn (2006a) identified one main social multiplier brought about by the industrial revolution in the United States that has bolstered intelligence across generations: an increase in educational attainment. Others have postulated various additional factors as leading to IQ gains, including increased environmental complexity associated with urbanization (Schooler, 1998) and a greater societal emphasis on cognitively challenging leisure activities (Schooler & Mulatu, 2001). The Flynn effect is not the only explanation for changes in cognitive abilities over time; other theories regarding changes across the lifespan exist. However, the

Flynn effect is unique because it emphasizes the effect that cohort differences may have on age-related cognitive changes.

Crystallized and Fluid Intelligence

Other theories regarding cognitive decline with age have relied on the constructs of crystallized and fluid intelligence when differentiating among cognitive processes that remain relatively stable versus those that decline gradually throughout individuals' lifetimes (Horn and Cattell, 1967). Fluid intelligence refers to on-the-spot, unlearned problem-solving skills while crystallized intelligence refers to learned factual knowledge. Generally, tests measuring crystallized intelligence show an increase in scores with increasing age while the opposite is true for tests measuring fluid intelligence. More specifically, performance on tests that include over-learned and well-practiced knowledge remains relatively intact with increasing age (Sinnett & Holen, 1999). On the other hand, decline with age occurs slowly, then more rapidly on tests that require reasoning and problem-solving (Kaufman & Horn, 1996).

A study conducted by Kaufman, Reynolds, and McLean (1989) also supports the idea of differences in decline between fluid and crystallized abilities. Specifically, the authors examined patterns of performance across age groups on the Wechsler Adult Intelligence Scale-Revised (WAIS-R) and found, that when they controlled for education level, scores on subtests of the Verbal scale (crystallized tasks) were maintained with age while subtests of the Performance scale (fluid tasks) showed declines with increasing age. This pattern is also reflected in the relative performance of different age groups within the normative sample on subtests of the Wechsler Adult Intelligence Scale-Third Edition (WAIS III)— the smallest age differences were found on the subtests involving crystallized intelligence (Vocabulary, Information, Comprehension, and Arithmetic), while the largest age differences were seen on subtests that measure fluid intelligence (Picture Arrangement, Matrix Reasoning, Digit Symbol, and Object Assembly) (Wechsler, 1997). Nonetheless, it is important to note that the Wechsler subtests are not pure measures of crystallized or especially fluid intelligence (Johnson & Bouchard, 2005).

Processing Speed

Other theories regarding cognitive decline with age indicate processing speed as a common factor underlying patterns of test performance. Salthouse (1996) proposed that as age increases, processing speed decreases, leading to impaired cognitive functioning because of two mechanisms: limited time and simultaneity. The limited time mechanism entails slower execution and completion of basic early operations, which leads to a decrease in the amount of time available to perform later operations, especially in the presence of external time constraints. The simultaneity mechanism entails loss or decay of important early-processed information before later processing such as encoding, elaboration, and retrieval can be performed. Other processing-speed theories include Botwinick's (1977) classic intellectual aging pattern in which non-speeded task performance is maintained while speeded task performance declines with increasing age. A study conducted by Fisk and Warr (1996) exemplified Botwinick's theory by demonstrating slowed processing and perceptual speed as a main factor contributing to cognitive decline with age, particularly on tests of working memory and central executive functioning (selection, retrieval, and utilization of cognitive strategies). In this study, Fisk and Warr found that controlling for perceptual speed accounted for all of the age-related variance in tests of working memory, as well as accounted for most of the age-related variance in tests of central executive functioning. Kaufman, Reynolds, and McLean (1989) found similar support for Botwinick's theory, as they also found maintenance of performance on non-speeded tasks but a decline in performance on speeded tasks on the WAIS-R across the 20- to 74-year-old age range. However, the authors noted that this pattern of performance was also consistent with Horn and Cattell's (1967) theory, since the non-speeded tasks of the WAIS-R measure crystallized intelligence while speeded tasks measure fluid intelligence.

Cohort Effects

A common consideration mentioned in most of the studies already discussed is that differences across age groups may be due to other factors including cohort differences. Most of the previously discussed studies are cross-sectional in nature, so that different age groups were compared at a single point in time. The major shortcoming of such studies is that they potentially confound the effects of aging with differences across cohorts in terms of culture, environment, and education (Hertzog, 1996). Flynn (1998) cautioned that cross-sectional studies may confound cognitive decline with population-wide IQ gains over time, or Flynn effect. He added that because fluid abilities show greater gains than crystallized abilities, cross-sectional findings of vastly greater declines in fluid rather than crystallized intelligence can be attributed to Flynn effects.

Longitudinal designs for research on aging and lifespan changes in cognitive abilities have many advantages. Hofer and Sliwinski (2006) emphasize that longitudinal studies allow researchers directly to examine intraindividual changes, differences in intraindividual changes, and their respective causes. Longitudinal studies, compared with cross-sectional ones, show fewer age changes, possibly due to their elimination of cohort effects (Lezak et al., 2004). Therefore, it is important to examine age-related cognitive changes with age longitudinally to determine whether cohort effects are greatly influencing the results found in cross-sectional studies.

A number of mixed cross-sectional and longitudinal studies have been conducted by Schaie and colleagues (Schaie, Labouvie, & Buech, 1973; Schaie & Hertzog, 1983; Schaie, 1994) in conjunction with the Seattle Longitudinal Study to quantify cohort differences in cognitive functioning across the lifespan. Results from these studies have consistently shown the pervasiveness of cohort differences in various cognitive abilities. Schaie et al. identified vast differences between cross-sectional and longitudinal analyses. Specifically, their results showed that, within a particular cohort, cognitive functions remain relatively stable throughout most of adulthood. On the other hand, cross-sectional comparisons indicate cognitive declines in some abilities, specifically crystallized ones, with individuals in later cohorts performing better than those in earlier cohorts. The authors attribute these cross-sectional differences to generational or cohort differences in the environment, and specifically to an increase in formal education (Schaie, 1994).

Ghisletta and Lindenberger (2004) applied latent growth and multilevel models to longitudinal data from the Berlin Aging Study and the Swiss Interdisciplinary Longitudinal Study on the Oldest Old. Such analyses address cohort effects by allowing for the separation of intraindividual versus interindividual changes. This study examined differential changes in fluid and crystallized abilities with age and found results consistent with the theory that fluid abilities decline while crystallized abilities remain steady with increased age. The authors found that fluid intelligence measured by a digit letter test declined over a period of six years while crystallized intelligence measured by a vocabulary test remained stable during the same period of time.

A study conducted by Rönnlund and Nilsson (2009) examined whether Flynn effects existed in the recall and recognition sub-factors of episodic memory as well as in the knowledge and fluency sub-factors of semantic memory of Swedish cohorts. The results indicated a general pattern of improvement in memory performance, with comparable magnitude across sub-factors, as birth cohorts became more recent. Regression analyses revealed significant Flynn effects on each of the sub-factors of episodic and semantic memory studied. Additional analyses indicated formal education as the main cause of the increase in test scores, a finding that was in agreement with a study conducted by the authors previously (Rönnlund & Nilsson, 2008). The authors further speculated that the basis of Flynn effect lies at the neural level, i.e., that education plays a role in increasing cognitive reserve and neural efficiency. The authors suggest that formal education, specifically the cognitive stimulation and demands posed to students in demanding environments, may also alter brain activity in various areas.

Accounting for the Flynn Effect

As can be seen from the studies discussed above, population gains in IQ over time are pervasive and have been observed repeatedly in both cross-sectional studies. The significance and practical implications of the Flynn effect are profound. For example, Hiscock (2007) pointed out that test norms need to be updated periodically to account for the Flynn effects;

otherwise one would obtain inflated scores if older normative data are used to interpret performance on cognitive ability tests. Additionally, differences in cognitive abilities among different age groups may be confounded by Flynn effects. Specifically, cross-sectional data may show more cognitive decline with age than longitudinal data (Lezak et al., 2004). It would thus be important to determine relative magnitudes of the Flynn effect for various cognitive abilities and subsequently apply the appropriate adjustments to tests scored using older normative data in order to determine an individual's true performance (Hiscock, 2007).

Dickinson and Hiscock (2010) adjusted WAIS-R and WAIS-III norms for distortions introduced by the Flynn effect. They initially determined the age group difference (AGD), or mean difference between norms for 20- and 70-year-olds on each of the eleven subtests. The authors next extrapolated the magnitude of the Flynn effect to a 50-year time span, and calculated a Flynn effect difference (FED) between the Wechsler Adult Intelligence Scale (WAIS) and WAIS-R as well as between the WAIS-R and WAIS-III for each of the eleven subtests. A true aging effect (TAE) for each subtest was then calculated by subtracting the FED from the AGD. Results revealed that the Flynn effect accounts for at least 85% of the difference in performance on WAIS subtests between 20- and 70-year olds. When a correction to WAIS-III norms suggested by Flynn (2009) was applied, the authors found that the Flynn effect accounted for 100% of the difference in performance between 20- and 70-year-olds. This study highlighted the importance of taking cohort effects into account and making appropriate adjustments for the Flynn effect when studying cognitive changes with age.

Objectives and Hypotheses

The first goal of the current study is to expand the Dickinson and Hiscock (2010) study by comparing different age groups (other than 20- and 70-year-olds) and determining the TAE for each of the 11 subtests of the Wechsler intelligence tests. The TAE will be obtained for the WAIS-R and WAIS-III by calculating the FED from the WAIS to WAIS-R and from the WAIS-R to WAIS-III for different intervals of time. From these data, true relative declines in various cognitive abilities across the lifespan can be ascertained. Next, to simulate a longitudinal study, one cohort's performance across subtests will be followed across successive revisions of the Wechsler intelligence tests. The WAIS was normed between 1953 and 1954 then revised and re-normed in 1978 to produce the WAIS-R (a time interval of approximately 24.5 years); the next revision and re-norming occurred in 1995 to produce the WAIS-III (a time interval of approximately 41.5 years) (Flynn, 1999). Therefore, one can determine the approximate ages of a cohort at the time that each specific Wechsler test was normed. For example, individuals who were 28 years old at the time the WAIS was normed would have been approximately 53 and 70 years old at the time the WAIS-R and WAIS-III were normed, respectively. The Dickinson and Hiscock method will be applied and compared to other methods of calculating the AGD, FED, and TAE for a specific cohort across successive revisions of the Wechsler intelligence tests. It is hypothesized that a) for age group comparisons, similar results to those found between 20- and 70-year-olds would be expected; specifically, that the Flynn effect accounts for at least 85% of the differences between the age groups compared and b) by following the same cohort, the Flynn effect would be eliminated and one would expect to find minimal differences in performance on the various subtests across the lifespan.

Method

The TAE between 16- and 66-year-olds from the WAIS to WAIS-R and from the WAIS-R to WAIS-III were calculated following the Dickinson and Hiscock (2010) method using the tables found in the administration or technical manuals for each respective Wechsler (1955, 1981, 1997) test. The basic schematic overview is depicted in Figure 1. First, the raw score corresponding to average performance (scaled score of 10) for the reference group of 16-year-olds was found for the WAIS-R. The raw score determined for 16-year-olds was then used to determine the corresponding scaled score for the comparison group of 66-year-olds on the WAIS-R. For example, if a raw score of 15 on Digit Span corresponds to a scaled score of 10 for 16-year-olds and to a scaled score of 12 for 66-year-olds, the scaled score of 12 for 66-year-olds (2 points above average) would be translated into a scaled score of 8 (2 points below average) on the normative distribution for 16-year-olds. This reversal in scaled score is applied because the older group's mean falls below that of the younger group: performance yielding a scaled score of 10 for 66-year-olds corresponds to performance yielding a scaled score of 8 for 16-year-olds. The same principle applies to instances in which an average raw score for 16-year-olds corresponds to a scaled score below 10 for 66-year-olds. In this case a scaled score of 8 would be translated into a scaled score of 12 for 16-year-olds. This process allows one to calculate the difference between the two age group means in terms of scaled-score units. This is the age group difference (AGD).

The second step involves applying a Flynn effect correction to the 50-year time interval using Flynn effect estimates for each subtest from a validity sample (*N* = 72) that was administered both the WAIS and WAIS-R (Wechsler, 1981). A corrected scaled score for 66-year-olds that accounts for the Flynn Effect was calculated using the following formula:

Corrected 66-year-old SS = Uncorrected 66-year-old SS + (Flynn effect correction * [50/24.5]).

The 50 in the equation corresponds to the age difference (in years) between 16- and 66-year-olds and the 24.5 corresponds to the number of years between the norming of the WAIS and WAIS-R. Thus, the corrected SS is expressed in scaled-score units per 50 years. This is the Flynn effect difference (FED) for each subtest. Lastly, the TAE was calculated for each subtest by subtracting the FED from the AGD (see Figure 2 for sample calculations).

This process was repeated in order to determine the TAE between 16- and 66-year-olds for the interval between the WAIS-R and WAIS-III. The Flynn effect corrections used to determine FEDs were obtained from a separate validity sample (*N*=192) of individuals who completed both the WAIS-R and WAIS-III (Tulsky, Zhu, & Ledbetter, 1997). Flynn (2009) found that the WAIS-III overestimates the Full Scale IQ by at least 1.65 points. Therefore, when calculating the comparison group's corrected scaled score for the interval between the WAIS-R and WAIS-III, an additional 1.65 points (0.33 scaled score points) correction will be applied using the following equation:

Corrected 66-year-old scaled score = uncorrected 66-year-old SS + (Flynn effect correction * 50/17) + (0.33*[50/17]).

The 50 in the equation corresponds to the age difference (in years) between 16- and 66-year-olds, and the 17 corresponds to the number of years between the norming of the WAIS-R and WAIS-III. The entire procedure will be repeated to determine the TAE between 16- and 74-year-olds and between 30- and 50-year-olds for the WAIS and WAIS-R and for the WAIS-R and WAIS-III. An average TAE for the WAIS-R and WAIS-III in addition to a global average based on all TAE calculations will be determined.

Finally, three models used to calculate the AGD, FED, and TAE for a simulated cohort across successive revisions of the Wechsler tests will be compared. The cohort to be followed is that consisting of 38-year-olds during the norming of the WAIS in 1953, making the members 63years old at the time the WAIS-R was normed, and 80 at the time the WAIS-III was normed. Model 1 involves conducting the same procedure used to compare two age groups, without regard to the cohort relationship as above, i.e., to calculate the AGD, FED, and TAE between 38- and 63-year-olds and 63- and 80-year-olds on the WAIS-R and WAIS-III.

Model 2 takes the cohort relationship into account and involves a similar method in which the first step is to obtain the raw score for 38-year-olds that is equivalent to average performance on the WAIS, or a scaled score of 10. The raw score will then be used to determine the scaled score for 63-year-olds on the WAIS as well as 38- and 63-year-olds on the WAIS-R, as the cohort was 63 years old approximately 24.5 years later when the WAIS-R was normed. The next step involves calculating the AGD by subtracting the 38-year-old scaled score from the 63-year-old scaled score on the WAIS and on the WAIS-R, respectively, then obtaining the average from the two calculations. The FED was calculated by subtracting the 38-year-old scaled score on the WAIS-R from the 38-year-old scaled score on the WAIS; the same calculation was repeated for 63-year-olds and then averaged between the two calculations. Lastly, the TAE was obtained by subtracting the FED from the AGD on the WAIS and WAIS-R, respectively, and then averaging these two values. The same procedures were conducted to obtain the AGD, FED, and TAE for 38- and 63-year-olds from the WAIS-R to WAIS-III and for 63- and 80-year-olds from the WAIS to WAIS-R and from the WAIS-R to WAIS-III.

Model 3 involved the same AGD and FED calculations as Model 2, but the TAE was calculated by subtracting the 63-year-old scaled score on the WAIS-R from the 38-year-olds scaled score on the WAIS. These calculations are performed for 38- and 63-year-olds from the WAIS-R to WAIS-III and for 63- and 80-year-olds from the WAIS to WAIS-R and from the WAIS-R to WAIS-III.

Results

16- and 66-year-olds

Table 1 depicts the calculations and results for the TAE calculations for the WAIS-R in units of scaled score points per 50 years (the age difference between the two groups). When averaged across all 11 subtests of the WAIS-R, the AGD between 16- and 66-year-olds was -1.3 scaled score units, which is equivalent to -6.4 IQ points. The corresponding FED between the two age groups was -2.8 scaled score units, which equates to -14.1 IQ points. As the FED was larger than the AGD, the Flynn effect was sufficient to account for 100% of the difference between 16- and 66-year-olds. By subtracting the FED from the AGD, an overall TAE of +1.6 scaled score units, or +7.7 IQ points, was obtained. In other words, the overall score, after adjustment for the Flynn effect, was higher for 66-year-olds than for 16-year-olds. When separated into the Verbal and Performance subtests, the 6 verbal subtests produced an average TAE of +3.2 scaled score units, or +16.1 IQ points, while the 5 performance subtests produced an average TAE of -0.50 scaled-score unit difference, or -2.3 IQ points, over the 50-year interval between the ages of 16 and 66 years. When subtests were examined individually, positive TAEs were obtained for the following subtests: Information, Digit Span, Vocabulary, Arithmetic, Comprehension, Similarities, and Picture Completion.

Negative TAEs were obtained for the remaining subtests which included Picture Arrangement, Block Design, Object Assembly, and Digit Symbol.

Table 2 depicts the results of the TAE calculations for the WAIS-III in scaled-score points per 50 years. When averaged across all 11 subtests of the WAIS-III, the overall AGD between 16- and 66-year-olds was -1.8 scaled score units, which is comparable to -9.1 IQ points. The corresponding FED between the two age groups was -2.5 scaled score units, or -12.3 IQ points. When the FED was divided by the AGD, the Flynn effect was found to be capable of accounting for more than 100% of the overall difference between 16- and 66-year-olds. By subtracting the FED from the AGD, an overall TAE of +0.70 scaled score units, or +3.2 IQ points, was obtained. When divided into the Verbal and Performance subtests, the 6 verbal subtests produced an average TAE of +1.9 scaled score units, or +9.3 IQ points over a 50-year interval. The 5 performance subtests resulted in an average TAE of -0.80 scaled score units, or -4.0 IQ points over the same interval. When individual subtests were examined, positive TAEs were obtained for the Information, Vocabulary, Arithmetic, Comprehension, Similarities, Picture Completion, and Object Assembly subtests. Negative TAEs were obtained for the remaining subtests: Digit Span, Picture Arrangement, Block Design, and Digit Symbol.

16- and 74-year-olds

Table 3 shows the results of the TAE calculations for the WAIS-R in scaled-score points per 58 years (the age difference between the two groups compared). These values have also been interpolated to an interval of 50 years to make them commensurate with previous estimates. When averaged across all 11 subtests of the WAIS-R, the AGD between 16- and

74-year-olds was -2.0 scaled score units per 50 years, which is equivalent to -10.2 IQ points. The corresponding FED between the two age groups was -2.8 scaled score units per 50 years, which equates to -14.1 IQ points. When the FED was divided by the AGD, the Flynn effect was found to be large enough to account for more than 100% of the difference between 16- and 74-year-olds.By subtracting the FED from the AGD, an overall TAE of +0.80 scaled score units per 50 years, or +3.9 IQ points, was obtained. When the Verbal and Performance subtests of the WAIS-R were considered separately, the 6 verbal subtests produced an average TAE of +2.6 scaled score units per 50 years, or +13.0 IQ points, while the 5 performance subtests produced an average TAE of -1.4 scaled score units per 50 years, or -7.0 IQ points per 50 years. When subtests were examined individually, positive TAEs were obtained for the following subtests: Information, Digit Span, Vocabulary, Arithmetic, Comprehension, Similarities, and Picture Completion, and negative TAEs were obtained for Picture Arrangement, Block Design, Object Assembly, and Digit Symbol.

Table 4 shows the calculations of WAIS-III TAE in scaled-score points per 58 and 50 years. When averaged across all 11 subtests of the WAIS-III, the AGD between 16- and 74-year-olds was -1.7 scaled score units per 50 years, which is equivalent to –8.6 IQ points. The corresponding FED between the two age groups was -2.5 scaled score units per 50 years, equal to -12.3 IQ points. When the FED was divided by the AGD, the Flynn effect was again found to be sufficiently large enough to account for all of the difference between 16- and 74-year-olds. By subtracting the FED from the AGD, an overall TAE of +0.70 scaled-score units per 50 years, or +3.7 IQ points, was obtained. When categorized according to Verbal and Performance subtests, the 6 verbal subtests produced an average TAE of +1.9 scaled score units per 50 years, or +9.3 IQ points between 16- and 74-year-olds. The 5 performance subtests resulted in an average TAE of -.60 scaled score units per 50 years, or -2.9 IQ points. When individual subtests were examined, positive TAEs were obtained for the Information, Vocabulary, Arithmetic, Comprehension, Similarities, and Object Assembly subtests. Negative TAEs were obtained for the remaining subtests: Digit Span, Picture Completion, Picture Arrangement, Block Design, and Digit Symbol.

30- and 50-year-olds

Table 5 depicts the calculations of WAIS-R TAE in scaled-score points per 20 years (the age difference between the two groups) and converted to scaled score points per 50 years. When averaged across all 11 subtests of the WAIS-R, the AGD between 30- and 50-year-olds was -2.7 scaled-score units per 50 years, equivalent to -13.6 IQ points. The corresponding FED between the two age groups was -2.8 scaled score units per 50 years, which equates to -14.1 IQ points. When the FED was divided by the AGD, the Flynn effect was found to be sufficient to account for more than 100% of the difference between 30- and 50-year-olds. By subtracting the FED from the AGD, an overall TAE of +0.1 scaled score units per 50 years, or +0.50 IQ points, was obtained. When divided into Verbal and Performance subtests, the 6 verbal subtests produced an average TAE of +0.8 scaled score units per 50 years, or +4.0 IQ points, while the 5 performance subtests produced an average TAE of -0.8 scaled score units per 50 years, or -4.0 IQ points. When subtests were examined individually, positive TAEs were obtained for: Vocabulary, Comprehension, Similarities, and Picture Completion. Negative TAEs were obtained for: Information, Digit Span, Arithmetic, Picture Arrangement, Block Design, Object Assembly, and Digit Symbol.

Table 6 depicts the calculations of the TAE for the WAIS-III in scaled-score points per 20 years and scaled-score points per 50 years. When averaged across all 11 subtests of the WAIS-III, the AGD between 20- and 50-year-olds was -0.70 scaled score units per 50 years, which equated to -3.4 IQ points. The corresponding FED between the two age groups was -2.5 scaled-score units per 50 years, or -12.4 IQ points. When the FED was divided by the AGD, the Flynn effect was large enough to account for 100% of the difference between 20- and 50-year-olds. By subtracting the FED from the AGD, an overall TAE of +1.8 scaled score units per 50 years, or +9.0 IQ points, was obtained. When categorized into Verbal and Performance subtests, the 6 verbal subtests produced an average TAE of +3.5 scaled-score units per 50 years, or 17.6 IQ points; the 5 performance subtests resulted in an average TAE of -0.30 scaled score units per 50 years, or -1.4 IQ points. When individual subtests were examined, positive TAEs were obtained for the Information, Digit Span, Vocabulary, Arithmetic, Comprehension, Similarities, Block Design, and Digit Symbol subtests. Negative TAEs were obtained for: Picture Completion, Picture Arrangement, and Object Assembly.

Average TAE

Table 7 shows the calculations of average TAE for the WAIS-R in scaled-score points per 50 years. When averaged across all analyses (Tables 1, 3, and 5) of the 11 subtests of the WAIS-R, the average AGD was -2.0 scaled-score units per 50 years, equivalent to -10 IQ points. The corresponding average FED was -2.8 scaled-score units per 50 years, which equates to -14.1 IQ points. When the FED was divided by the AGD, the Flynn effect was found to be sufficient to account for 100% of the difference in performance among all the groups compared. By subtracting the average FED from the average AGD, an average overall TAE of +0.80 scaled-score units per 50 years, or +4 IQ points, was obtained. When the Verbal and Performance subtests were considered separately, all analyses of the 6 verbal subtests produced an average TAE of +2.2 scaled-score units per 50 years, or +11 IQ points. All analyses of the 5 performance subtests produced an average TAE of -0.9 scaled-score units per 50 years, or -4.5 IQ points. When subtests were examined individually, positive TAEs, on average, were obtained for Information, Vocabulary, Arithmetic, Comprehension, Similarities, and Picture Completion. Negative TAEs, on average, were obtained for Digit Span, Picture Arrangement, Block Design, Object Assembly, and Digit Symbol.

Table 8 shows the calculations of average TAE for the WAIS-III in scaled-score points per 50 years. When averaged across all analyses (Tables 2, 4, and 6) of the 11 subtests of the WAIS-III, the average AGD was -1.4 scaled score units per 50 years, equivalent to -7 IQ points. The corresponding average FED was -2.5 scaled score units per 50 years, which equates to -12.5 IQ points. When the average FED was divided by the average AGD, the Flynn effect was found to be large enough to account for 100% of the difference in average performance among all the groups compared. By subtracting the average FED from the average AGD, an average overall TAE of +1.1 scaled-score units per 50 years, or +5.5 IQ points, was obtained. When divided into Verbal and Performance subtests, all analyses of the 6 verbal subtests produced an average TAE of +2.4 scaled-score units per 50 years, or +12 IQ points. All analyses of the 5 performance subtests produced an average TAE of -0.6 scaled score units per 50 years, or -3 IQ points. When subtests were examined individually, positive TAEs, on average, were obtained for Information, Digit Span, Vocabulary, Arithmetic, Comprehension, Similarities, and Digit Symbol. Negative TAEs, on average, were obtained for Picture Completion, Picture Arrangement, Block Design, and Object Assembly.

Table 9 shows the calculations of the global average TAE across Wechsler tests in units of scaled-score points per 50 years. When averaged across all analyses (Tables 1-6) of the 11 subtests, the average overall AGD was -1.7 scaled-score units per 50 years, equivalent to -8.5 IQ points. The corresponding average overall FED was -2.7 scaled-score units per 50 years, which equates to -13.5 IQ points. When the FED was divided by the AGD, the Flynn effect was found to be sufficiently large enough to account for 100% of the difference in performance among all the groups compared. By subtracting the average overall FED from the average overall AGD, an average overall TAE of +0.9 scaled-score units per 50 years, or +4.5 IQ points, was obtained. When divided into Verbal and Performance subtests, all analyses of the 6 verbal subtests produced an average TAE of +2.3 scaled-score units per 50 years, or +11.5 IQ points. All analyses of the 5 performance subtests produced an average TAE of -0.7 scaled-score units per 50 years, or -3.5 IQ points. When subtests were examined individually, positive TAEs, on average, were obtained for Information, Vocabulary, Arithmetic, Comprehension, Similarities, and Picture Completion. Negative TAEs were obtained for Digit Span, Picture Arrangement, Block Design, Object Assembly, and Digit Symbol.

Simulated Longitudinal Study

Model 1: 38- and 63-year-olds. Table 10 depicts the calculations of AGD, FED, and TAE between 38- and 63-year-olds on the WAIS-R in scaled-score units per 25 years, and converted to scaled-score units per 50 years. When averaged across all 11 subtests of the

WAIS-R, the AGD between the two groups was -2.7 scaled-score units per 50 years, equivalent to -13.6 IQ points. The corresponding FED was -2.8 scaled score units per 50 years, which equates to -13.8 IQ points. When the FED was divided by the AGD, the Flynn effect was large enough to account for 100% of the difference in scores between the two age groups. By subtracting the FED from the AGD, an overall TAE of +0.0 scaled-score units per 50 years, or +0.0 IQ points, was obtained. When divided into Verbal and Performance subtests, the 6 verbal subtests produced an average TAE of +0.8 scaled-score units per 50 years, or +4.2 IQ points. The 5 performance subtests produced an average TAE of -0.9 scaled-score units per 50 years, or -4.6 IQ points. When subtests were examined individually, positive TAEs were obtained for Information, Vocabulary, Arithmetic, Comprehension, Similarities, and Picture Completion. Negative TAEs were obtained for Digit Span, Picture Arrangement, Block Design, Object Assembly, and Digit Symbol.

Table 11 shows results of the AGD, FED, and TAE calculations between 38- and 63-year-olds on the WAIS-III in scaled-score units per 17 years and converted to scaled-score units per 50 years. When averaged across all 11 subtests on the WAIS-III, an AGD of -2.7 scaled-score units per 50 years, or -13.6 IQ points was obtained. The corresponding FED for was -2.5 scaled-score units per 50 years, or -12.3 IQ points. When the FED was divided by the AGD, the Flynn effect was found to account for approximately 93% of the difference in scores between the two age groups. By subtracting the FED from the AGD, an overall TAE of -0.3 scaled score units, or -1.3 IQ points, was obtained. When the Verbal and Performance subtests were considered separately, the 6 verbal subtests produced an average TAE of +0.5 scaled-score units per 50 years, or +2.6 IQ points. The 5 performance subtests produced an average TAE of -1.2 scaled-score units per 50 years, or -6.0 IQ points. When subtests were examined individually, positive TAEs were obtained for Digit Span, Arithmetic, Similarities, Picture Completion, Block Design, and Object Assembly. Negative TAEs were obtained for Information, Vocabulary, Comprehension, Picture Arrangement, and Object Assembly.

Model 1: 63- and 80-year-olds. Table 12 depicts the calculations of AGD, FED, and TAE between 63- and 80-year-olds on the WAIS-R in scaled-score units per 17 years and converted to scaled-score units per 50 years. Scaled scores for 74-year-olds were extrapolated to represent 80-year-olds due to availability of normative data on the WAIS-R only up to that particular age. When averaged across the 11 subtests, an AGD of -4.3 scaled-score units per 50 years, equivalent to -21.4 IQ points, was obtained. The corresponding FED was -2.8 scaled-score units per 50 years, which equates to -13.8 IQ points. When the FED was divided by the AGD, the Flynn effect was found to account for approximately 65% of the difference in scores for the cohort at age 38 and at age 63. By subtracting the FED from the AGD, an overall TAE of -1.5 scaled-score units per 50 years, or -7.6 IQ points, was obtained. When divided into Verbal and Performance subtests, the 6 verbal subtests produced an average TAE of -0.1 scaled-score units per 50 years, or -0.5 IQ points. The 5 performance subtests produced an average TAE of -3.2 scaled-score units per 50 years, or -16.0 IQ points. When subtests were examined individually, a positive TAE was obtained for Vocabulary, Arithmetic, and Comprehension. Negative TAEs were obtained for Information, Digit Span, Similarities, Picture Completion, Picture Arrangement, Block Design, Object Assembly, and Digit Symbol.

Table 13 shows results of the AGD, FED, and TAE calculations between 63- and 80-year-olds on the WAIS-III. When averaged across all subtests, an AGD of -8.0 scaled-score units per 50 years, or -40.1 IQ points, was obtained. The corresponding FED was -2.5 scaled-score units per 50 years, or -12.3 IQ points. When the FED was divided by the AGD, the Flynn effect was found to account for approximately 30% of the difference in scores between the two groups. By subtracting the FED from the AGD, an overall TAE of -5.6 scaled-score units per 50 years, or -27.8 IQ points, was obtained. When the Verbal and Performance subtests were considered separately, the 6 verbal subtests produced an average TAE of -3.5 scaled-score units per 50 years, or -17.7 IQ points. The 5 performance subtests produced an average TAE of -8.0 scaled-score units per 50 years, equivalent to -39.8 IQ points. When subtests were examined individually, negative TAEs were obtained for all subtests.

Model 1: Global Average. Table 14 shows the calculations of the global average AGD, FED, and TAE across age groups and Wechsler tests in units of scaled-score points per 50 years. When averaged across all analyses (Tables 10-13) of the 11 subtests, the average overall AGD was -4.4 scaled-score units per 50 years, equivalent to -22.2 IQ points. The corresponding average overall FED was -2.6 scaled-score units per 50 years, which equates to -13.1 IQ points. When the FED was divided by the AGD, the Flynn effect was found to be sufficiently large enough to account for approximately 59% of the difference in performance among all the groups compared. By subtracting the average overall FED from the average overall AGD, an average overall TAE of -1.8 scaled-score units per 50 years, or -9.1 IQ points, was obtained. When separated into Verbal and Performance subtests, all analyses of the 6 verbal subtests produced an average TAE of -0.6 scaled-score units per 50 years, or -2.9 IQ points. All analyses of the 5 performance subtests produced an average TAE of -3.3 scaled-score units per 50 years, or -16.6 IQ points. When subtests were examined individually, positive TAEs, on average, were obtained for Vocabulary and Similarities.

Negative TAEs were obtained for Information, Digit Span, Arithmetic, Comprehension, Picture Completion, Picture Arrangement, Block Design, Object Assembly, and Digit Symbol.

Model 2: 38- and 63-year-olds. Table 15 depicts calculations of the AGD, FED, and TAE of the cohort at age 38 and 63 from the WAIS to the WAIS-R, respectively, in scaled-score units per 25 years and converted to 50 years. Due to dramatic changes in the Picture Arrangement subtest from the WAIS to WAIS-R, scaled scores for the subtest were adjusted using a ratio of raw score ranges for each version of the Wechsler tests. When averaged across the 11 subtests, an AGD of -2.9 scaled-score units per 50 years, equivalent to -14.5 IQ points, was obtained. The corresponding FED was also -2.9 scaled-score units per 50 years, or -14.5 IQ points. When the FED was divided by the AGD, the Flynn effect was sufficiently large enough to account for 100% of the difference in scores for the cohort at age 38 and at age 63. By subtracting the FED from the AGD, an overall TAE of 0 scaled-score units per 50 years, or 0 IQ points, was obtained. When the Verbal and Performance Subtests were considered separately, the 6 verbal subtests produced an average TAE of +2.0 scaled-score units per 50 years, or +10.0 IQ points. The 5 performance subtests produced an average TAE of -2.4 scaled-score units per 50 years, or -12.0 IQ points. When subtests were examined individually, a positive TAE was obtained for Information, Digit Span, Vocabulary, Arithmetic, Comprehension, Similarities, and Picture Completion. Negative TAEs were obtained for Picture Arrangement, Block Design, Object Assembly, and Digit Symbol.

Table 16 shows calculations of the AGD, FED, and TAE of the cohort at age 38 and 63 from the WAIS-R to the WAIS-III, in scaled-score units per 25 years and converted to 50 years. As before, major changes in the Picture Arrangement subtest across revisions of the Wechsler tests was accounted for by adjusting scaled scores using a ratio of raw score ranges for each version of the Wechsler tests. When averaged across the 11 subtests, an AGD of -2.3 scaled-score units per 50 years, equivalent to -11.5 IQ points, was obtained. The corresponding FED was -3.4 scaled-score units per 50 years, or -17.0 IQ points. When the FED was divided by the AGD, the Flynn effect was sufficiently large enough to account for over 100% of the difference in scores for the cohort at age 38 and at age 63. By subtracting the FED from the AGD, an overall TAE of +1.1 scaled-score units per 50 years, or +5.7 IQ points, was obtained. When divided into Verbal and Performance subtests, the 6 verbal subtests produced an average TAE of +0.3 scaled-score units per 50 years, or +1.4 IQ points. The 5 performance subtests produced an average TAE of +2.2 scaled-score units per 50 years, or +10.8 IQ points. When subtests were examined individually, a positive TAE was obtained for Digit Span, Arithmetic, Similarities, Picture Completion, Block Design, and Digit Symbol. Negative TAEs were obtained for Information, Vocabulary, Comprehension, Picture Arrangement, and Object Assembly.

Model 2: 63- and 80-year-olds. Table 17 depicts calculations of the AGD, FED, and TAE of the cohort at age 63 and 80 from the WAIS-R to the WAIS-III in scaled-score units per 17 years and converted to 50 years. Due to availability of normative data only up to age 74 on the WAIS-R, scaled score values for this age group were utilized and extrapolated to 80-year-olds. When averaged across the 11 subtests, an AGD of -6.1 scaled-score units per 50 years, equivalent to -30.7 IQ points, was obtained. The corresponding FED was -5.9 scaled-score units per 50 years, or -29.4 IQ points. When the FED was divided by the AGD, the Flynn effect accounted for approximately 96% of the difference in scores for the cohort at age 63 and at age 80. By subtracting the FED from the AGD, an overall TAE of -0.3 scaled-score units per 50 years, or -1.3 IQ points, was obtained. When the Verbal and Performance subtests were considered separately, the 6 verbal subtests produced an average TAE of +2.5 scaled-score units per 50 years, or +12.6 IQ points. The 5 performance subtests produced an average TAE of -3.5 scaled-score units per 50 years, or -17.6 IQ points. When subtests were examined individually, a positive TAE was obtained for Information, Digit Span, Vocabulary, Arithmetic, Comprehension, Similarities, and Picture Completion. Negative TAEs were obtained for Picture Arrangement, Block Design, Object Assembly, and Digit Symbol.

Table 18 shows calculations of the AGD, FED, and TAE of the cohort at age 63 and 80 from the WAIS-R to the WAIS-III, respectively, in scaled-score units per 17 years and converted to 50 years. As before, scaled scores for 74-year-olds were extrapolated and applied to 80-year-olds on the WAIS-R. When averaged across the 11 subtests, an AGD of -5.2 scaled-score units per 50 years, equivalent to -26.1 IQ points, was obtained. The corresponding FED was -3.0 scaled-score units per 50 years, or -14.9 IQ points. When the FED was divided by the AGD, the Flynn effect accounted for approximately 57% of the difference in scores for the cohort at age 63 and at age 80. By subtracting the FED from the AGD, an overall TAE of -2.2 scaled-score units per 50 years, or -11.2 IQ points, was obtained. When separated into Verbal and Performance subtests, the 6 verbal subtests produced an average TAE of -2.5 scaled-score units per 50 years, or -12.3 IQ points. The 5 performance subtests produced an average TAE of -2.0 scaled-score units per 50 years, or -9.8 IQ points. When subtests were examined individually, a positive TAE was obtained for Digit Span, Arithmetic, Similarities, Picture Completion, Block Design, and Digit Symbol.

Negative TAEs were obtained for Information, Vocabulary, Comprehension, Picture Arrangement, and Object Assembly.

Model 2: Global Average. Table 19 shows the calculations of the global average AGD, FED, and TAE for the cohort at different ages and across Wechsler tests in units of scaled-score points per 50 years. When averaged across all analyses (Tables 15-18) of the 11 subtests, the average overall AGD was -4.1 scaled-score units per 50 years, equivalent to -20.7 IQ points. The corresponding average overall FED was -3.8 scaled-score units per 50 years, which equates to -19.0 IQ points. When the FED was divided by the AGD, the Flynn effect was found to be sufficiently large enough to account for approximately 92% of the difference in performance among all the groups compared. By subtracting the average overall FED from the average overall AGD, an average overall TAE of -0.3 scaled-score units per 50 years, or -1.7 IQ points, was obtained. When categorized by Verbal and Performance subtests, all analyses of the 6 verbal subtests produced an average TAE of +0.6 scaled-score units per 50 years, or +2.8 IQ points. All analyses of the 5 performance subtests produced an average TAE of -1.4 scaled-score units per 50 years, or -7.2 IQ points. When subtests were examined individually, positive TAEs, on average, were obtained for Digit Span, Arithmetic, Comprehension, Similarities, and Picture Completion. Negative TAEs were obtained for Information, Vocabulary, Picture Arrangement, Block Design, Object Assembly, and Digit Symbol.

Model 3. Table 20 depicts calculations of the TAE for the cohort at age 38 and 63 and at age 63 and 80 from the WAIS to WAIS-R and from the WAIS-R to WAIS-III, respectively, and the average TAE collapsed across ages and versions of the Wechsler tests in scaled-score points per 50 years. For the cohort at age 38 and 63 from the WAIS to WAIS-R, the average TAE was 0 scaled-score units per 50 years, or 0 IQ points. At the ages 63 and 80 from the WAIS-R to WAIS-III, the average TAE for the cohort was -2.2 scaled-score units per 50 years, or -11.1 IQ points. When collapsed across ages and Wechsler tests, the average overall TAE was -1.1 scaled-score units per 50 years, equivalent to -5.6 IQ points. When the Verbal and Performance subtests were considered separately, the 6 verbal subtests produced an average overall TAE of -0.2 scaled-score units per 50 years, or -1.1 IQ points. The 5 performance subtests produced an average overall TAE of -2.2 scaled-score units, equivalent to -11.0 IQ points per 50 years. When individual subtests were examined, an overall positive TAE was found for Digit Span, Arithmetic, Similarities, and Picture Completion. Negative TAEs were found for Information, Vocabulary, Comprehension, Picture Arrangement, Block Design, Object Assembly, and Digit Symbol overall.

Discrepancy Index. A percent difference between the average AGD, FED, or TAE was obtained in order to ascertain the degree of convergence or divergence among the models compared. In comparing Model 1 and Model 2, there was an approximate 4% difference in AGD, a 19% difference in FED, and a 68% difference in TAE. When comparing Model 2 and Model 3, there was no difference in the AGD or FED as both methods involved the same procedure to obtain those values; however, there was a 53% difference in TAE between the two models. Lastly, when comparing Model 1 and Model 3, the percent difference in AGD and FED between the two models was the same as in the Model 1 and Model 2 comparison due to the same method employed in Model 3 as in Model 2. The percent difference in TAE between Model 1 and Model 3 was approximately 24%.

Discussion

Cross-sectional Analyses

Results of analyses comparing various age groups' performance on subtests within the WAIS-R and WAIS-III after accounting for the Flynn effect were, on average, consistent with the Dickinson and Hiscock (2010) findings of an enormous contribution of the Flynn effect to age differences in norms for the Wechsler IQ tests. Specifically, when averaged across all analyses involving age differences in performance on the WAIS-R, the Flynn effect was found to account for 100% of the overall difference amongst the age groups compared, versus the 85% estimate found by Dickinson and Hiscock (2010) when comparing 20- and 70-year-olds. The modest TAEs obtained across analyses indicate that IQ may actually remain relatively stable, on average, across a large segment of the lifespan.

When average performance on subtests within the Verbal Scale of the WAIS-R was examined, the AGD was smaller than the FED for all subtests except Digit Span. For the WAIS-III, the AGD was smaller than the FED for all subtests except Information and Arithmetic. A larger AGD would have indicated residual age-related cognitive decline after taking the Flynn effect into account. However, in this case the Flynn effect is larger, on average, than the age-group difference. Thus, the Flynn effect appears to be masking overall gains by older age groups on Verbal scale subtests. When average performance on subtests within the Performance Scale of the WAIS-R was examined, the AGD was larger than the FED on all subtests except for Picture Completion; the AGD was larger than the FED on all Performance subtests except for Digit Symbol on the WAIS-III. This tendency toward a decrease in raw scores suggests that there is some residual age-related decline in these abilities after adjustment for the Flynn effect. However, the overall decrease in scores observed was relatively small, suggesting that the Flynn effect may be exaggerating declines on Performance scale subtests.

The pattern of performance observed on Verbal and Performance subtests is relatively consistent with theories of cognitive decline related to fluid and crystallized intelligence. Specifically, these findings are consistent with the Kaufman, Reynolds, and McLean (1989) study that found that crystallized abilities, roughly measured by the WAIS-R Verbal Scale, remain relatively stable with age; though the current study suggests that such abilities may actually improve or increase with age. Fluid abilities, as measured by the Performance Scale, show declines with increased age as found in the current study.

It is important to note that the Wechsler tests are not pure measures of fluid and crystallized abilities (Johnson & Bouchard, 2005), so other processes may be affecting the patterns of raw score increases or declines found in the current study. Several subtests of the Wechsler tests have a speed component or external time constraint; declines found in such subtests may therefore be due to declines in processing speed with age. The majority of subtests in the Performance Scale including Block Design, Digit Symbol, Picture Arrangement, and Object Assembly have a speed component. In the current study, these subtests on average had negative TAEs. Therefore, declines in performance with age on these particular subtests due to a decline in processing speed cannot be ruled out.

Within-Cohort Analyses

Models 1, 2, and 3 each differed in their estimation of the TAE: The TAE for Model 1 and for Model 2 was determined by the difference between the AGD and FED, while Model 3 involved a direct calculation of the TAE from scaled scores of a particular cohort from one version of the Wechsler test to the next. Though Models 1 and 2 involved the same AGD-FED calculation to obtain the TAE, their respective means of calculating the individual components of the TAE, specifically the FED, were quite different. Like the Dickinson and Hiscock (2010) method, Model 1 utilized Flynn effect estimates based on validity samples given successive revisions of Wechsler tests in order to determine the FED; the FED for Model 2 was based solely on a difference in scaled scores determined from an average raw score for each subtest. Model 3's direct calculation of the TAE is possible only because the FED must be zero within a cohort. Despite these differences, there was little to no difference in the overall AGD obtained for each model. There was at least an 18% divergence in estimation of the FED among the three models. The differences among the FED estimates taken into account with the larger divergence in TAE, ranging from 23% to as much as 68%, among the models suggests that the TAE depends on the particular method used to calculate the FED.

The largest discrepancy in overall TAE was found between Model 1 and Model 2. Given that the FED for Model 1 is based on Flynn effect estimates obtained from relatively small comparison groups (*N* = 72 and *N* = 192 for the WAIS to WAIS-R and WAIS-R to WAIS-III, respectively), Model 2 may be a better method of calculating the FED, as it involves direct comparisons of scaled scores from the normative samples of the respective versions of the Wechsler IQ tests. In comparing Model 2 and Model 3, there was a 53% discrepancy between their respective estimates of the TAE. When the TAE is averaged across Models 1 and 2, the TAE estimates are the same as the Model 3 calculations. This suggests that Model 1 may be overestimating the TAE whereas Model 2 may be underestimating the TAE. Therefore, the direct calculation of the TAE from the normative data employed by Model 3 may be a better approach towards calculating the TAE.

Despite the differences amongst the three models, results from each of the models displayed a similar trend in IQ scores overall and in the Verbal and Performance scales separately. Across analyses and Wechsler tests, the cohort showed a minimal overall TAE, suggesting that IQ remains relatively stable throughout a large portion of adulthood. When looking at the cohort's average performance on subtests of the Verbal scale, each of the models showed minimal changes, or TAEs, ranging from a decrease of 1 IQ point per 50 years to an increase of 3 IQ points per 50 years. This suggests that verbal abilities also remain quite stable for a large segment of the lifespan. The cohort's performance on subtests of the Performance scale showed, on average, negative TAEs indicative of overall declines with increased age.

The pattern of performance observed is consistent with theories of fluid and crystallized intelligence that suggest crystallized abilities, such as those measured by the Verbal scale, remain stable throughout the lifespan while fluid abilities such as those measured by the Performance scale decline with age (Horn & Cattel, 1967). However, it is again difficult to rule out the role of processing speed in the average declines in raw scores for the majority of Performance Scale subtests that have external time constraints.

Since a single cohort was followed across successive revisions of the Wechsler IQ tests, one would expect to find minimal to no differences in scores due to Flynn effects.

However, the Flynn effect was still found to account for a large portion, at least 59% in Model 1 or as much as 93% in Model 2, of the difference in scores within the cohort. This may be due to the nature of the normative data: norms are available for a range of ages rather than a single age group, and the ranges are not always consistent across versions of the Wechsler tests. Additionally, a limitation of the cohort followed in this study was the lack of normative data for 80-year-olds on the WAIS-R. Even though a single cohort was followed, intraindividual and interindividual differences are still present within the normative sample.

Conclusions

The results of the current study reiterate the Dickinson and Hiscock (2010) findings of the large contribution of the Flynn effect to age-related changes in performance on IQ tests. The Flynn effect was large enough to account for 100% of the variance in performance between age groups for cross-sectional analyses. After accounting for the Flynn effect, IQ was found to be relatively stable across the adult portion of the lifespan. Verbal abilities remain stable and even show gains through a large segment of the lifespan, while abilities measured by the Performance scale show modest declines from younger to older samples. These findings are consistent with longitudinal studies of cognitive aging as well as with findings from the simulated cohort analyses conducted.

Model comparisons of data from the same cohort measured at different times suggest that the Dickinson and Hiscock (2010) method that utilized Flynn effect estimates from a validity sample given subsequent versions the Wechsler tests may not be the best way to correct and account for cohort effects. In fact, the authors discussed that their method appeared to underestimate the magnitude of the Flynn effect, particularly for performance subtests, and its impact on age differences. In agreement with Flynn's (1999, 2006b, 2007) estimates, Dickinson and Hiscock (2010) concluded that the magnitude of the Flynn effect is 4 IQ points per decade, or 4.0 scaled-score points per 50 years, for PIQ and 2 IQ points per decade, or 2.0 scaled-score points per 50 years, for VIQ. If the FED were set to these estimates, the TAE for the Performance scale would be reduced, indicative of smaller declines in these abilities with age. On the other hand, the method employed in Model 2 may be overestimating the Flynn effect, which may be due to the normative table involving ranges of, instead of exact, age groups. The model comparisons implicated direct calculations involving data from the normative sample as the preferred method of accurately estimating differences due to Flynn effects in order to subsequently obtain the most precise estimate of cognitive changes with age.

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Figure 1. Schematic diagram of basic method. Adapted from "Age-related IQ decline is reduced markedly after adjustment for the Flynn effect," by M. D. Dickinson and M. Hiscock, 2010, *Journal of Clinical and Experimental Neuropsychology, 32*(8), 865-870. doi: 10.1080/13803391003596413. Adapted with permission.

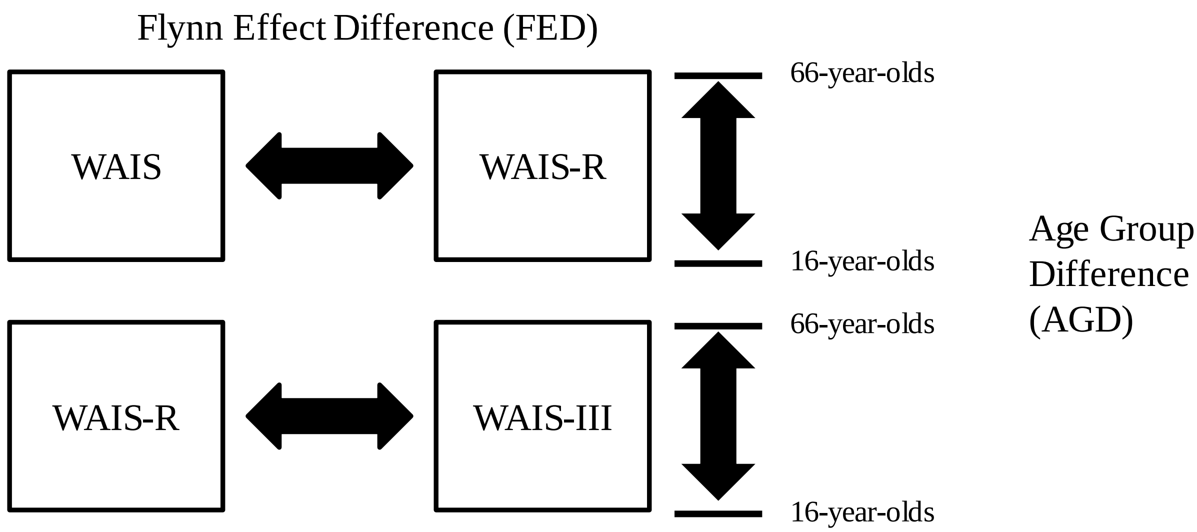

Figure 2. Example of calculations performed to obtain the AGD, FED, and TAE for the interval between the WAIS and WAIS-R

16yo Raw Score	**16yo Scaled Score**	**Uncorrected 66yo Scaled Score**	**Flynn Effect Correction (from validity sample)**	**Corrected 66yo Scaled Score**	**AGD**	**FED**	**TAE**
15	10	9	0.5	10.02	-1.0	-1.02	+.02

Uncorrected 66yo SS – 16yo SS

AGD - FED

Uncorrected 66yo SS + (Flynn Effect correction * [50/24.5])

Uncorrected 66yo SS - Corrected 66yo SS

Table 1. Calculations of the TAE between 16- and 66-year-olds for the WAIS-R subtests in scaled-score points per 50 years.

SUBTEST	**AGD**	**FED**	**TAE**
Verbal Scale			
Information	1	-2.2	3.2
Digit Span	-1	-1.2	0.2
Vocabulary	1	-3.7	4.7
Arithmetic	0	-2.0	2.0
Comprehension	1	-3.7	4.7
Similarities	0	-4.5	4.5
Performance Scale			
Picture Completion	-2	-3.7	1.7
Picture Arrangement	-3	-1.6	-1.4
Block Design	-3	-2.0	-1.0
Object Assembly	-3	-2.7	-0.4
Digit Symbol	-5	-3.7	-1.3
Verbal Mean	0.3	-2.9	3.2
Performance Mean	-3.2	-2.7	-0.5
Overall Mean	-1.3	-2.8	1.6

Table 2. Calculations of the TAE between 16- and 66-year-olds for the WAIS-III subtests in scaled-score points per 50 years.

SUBTEST	AGD	FED	TAE
Verbal Scale			
Information	1	-1.0	2.0
Digit Span	-2	-1.3	-0.7
Vocabulary	1	-2.7	3.7
Arithmetic	0	-0.1	0.1
Comprehension	1	-2.4	3.4
Similarities	-1	-3.6	2.6
Performance Scale			
Picture Completion	-2	-2.2	0.2
Picture Arrangement	-4	-2.7	-1.3
Block Design	-6	-3.0	-3.0
Object Assembly	-3	-3.6	-0.6
Digit Symbol	-5	-4.5	-0.5
Verbal Mean	0.0	-1.9	1.9
Performance Mean	-4.0	-3.2	-0.8
Overall Mean	-1.8	-2.5	0.7

Table 3. Calculations of the TAE between 16- and 74-year-olds for the WAIS-R subtests in scaled-score points per 58 years (in scaled-score points per 50 years in parentheses).

SUBTEST	AGD	FED	TAE
Verbal Scale			
Information	0 (0)	-2.6 (-2.2)	2.6 (2.2)
Digit Span	-1 (-0.9)	-1.4 (-1.2)	0.4 (0.4)
Vocabulary	1 (0.9)	-4.3 (-3.7)	5.3 (4.5)
Arithmetic	0 (0)	-2.4 (-2.0)	2.4 (2.0)
Comprehension	0 (0)	-4.3 (-3.7)	4.3 (3.7)
Similarities	-2 (-1.7)	-5.2 (-4.5)	3.2 (2.8)
Performance Scale			
Picture Completion	-4 (-3.4)	-4.3 (-3.7)	0.3 (0.2)
Picture Arrangement	-4 (-3.4)	-1.9 (-1.6)	-2.1 (-1.8)
Block Design	-4 (-3.4)	-2.4 (-2.0)	-1.6 (-1.4)
Object Assembly	-4 (-3.4)	-3.1 (-2.7)	-0.9 (-0.8)
Digit Symbol	-8 (-6.9)	-4.3 (-3.7)	-3.7 (-3.2)
Verbal Mean	-0.3 (-0.3)	-3.4 (-2.9)	3.0 (2.6)
Performance Mean	-4.8 (-4.1)	-3.2 (-2.7)	-1.6 (-1.4)
Overall Mean	-2.4 (-2.0)	-3.3 (-2.8)	0.9 (0.8)

Table 4. Calculations of the TAE between 16- and 74-year-olds for the WAIS-III subtests in scaled-score points per 58 years (in scaled-score points per 50 years in parentheses).

SUBTEST	**AGD**	**FED**	**TAE**
Verbal Scale			
Information	1 (0.9)	-1.1 (-1.0)	2.1 (1.8)
Digit Span	-2 (-1.7)	-1.5 (-1.3)	-0.5 (-0.5)
Vocabulary	1 (0.9)	-3.2 (-2.7)	4.2 (3.6)
Arithmetic	0 (0)	-0.1 (-0.1)	0.1 (0.1)
Comprehension	1 (0.9)	-2.8 (-2.4)	3.8 (3.3)
Similarities	-1 (-0.9)	-4.2 (-3.6)	3.2 (2.8)
Performance Scale			
Picture Completion	-3 (-2.6)	-2.5 (-2.1)	-0.5 (-0.4)
Picture Arrangement	-5 (-4.3)	-3.2 (-2.7)	-1.8 (-1.6)
Block Design	-4 (-3.4)	-3.5 (-3.0)	-0.5 (-0.4)
Object Assembly	-4 (-3.4)	-4.2 (-3.6)	0.2 (0.2)
Digit Symbol	-6 (-5.2)	-5.2 (-4.5)	-0.8 (-0.7)
Verbal Mean	0.0 (0)	-2.1 (-1.9)	2.1 (1.9)
Performance Mean	-4.4 (-3.8)	-3.7 (-3.2)	-0.7 (-0.6)
Overall Mean	-2.0 (-1.7)	-2.9 (-2.5)	0.9 (0.7)

Table 5. Calculations of the TAE between 30- and 50-year-olds for the WAIS-R subtests in scaled-score points per 20 years (in scaled-score points per 50 years in parentheses).

SUBTEST	AGD	FED	TAE
Verbal Scale			
Information	-1 (-2.5)	-0.9 (-2.3)	-0.1 (-0.2)
Digit Span	-1 (-2.5)	-0.5 (-1.2)	-0.5 (-1.3)
Vocabulary	-1 (-2.5)	-1.5 (-3.7)	0.5 (1.2)
Arithmetic	-1 (-2.5)	-0.8 (-2.1)	-0.2 (-0.5)
Comprehension	0 (0)	-1.5 (-3.7)	1.5 (3.7)
Similarities	-1 (-2.5)	-1.8 (-4.5)	0.8 (2.0)
Performance Scale			
Picture Completion	-1 (-2.5)	-1.5 (-3.7)	0.5 (1.2)
Picture Arrangement	-1 (-2.5)	-0.7 (-1.6)	-0.3 (-0.9)
Block Design	-1 (-2.5)	-0.8 (-2.1)	-0.2 (-0.5)
Object Assembly	-2 (-5)	-1.1 (-2.7)	-0.9 (-2.3)
Digit Symbol	-2 (-5)	-1.5 (-3.7)	-0.5 (-1.3)
Verbal Mean	-0.8 (-2.1)	-1.2 (-2.9)	0.3 (0.8)
Performance Mean	-1.4 (-3.5)	-1.1 (-2.7)	-0.3 (-0.8)
Overall Mean	-1.1 (-2.7)	-1.1 (-2.8)	0.0 (0)

Table 6. Calculations of the TAE between 30- and 50-year-olds for the WAIS-III subtests in scaled-score points per 20 years (in scaled-score points per 50 years in parentheses).

SUBTEST	AGD	FED	TAE
Verbal Scale			
Information	1 (2.5)	-0.4 (-1.0)	1.4 (3.5)
Digit Span	0 (0)	-0.5 (-1.3)	0.5 (1.3)
Vocabulary	1 (2.5)	-1.1 (-2.7)	2.1 (5.2)
Arithmetic	1 (2.5)	0.0 (0)	1.0 (2.5)
Comprehension	1 (2.5)	-1.0 (-2.5)	2.0 (4.9)
Similarities	0 (0)	-1.5 (-3.6)	1.5 (3.6)
Performance Scale			
Picture Completion	-1 (-2.5)	-0.9 (-2.2)	-0.1 (-0.3)
Picture Arrangement	-2 (-5.0)	-1.1 (-2.7)	-0.9 (-2.3)
Block Design	-1 (-2.5)	-1.2 (-3.0)	0.2 (0.5)
Object Assembly	-2 (-5.0)	-1.5 (-3.6)	-0.6 (-1.4)
Digit Symbol	-1 (-2.5)	-1.8 (-4.5)	0.8 (2.0)
Verbal Mean	0.7 (1.7)	-0.7 (-1.9)	1.4 (3.5)
Performance Mean	-1.4 (-3.5)	-1.3 (-3.2)	-0.1 (-0.3)
Overall Mean	-0.3 (-0.7)	-1.0 (-2.5)	0.7 (1.8)

Table 7. Calculations of the average TAE for the WAIS-R subtests in scaled-score points per 50 years.

SUBTEST	**AGD**	**FED**	**TAE**
Verbal Scale			
Information	-0.5	-2.2	1.7
Digit Span	-1.5	-1.2	-0.2
Vocabulary	-0.2	-3.7	3.5
Arithmetic	-0.8	-2.0	1.2
Comprehension	0.3	-3.7	4.0
Similarities	-1.4	-4.5	3.1
Performance Scale			
Picture Completion	-2.6	-3.7	1.0
Picture Arrangement	-3.0	-1.6	-1.4
Block Design	-3.0	-2.0	-1.0
Object Assembly	-3.8	-2.7	-1.2
Digit Symbol	-5.6	-3.7	-1.9
Verbal Mean	-0.7	-2.9	2.2
Performance Mean	-3.6	-2.7	-0.9
Overall Mean	-2.0	-2.8	0.8

Table 8. Calculations of the average TAE for the WAIS-III subtests in scaled-score points per 50 years.

SUBTEST	AGD	FED	TAE
Verbal Scale			
Information	1.5	-1.0	2.4
Digit Span	-1.2	-1.3	0.0
Vocabulary	1.5	-2.7	4.2
Arithmetic	0.8	0.0	0.9
Comprehension	1.5	-2.4	3.9
Similarities	-0.6	-3.6	3.0
Performance Scale			
Picture Completion	-2.4	-2.2	-0.2
Picture Arrangement	-4.4	-2.7	-1.7
Block Design	-4.0	-3.0	-1.0
Object Assembly	-3.8	-3.6	-0.6
Digit Symbol	-4.2	-4.5	0.3
Verbal Mean	0.6	-1.9	2.4
Performance Mean	-3.8	-3.2	-0.6
Overall Mean	-1.4	-2.5	1.1

Table 9. Calculations of the global average TAE across Wechsler tests in scaled-score points per 50 years.

SUBTEST	AGD	FED	TAE
Verbal Scale			
Information	0.5	-1.6	2.1
Digit Span	-1.4	-1.3	-0.1
Vocabulary	0.6	-3.2	3.8
Arithmetic	0.0	-1.1	1.0
Comprehension	0.9	-3.1	4.0
Similarities	-1.0	-4.1	3.1
Performance Scale			
Picture Completion	-2.5	-2.9	0.4
Picture Arrangement	-3.7	-2.2	-1.6
Block Design	-3.5	-2.5	-1.0
Object Assembly	-3.8	-3.2	-0.9
Digit Symbol	-4.9	-4.1	-0.8
Verbal Mean	-0.1	-2.4	2.3
Performance Mean	-3.7	-3.0	-0.7
Overall Mean	-1.7	-2.7	0.9

Table 10. Calculations of the AGD, FED, and TAE between 38- and 63-year-olds for the WAIS-R subtests in scaled-score points per 25 years (in scaled-score points per 50 years in parentheses).

SUBTEST	AGD	FED	TAE
Verbal Scale			
Information	-1 (-2)	-1.1 (-2.2)	0.1 (0.2)
Digit Span	-1 (-2)	-0.6 (-1.2)	-0.4 (-0.8)
Vocabulary	-1 (-2)	-1.8 (-3.6)	0.8 (1.6)
Arithmetic	-1 (-2)	-1.0 (-2.0)	0.0 (0.0)
Comprehension	-1 (-2)	-1.8 (-3.6)	0.8 (1.6)
Similarities	-1 (-2)	-2.2 (-4.4)	1.2 (2.4)
Performance Scale			
Picture Completion	-1 (-2)	-1.8 (-3.6)	1.8 (1.6)
Picture Arrangement	-2 (-4)	-0.8 (-1.6)	-6.2 (-2.4)
Block Design	-2 (-4)	-1.0 (-2.0)	-1.0 (-2.0)
Object Assembly	-2 (-4)	-1.3 (-2.6)	-0.7 (-1.4)
Digit Symbol	-2 (-4)	-1.8 (-3.6)	-0.2 (-0.4)
Verbal Mean	-1.0 (-2.0)	-1.4 (-2.8)	0.4 (0.8)
Performance Mean	-1.8 (-3.6)	-1.3 (-2.7)	-0.5 (-0.9)
Overall Mean	-1.4 (-2.7)	-1.4 (-2.8)	0.0 (0.0)

Table 11. Calculations of the AGD, FED, and TAE between 38- and 63-year-olds for the WAIS-III subtests in scaled-score points per 25 years (in scaled-score points per 50 years in parentheses).

SUBTEST	**AGD**	**FED**	**TAE**
Verbal Scale			
Information	0 (0)	-0.5 (-1.0)	0.5 (1.0)
Digit Span	-1 (-2)	-0.6 (-1.3)	-0.4 (-0.7)
Vocabulary	-1 (-2)	-1.4 (-2.7)	0.4 (0.7)
Arithmetic	0 (0)	0.0 (-0.1)	0.0 (0.1)
Comprehension	-1 (-2)	-1.2 (-2.4)	0.2 (4.4)
Similarities	-1 (-2)	-1.8 (-3.6)	0.8 (1.6)
Performance Scale			
Picture Completion	-2 (-4)	-1.1 (-2.1)	-0.9 (-1.9)
Picture Arrangement	-2 (-4)	-1.4 (-2.7)	-0.6 (-1.3)
Block Design	-2 (-4)	-1.5 (-3.0)	-0.5 (-1.0)
Object Assembly	-2 (-4)	-1.8 (-3.6)	-0.2 (-0.4)
Digit Symbol	-3 (-6)	-2.2 (-4.5)	-0.8 (-1.5)
Verbal Mean	-0.7 (-1.3)	-0.9 (-1.9)	0.3 (0.5)
Performance Mean	-2.2 (-4.4)	-1.6 (-3.2)	-0.6 (-1.2)
Overall Mean	-1.4 (-2.7)	-1.2 (-2.5)	-0.1 (-0.3)

Table 12. Calculations of the AGD, FED, and TAE between 63- and 80-year-olds for the WAIS-R subtests in scaled-score points per 17 years (in scaled-score points per 50 years in parentheses).

SUBTEST	**AGD**	**FED**	**TAE**
Verbal Scale			
Information	-1 (-2.9)	-0.7 (-2.2)	-0.3 (-0.7)
Digit Span	-1 (-2.9)	-0.4 (-1.2)	-0.6 (-1.7)
Vocabulary	-1 (-2.9)	-1.2 (-3.6)	0.2 (0.7)
Arithmetic	0 (0)	-0.7 (-2.0)	0.7 (2.0)
Comprehension	-1 (0)	-1.2 (-3.6)	0.2 (0.7)
Similarities	-2 (-5.9)	-1.5 (-4.4)	-0.5 (-1.5)
Performance Scale			
Picture Completion	-2 (-5.9)	-1.2 (-3.6)	-0.8 (-2.3)
Picture Arrangement	-2 (-5.9)	-0.5 (-1.6)	-1.5 (-4.3)
Block Design	-2 (-5.9)	-0.7 (-2.0)	-1.3 (-3.9)
Object Assembly	-1 (-2.9)	-0.9 (-2.6)	-0.1 (-0.3)
Digit Symbol	-3 (-8.8)	-1.2 (-3.6)	-1.8 (-5.2)
Verbal Mean	-1.0 (-2.9)	-1.0 (-2.8)	0.0 (-0.1)
Performance Mean	-2.0 (-5.8)	-0.9 (-2.7)	-1.1 (-3.2)
Overall Mean	-1.5 (-4.3)	-0.9 (-2.8)	-0.5 (-1.5)

Table 13. Calculations of the AGD, FED, and TAE between 63- and 80-year-olds for the WAIS-III subtests in scaled-score points per 17 years (in scaled-score points per 50 years in parentheses).

SUBTEST	**AGD**	**FED**	**TAE**
Verbal Scale			
Information	-2 (-5.9)	-0.3 (-1.0)	-1.7 (-4.9)
Digit Span	-1 (-2.9)	-0.4 (-1.3)	-0.6 (-1.7)
Vocabulary	-1 (-2.9)	-0.9 (-2.7)	-0.1 (-0.2)
Arithmetic	-3 (-8.8)	0.0 (-0.1)	-3.0 (-8.7)
Comprehension	-2 (-5.9)	-0.8 (-2.4)	-1.2 (-3.4)
Similarities	-2 (-5.9)	-1.2 (-3.6)	-0.8 (-2.3)
Performance Scale			
Picture Completion	-3 (-8.8)	-0.7 (-2.1)	-2.3 (-6.7)
Picture Arrangement	-4 (-11.8)	-0.9 (-2.7)	-3.1 (-9.0)
Block Design	-4 (-11.8)	-1.0 (-3.0)	-3.0 (-8.7)
Object Assembly	-4 (-11.8)	-1.2 (-3.6)	-2.8 (-8.1)
Digit Symbol	-4 (-11.8)	-1.5 (-4.5)	-2.5 (-7.3)
Verbal Mean	-1.8 (-5.4)	-0.6 (-1.9)	-1.2 (-3.5)
Performance Mean	-3.8 (-11.2)	-1.1 (-3.2)	-2.7 (-8.0)
Overall Mean	-2.7 (-8.0)	-0.8 (-2.5)	-1.9 (-5.6)

Table 14. Model 1 global average AGD, FED, and TAE across Wechsler tests and age groups in scaled-score points per 50 years.

SUBTEST	AGD	FED	TAE
Verbal Scale			
Information	-2.7	-1.6	-1.1
Digit Span	-2.5	-1.2	-1.2
Vocabulary	-2.5	-3.2	0.7
Arithmetic	-2.7	-1.0	-1.6
Comprehension	-3.2	-3.0	-0.2
Similarities	-3.9	-4.0	0.1
Performance Scale			
Picture Completion	-5.2	-2.9	-2.3
Picture Arrangement	-6.4	-2.2	-4.2
Block Design	-6.4	-2.5	-3.9
Object Assembly	-5.7	-3.1	-2.6
Digit Symbol	-7.6	-4.0	-3.6
Verbal Mean	-2.9	-2.3	-0.6
Performance Mean	-6.3	-2.9	-3.3
Overall Mean	-4.4	-2.6	-1.8

Table 15. Calculations of the AGD, FED, and TAE of the cohort at age 38 and 63 from the WAIS to WAIS-R in scaled-score points per 25 years (in scaled-score points per 50 years in parentheses).

SUBTEST	**AGD**	**FED**	**TAE**
Verbal Scale			
Information	-1.0 (-2)	-2.0 (-4)	1.0 (2)
Digit Span	-1.5 (-3)	-3.5 (-7)	2.0 (4)
Vocabulary	-0.5 (-1)	-0.5 (-1)	0.0 (0)
Arithmetic	-1.0 (-2)	-1.0 (-2)	0.0 (0)
Comprehension	0.0 (0)	-2.0 (-4)	2.0 (4)
Similarities	-1.0 (-2)	-2.0 (-4)	1.0 (2)
Performance Scale			
Picture Completion	-1.5 (-3)	-1.5 (-3)	0.0 (0)
Picture Arrangement	-3.0 (-6)	-2.0 (-4)	-1.0 (-2)
Block Design	-2.0 (-4)	0.0 (0)	-2.0 (-4)
Object Assembly	-2.0 (-4)	0.0 (0)	-2.0 (-4)
Digit Symbol	-2.5 (-5)	-1.5 (-3)	-1.0 (-2)
Verbal Mean	-0.8 (-1.7)	-1.8 (-3.7)	1.0 (2.0)
Performance Mean	-2.2 (-4.4)	-1.0 (-2.0)	-1.2 (-2.4)
Overall Mean	-1.5 (-2.9)	-1.5 (-2.9)	0.0 (0)

Table 16. Calculations of the AGD, FED, and TAE of the cohort at age 38 and 63 from the WAIS-R to WAIS-III in scaled-score points per 25 years (in scaled-score points per 50 years in parentheses).

SUBTEST	**AGD**	**FED**	**TAE**
Verbal Scale			
Information	-0.5 (-1)	1.0 (-2)	-1.5 (-3)
Digit Span	-0.5 (-1)	-2.0 (-4)	1.5 (3)
Vocabulary	-1.0 (-2)	-0.5 (-1)	-1.5 (-3)
Arithmetic	-0.5 (-1)	-2.0 (-4)	1.5 (3)
Comprehension	-1.0 (-2)	-0.5 (-1)	-0.5 (-1)
Similarities	-1.0 (-2)	-2.5 (-5)	1.5 (3)
Performance Scale			
Picture Completion	-1.0 (-2)	-4.5 (-9)	3.5 (7)
Picture Arrangement	-1.5 (-3)	-1.0 (-2)	-0.5 (-1)
Block Design	-1.5 (-3)	-3.0 (-6)	1.5 (3)
Object Assembly	-2.0 (-4)	-1.5 (-3)	-0.5 (-1)
Digit Symbol	-2.0 (-4)	-3.5 (-7)	1.5 (3)
Verbal Mean	-0.8(-1.5)	-0.9 (-1.8)	0.1 (0.3)
Performance Mean	-1.6 (-3.2)	-2.7 (-5.4)	1.1 (2.2)
Overall Mean	-1.1 (-2.3)	-1.7 (-3.4)	0.6 (1.1)

Table 17. Calculations of the AGD, FED, and TAE of the cohort at age 63 and 80 from the WAIS to WAIS-R in scaled-score points per 17 years (in scaled-score points per 50 years in parentheses).

SUBTEST	AGD	FED	TAE
Verbal Scale			
Information	-2.0 (-5.9)	-3.0 (-8.8)	1.0 (2.9)
Digit Span	-1.5 (-4.4)	-3.5 (-10.3)	2.0 (5.9)
Vocabulary	-1.0 (-2.9)	-1.0 (-2.9)	0.0 (0)
Arithmetic	-2.0 (-5.9)	-2.0 (-5.9)	0.0 (0)
Comprehension	-2.0 (-5.9)	-3.0 (-8.8)	1.0 (2.9)
Similarities	-1.5 (-4.4)	-2.5 (-7.4)	1.0 (2.9)
Performance Scale			
Picture Completion	-2.5 (-7.4)	-3.5 (-10.3)	1.0 (2.9)
Picture Arrangement	-2.5 (-7.4)	-0.5 (-1.5)	-2.0 (-5.9)
Block Design	-2.5 (-7.4)	0.5 (1.5)	-3.0 (-8.8)
Object Assembly	-1.5 (-4.4)	-0.5 (-1.5)	-1.0 (-2.9)
Digit Symbol	-4.0 (-11.8)	-3.0 (-8.8)	-1.0 (-2.9)
Verbal Mean	-1.7 (-4.9)	-2.5 (-7.4)	0.8 (2.5)
Performance Mean	-2.6 (-7.6)	-1.4 (-4.1)	-1.2 (-3.5)
Overall Mean	-2.1 (-6.1)	-2.0 (-5.9)	-0.1 (-0.3)

Table 18. Calculations of the AGD, FED, and TAE of the cohort at age 63 and 80 from the WAIS-R to WAIS-III in scaled-score points per 17 years (in scaled-score points per 50 years in parentheses).

SUBTEST	**AGD**	**FED**	**TAE**
Verbal Scale			
Information	-1.5 (-4.4)	1.2 (3.4)	-2.7 (7.8)
Digit Span	-1.0 (-2.9)	-1.3 (-3.9)	0.3 (1.0)
Vocabulary	-1.0 (-2.9)	0.7 (-2.0)	-1.7 (-4.9)
Arithmetic	-0.5 (-1.5)	-0.8 (-2.4)	0.3 (1.0)
Comprehension	-1.5 (-4.4)	0.2 (-0.5)	-1.7 (-4.9)
Similarities	-1.5 (-4.4)	-1.8 (-5.4)	0.3 (1.0)
Performance Scale			
Picture Completion	-2.0 (-5.9)	-3.3 (-9.8)	1.3 (3.9)
Picture Arrangement	-3.0 (-8.8)	-0.3 (-1.0)	-2.7 (-7.8)
Block Design	-2.0 (-5.9)	-3.3 (-9.8)	1.3 (3.9)
Object Assembly	-2.5 (-7.4)	1.2 (3.4)	-3.7 (-10.8)
Digit Symbol	-3.0 (-8.8)	-3.3 (-9.8)	0.3 (1.0)
Verbal Mean	-1.2 (-3.4)	-0.3 (-1.0)	-0.8 (-2.5)
Performance Mean	-2.5 (-7.4)	-1.8 (-5.4)	-0.7 (-2.0)
Overall Mean	-1.8 (-5.2)	-1.0 (-3.0)	-0.8 (-2.2)

Table 19. Model 2 global average AGD, FED, and TAE across Wechsler tests and age groups in scaled-score points per 50 years.

SUBTEST	AGD	FED	TAE
Verbal Scale			
Information	-3.3	-1.8	-1.5
Digit Span	-2.8	-6.3	3.5
Vocabulary	-2.2	-0.2	-2.0
Arithmetic	-2.6	-3.6	1.0
Comprehension	-3.0	-3.3	0.2
Similarities	-3.2	-5.4	2.2
Performance Scale			
Picture Completion	-4.6	-8.0	3.5
Picture Arrangement	-6.3	-2.1	-4.2
Block Design	-5.1	-3.6	-1.5
Object Assembly	-4.9	-0.2	-4.7
Digit Symbol	-7.4	-7.1	-0.3
Verbal Mean	-2.9	-3.4	0.6
Performance Mean	-5.6	-4.2	-1.4
Overall Mean	-4.1	-3.8	-0.3

Table 20. Model 3 calculations of the TAE in scaled-score points per 50 years.

SUBTEST	**WAIS to WAIS-R (38 and 63 years old)**	**WAIS-R to WAIS-III (63 and 80 years old)**	**GLOBAL AVERAGE**
Verbal Scale			
Information	2.0	-7.8	-2.9
Digit Span	4.0	1.0	2.5
Vocabulary	0.0	-4.9	-2.5
Arithmetic	0.0	1.0	0.5
Comprehension	4.0	-4.9	-0.5
Similarities	2.0	1.0	1.5
Performance Scale			
Picture Completion	0.0	3.9	2.0
Picture Arrangement	-2.0	-7.8	-4.9
Block Design	-4.0	3.9	0.0
Object Assembly	-4.0	-10.8	-7.4
Digit Symbol	-2.0	1.0	-0.5
Verbal Mean	2.0	-2.5	-0.2
Performance Mean	-2.4	-2.0	-2.2
Overall Mean	0.0	-2.2	-1.1

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