The Peak in Performance across Different Abilities across Age Groups on the Wechsler Abbreviated Scales of Intelligence – Second Edition

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This paper describes the pattern of median performance on the sub-tests of the *Wechsler Abbreviated Scales of Intelligence 2nd edition* across age groups 6-90 years from the test standardisation (N=2300). The median raw-score for: (a) block design peaks at age 25; (b) matrix reasoning sub-test rises steeply up to ages 20-25; (c) vocabulary peaks at age 30-55; and (d) similarities task peaks in the age groups 30-45. When compared to performance at age 25, the major finding is that the decline at age 85 is highest for the block design (0.46 of age 25) then the matrix reasoning (0.52 of age 25) followed by similarities (0.78 of age 25) and finally, vocabulary (0.89 of age 25). There is continuing evidence for the differential decline in abilities. It applies particularly in the area of fluid intelligence and is consistent with previous findings in psychological assessment of cognitive abilities.

Keywords: intelligence, age, crystallised intelligence, fluid intelligence, intelligence tests

The purpose of this report is to confirm the peak in performance on different abilities on the *Wechsler Abbreviated Scale of Intelligence-Second Edition* (WASI-II; Wechsler, 2011). The importance of age-related changes in intellectual abilities is that they have implications for recommendations concerning intellectual development in educational, vocational or rehabilitation settings that deal with learning potential, expertise, creativity or geropsychology (Gow, 2016; Harada, Natelson Love, & Triebel, 2013; Jauk, Benedek, Dunst, & Neubauer, 2013; Masunaga & Horn, 2001; Schaie, 1994).

Typically, performance on intelligence tests increases up to early adulthood and then declines in the older age groups. It varies slightly across the types of cognitive abilities being assessed and, in most instances, psychologists will make adjustments for maturation by the use of age-norms. Such cross-sectional declines in intellectual performances have been reported for almost 90 years (Salthouse, 2009). Salthouse (2010) commented:

> On one hand, there is increase, at least until people are in their 60s, for measures representing products of processing carried out in the past, such as vocabulary or general information in which the relevant acquisition occurred earlier in one's life. On the other hand, there is nearly linear decline from early adulthood on measures representing efficiency or effectiveness of processing carried out at the time of assessment, usually involving manipulations or transformations of abstract or familiar material. (p. 2)

The *WASI-II* is ideal for examining performance across a wide age range as it is intended for use with children and adults (age range 6-90 years). It reports results for a general ability factor as well as secondary verbal factor (Verbal Comprehension) analogous to crystallised intelligence and a performance factor (Perceptual Reasoning), analogous to fluid intelligence.

The fluid non-verbal cognitive abilities involve the "capacity to perceive relations and educe correlates… they involve concept formation and attainment, reasoning and abstracting" (Horn & Cattell, 1967, p. 109). As noted, fluid intelligence such as perceptual or performance reasoning may decline across the life-span (Hartshorne & Germine, 2015; Salthouse, 2004, 2010).

On the other hand, the crystallised abilities reflect "the extent to which one has appropriated the collective intelligence of his culture for his own use"(sic) (Horn & Cattell, 1967, p. 111). It includes skills such as vocabulary or verbal reasoning that tend to increase over much of the life-span of most people. For instance, Horn and Cattell (1967) had examined age differences in 297 persons in five age groups (14-17, 18-20, 21-28, 29-39, 40-61). They were concerned primarily with demonstrating the utility of the theory of fluid and crystallised intelligence. The participants were prisoners, school students and employment service clients and predominantly males (72%). Higher levels of fluid intelligence were confirmed in younger groups whereas crystallised intelligence was higher for the older adults.

Using the normative data from the Wechsler Adult intelligence Scale-III (Wechsler, 1997a) and the Wechsler Memory Scale-III Wechsler, 1997b), Hartshorne and Germine (2015) reported: "We observed the previously reported pattern of earlier peaks for fluid intelligence than for crystallised intelligence…" (p. 434). Vocabulary peaked at around age 50, Similarities at around age 40 whereas Block Design peaked in the mid-20s (see their Figure 1, p. 436). This implies that cognitive ability is heterogeneous.

The traditional distinction between verbal and non-verbal reasoning was maintained in this paper. Fluid reasoning was represented by the Block Design and Matrix Reasoning sub-tests. Crystallised reasoning was represented by the Vocabulary and Similarities sub-tests. At the outset it was expected that in a cross-sectional age comparison, the non-verbal or fluid reasoning abilities would be affected by age more than the verbal or crystallised abilities.

Method

Participants

The results for this paper were derived from the standardisation group for the *WASI-II*. The standardisation comprised a representative sample of 2,300 (based on sex, age, ethnicity, education and region in the US). Results are reported for 45 separate age groups.

Instruments

By way of background, (a) the block design subtest focuses on the ability to analyse and organise 13 visual stimuli; (b) matrix reasoning involves visual intelligence, spatial ability, knowledge of relationships, unravelling simultaneous processes and organising perceptions when solving 30 incomplete matrices; (c) vocabulary comprises three picture items and 28 verbal items that focus on word knowledge and concepts; and (d) similarities involves three picture items and 16 verbal pairs that require finding an analogy between items ranging from concrete to abstract relationships or categories.

Split-half reliability estimates cited for the *WASI-II* subtests ranged from .87 to .92 and around .96-.97 for the full-scale IQ across both child and adult samples. The corrected test re-test stability coefficients for 12 to 88 days for the sub-tests were .79 to .90 for a child sample (N=103) and .83 to .94 for an adult sample (N=112) (Wechsler, 2011, pp. 116-117).

Procedure

The median score for each age group in the user's manual for the *WASI-II* was determined at each age point. It was then possible to determine how the raw score changed across age groups. Separately, age 25 was chosen as a benchmark for comparisons across the four cognitive abilities. It was selected as the basis for comparison as this was the first point at which abilities started to peak or plateau across most of the sub-tests.

Results

Fluid reasoning increases up to early adulthood but declines markedly thereafter. This is seen in the results from both the block design and matrix reasoning sub-tests.

Block Design. The median raw-score for block design increases monotonically from age 6 (raw score = 9) and peaks at age 25 years (raw score = 45). It declines consistently thereafter to a median raw score of 21 at age 85. This is illustrated graphically in Figure 1.

Matrix Reasoning. The median raw scores on the matrix reasoning sub-test follow a similar pattern, rising steeply from age 6 up to ages 20-25 then decline to a median score of 11 at age 85.

Crystallised intelligence also declines over time but (a) the peak comes much later in the age span than for fluid reasoning; and (b) the rate of decline is much lower and slower.

Vocabulary. The median raw-score for vocabulary increases monotonically from age 6 (raw score = 15) and peaks at age 30-55 years (raw score = 39) and declines consistently thereafter to a raw score = 34 at age 85. This is illustrated graphically in Figure 3.

Similarities. The decline is comparable for the similarities task. It involves a different aspect of reasoning from vocabulary but still peaks in the age groups 30-45 (raw score= 33) and declines to a raw score of 30 at age 65 and a raw score of 25 at age 85.

Peak Performance

The decline in ability from age 25 to ages 65, 75 or 85 is summarised in Table 1. In Table 1, for instance, in the first column the median score at age 65 on block design is .667 or around two-thirds of that at age 25; by age 75 it is almost one half (.556); and by age 85 the median score is less than half that of 25-year-olds. The remaining columns are read in a similar fashion. The decline is highest for the block design then the matrix reasoning tasks followed by similarities and finally vocabulary.

Discussion and Conclusions

Learned skills (e.g., vocabulary) held up fairly well across the lifespan compared with the more novel tasks in block design and matrix reasoning. The median raw-scores for block design and matrix reasoning increase monotonically from age 6 and peaks at around 25 years whereas the median raw-scores for vocabulary and similarities peak at age 30-55 years.

The results of this comparison have implications for the use of intelligence test findings. Although there is an inherent general factor of ability across the four sub-tests, there is no particular age group which is best on all four tests. Accordingly, it is not at all clear that the results from the four sub-tests can be confined into one

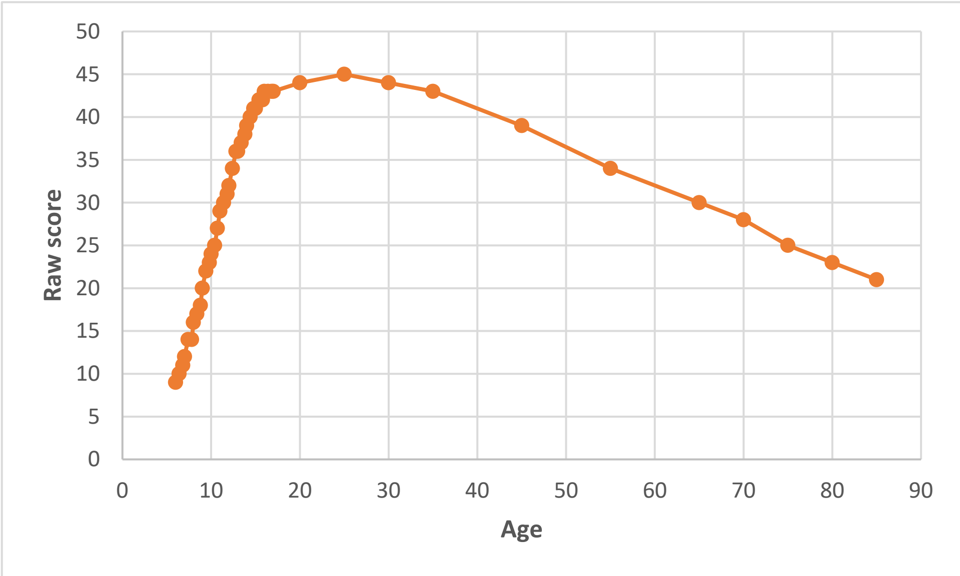

Figure 1

Median Block Design Scores on the WASI-II Across the 45 Age Groups.

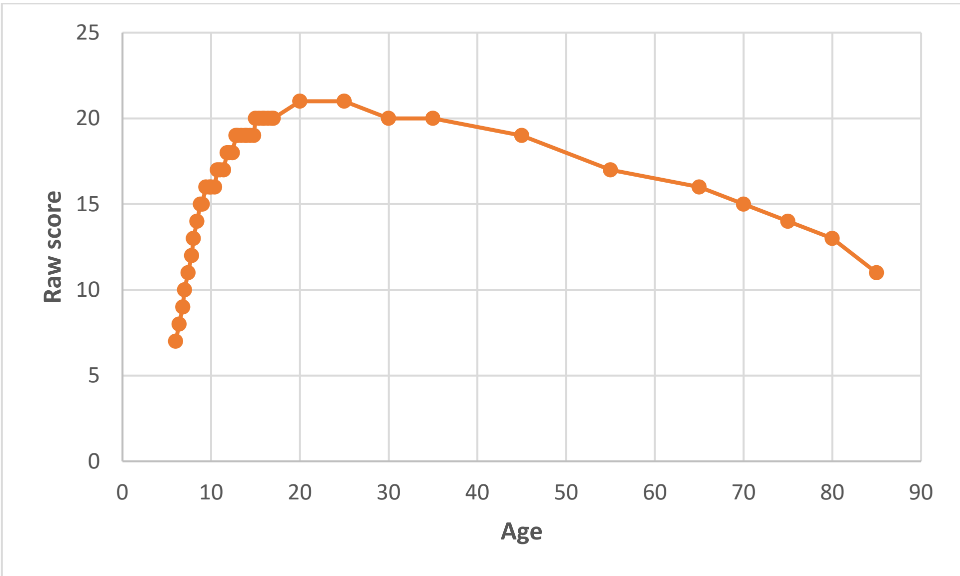

Figure 2

Median Matrix Reasoning Scores on the WASI-II Across the 45 Age Groups.

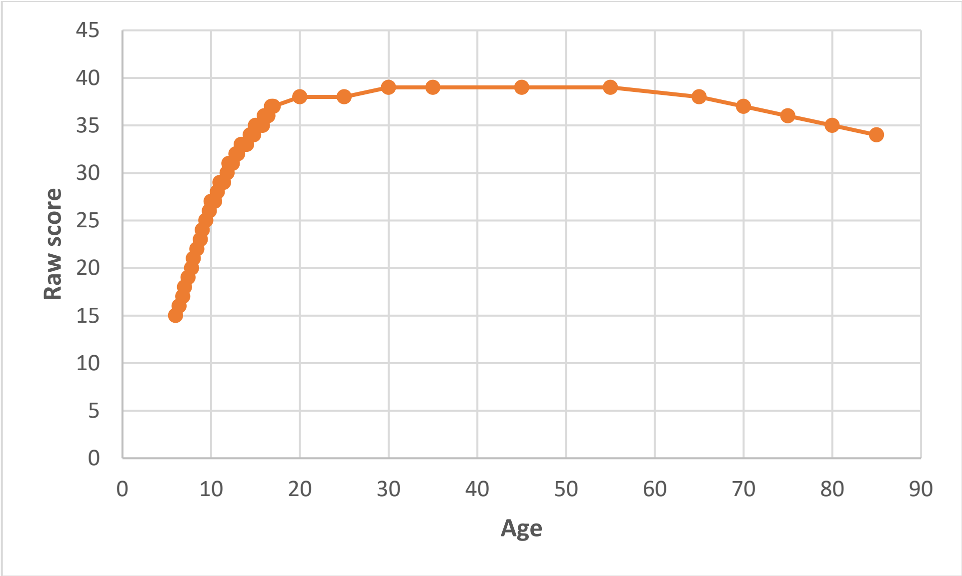

Figure 3

Median Vocabulary Scores on the WASI-II Across the 45 Age Groups.

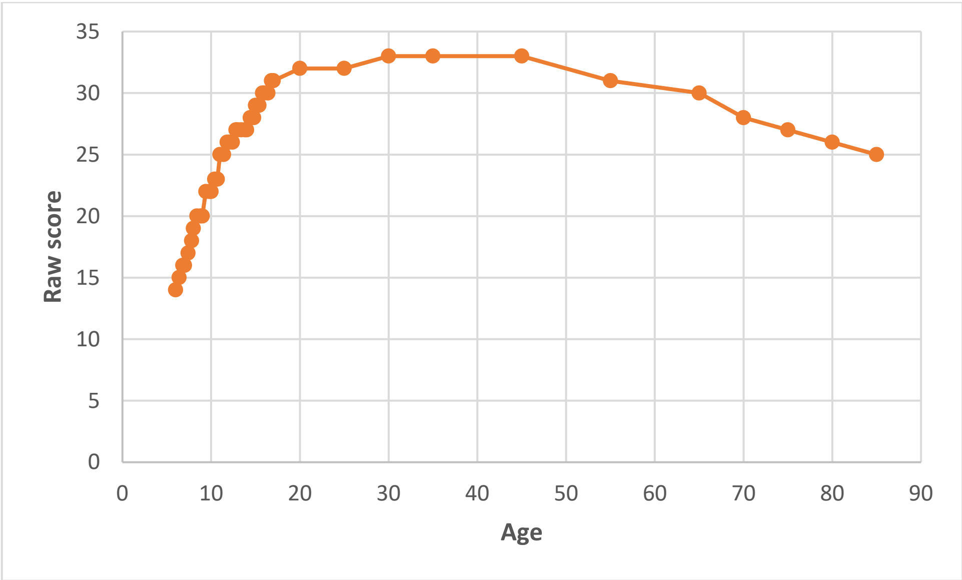

Figure 4

Median Similarities Scores on the WASI-II Across the 45 Age Groups.

Table 1.

Proportional Declines in Scores Form Age 25 to Ages 65, 75 and 85

	Block design	Matrix reasoning	Similarities	Vocabulary
Age 25 to 65	0.667	0.762	0.938	1.000
Age 25 to 75	0.556	0.667	0.844	0.947
Age 25 to 85	0.467	0.524	0.781	0.895

meaningful measure of intelligence for all age groups. As a normed measure it may still be helpful in providing information about the test taker for his/her age.

The pattern of results across the age groups shows that the fluid and crystallised abilities follow quite different trajectories. Even if converted to norm-referenced values it is doubtful that performance relative to the mean on one ability should be added to performance relative to the mean on another ability. The fact that this additive approach to measurement (Michell, 2005) has worked in a practical sense is a testament to the validity of intelligence as a key psychological construct.

One limitation of this report is that cross-sectional data may be influenced by social and cultural developments in the population. Secondly, the data is from those surviving to a particular age and it makes the validity of cross-age comparisons fraught with difficulties. As a third limitation, Crimmon and Smith (2013, p. 341) noted there is no "…evaluation of working memory or processing speed, two important aspects of cognitive functioning known to contribute to overall intelligence." A third limitation is the assumption that the median score is somehow a reasonably representative indicator of an age group. Nevertheless, there is some evidence for the differential decline in abilities using data from the standardisation sample of the *WASI-II*. This applies particularly in the area of fluid intelligence and is consistent with previous findings in psychological assessment of cognitive abilities.

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