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Normal aging increases cognitive heterogeneity: Analysis of dispersion in WAIS-III scores across age

Alfredo Ardila *

Department of Communication Sciences and Disorders, Florida International University, HLS139, Miami, FL 33199, USA

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Abstract

Individual differences in cognitive decline during normal aging need further delineation. The purpose of this study was to find the score dispersions in the WAIS-III subtests at different ages. Norms presented in the Administration and Scoring Manual [Wechsler, D. (1997). *WAIS-III: Administration and scoring manual*. San Antonio: The Psychological Corporation] were used. The WAIS-III was standardized and normalized using 2450 American adults divided into 13 age ranges and 4 education groups. Means and standard deviations for the different WAIS-III subtests were deduced and the ratio *Percentage of the mean* = "(standard deviation/mean) × 100" was calculated. It was hypothesized that during normal aging, whereas mean scores decrease, score dispersions increase, pointing to an increased heterogeneity in intellectual abilities in older individuals. In all subtests, except Digit Span, it was found that score dispersions indeed increased during aging. However, in some subtests, increase in dispersion was less than 20% (Block Design, Object Assembly, and Information), whereas in others, increase in dispersion was over 200% (Matrix Reasoning, L-N Sequencing, Digit-Symbol, Picture Completion, and Picture Arrangement). It was proposed that cognitive heterogeneity during normal aging is related to those abilities measured with these latter subtests, basically, executive functions, attention, and selected non-verbal abilities. In other abilities (e.g., visuoconstructive abilities and fund of general information), normal aging is associated with a more homogenous pattern of decline.

Keywords: Aging; WAIS-III; Cognitive changes

Diverse social, physical, psychological, and cognitive changes develop with aging. Cognitive changes include attention, memory, language, visuospatial and visuomotor abilities, perception, and executive functions (Albert & Knoefel, 1994; Ardila, 2003; Cummings & Benson, 1992; Mendez & Cummings, 2003; Rosselli & Ardila, 2001). Usually, memory is considered to be the cognitive domain most sensitive to the aging effect (Albert, 1997, 2002). Age-related cognitive changes, however, are not homogenous; variations in the magnitude and rate depend on the specific cognitive function (Albert, 1994). Neuropsychological test performance tends to present a negative correlation with age, but some subjects can maintain appropriate cognitive functioning even during the eighth decade of life (Cerella, 1990; von Faber et al., 2001).

Consequently, age is a significant variable influencing intelligence measures (Albert & Heaton, 1988; Wechsler, 1997). Some of the intelligence subtest scores (e.g., WAIS subtests), however, are influenced by age, while others

* Tel.: +1 305 348 2750.
E-mail address: ardilaa@fiu.edu.

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remain relatively independent from this variable. The classical age-intelligence pattern describes non-verbal IQ as strongly influenced by age as compared to verbal IQ. Verbal subtests have been considered to measure "crystallized intelligence" (Cattell, 1963; Ryan, Sattler, & Lopez, 2000), a type of intelligence that is maintained with little variance over a lifetime (Mackay, Connor, Albert, & Obler, 2002). Through this type of intelligence the subject expresses previous verbal learning and general fund of knowledge (Horn, 1985; Horn & Cattell, 1966).

Non-verbal (or performance) subtests are part of "fluid intelligence" that allows the use of current information in the solution of new problems (Cattell, 1963). This type of intelligence requires visuomotor and/or spatial skills and is very sensitive to aging: younger subjects outperform older ones in those tasks or problems that require the use of fluid intelligence (Ardila & Rosselli, 1989; Ryan et al., 2000). Older subjects perform well on tasks that use previous knowledge in the solution of the problem, but may have serious difficulties in tasks that require unfamiliar solutions.

A fundamental factor impacting scores on non-verbal tests is speed. When time limits are used, older people are at disadvantage (Albert, 1994; La Rue, 1992). Age is usually associated with motor slowness, decreased speed in perceptual information processing, and an increase in reaction times. Other factors such as flexibility of thinking and meaningfulness of the test may influence test performance as well (Albert, Wolfe, & Lafleche, 1990). It is assumed that flexibility of thinking decreases only after the seventies (Willis, Geo, Thomas, & Garry, 1988). Wecker, Kramer, Hallam, & Delis (2005) administered to 719 individuals, 20–89-year old, three different tasks that required verbal and non-verbal cognitive switching. It was found that mental flexibility is affected by age independently from age-related changes in component skills.

The most common test of intelligence in adults is the Wechsler Adult Intelligence Scale (WAIS) (Wechsler, 1944, 1977). Two additional versions have been developed: WAIS-R (Wechsler, 1981) and WAIS III (Wechsler, 1997). WAIS scales are sensitive to the aging effect. For instance, to obtain an IQ of 100 (average) at age 74 requires answering correctly half of the questions needed to obtain the same IQ at age 20. Due to this age effect, the WAIS scales adjust scores according to the subjects' age. The latest WAIS version (WAIS-III) includes some new subtests directed to overcome some of the limitations found in the previous Wechsler intelligence scale versions: Instead of 11 subtests, there are 14 (seven verbal subtests and seven performance subtests) subtests. In the Verbal Scale, the Letter-Number Sequencing subtest is added. In the Performance Scale, Matrix Reasoning and Symbol Search areas are added. Besides, the Digit-Symbol subtest is used under different conditions: Digit-Symbol—Coding (as previously used), Digit-Symbol—Incidental Learning (paring—to recall the symbols matched with the numbers; and free recall—to recall the symbols used in the coding section), and Digit-Symbol—Copy (to copy the symbols that were used in the Digit-Symbol—Coding).

Regardless, there are a significant amount of publications analyzing different aspects of the WAIS-III (currently there are over 100 published papers); seemingly only one paper has approached the question of WAIS-III scores and aging. Ryan et al. (2000) investigated the effect of age on the Wechsler Adult Intelligence Scale-III using the normative scores. They found that there were few differences in the verbal abilities of the younger and older age groups. The Information subtest showed the most stability across the age ranges. Performance subtests presented significant changes across age ranges. They concluded that, with advancing age, performance on subtests measuring speed of information processing and perceptual organization change substantially, whereas verbal subtests show minimal or no change. They interpreted these results as supporting the view that measures of fluid intelligence show more of a decline with advancing age than do measures of crystallized intelligence. No analysis of score dispersions across age ranges, however, is presented.

In summary, it is well known that cognitive decline occurs with age. However, individual differences in cognitive decline are not so clear. An obvious way to find individual differences during normal aging is to analyze the dispersion in test scores occurring at different ages.

The purpose of this study was to find the score dispersions in different WAIS-III subtests at different ages. It was hypothesized that, whereas mean scores decrease, dispersions increase, pointing to an increased heterogeneity intellectual ability during normal aging. Dispersion was understood not simply as the standard deviations of the test scores, but as the relationship between the standard deviations and the means of the different test scores.

1. Procedure

Norms presented in the Administration and Scoring Manual (Wechsler, 1997) were used. The WAIS-III standardization data were not available, and only the information contained in the WAIS-III Administration and Scoring Manual was used in the analyses presented in this paper. Means and standard deviations for the different WAIS-III subtests were deduced using the following procedure:

(1) In each subtest, the raw score corresponding to the scaled score 10 was considered as the mean. When the scaled score 10 corresponded to a score range (e.g., 34–38) the mean for the range was used (e.g., 36).
(2) For calculating the standard deviations, scaled scores equal to 7 and 13 were selected (i.e., minus one and plus one standard deviation). The mean raw score minus the raw score corresponding to a scaled score 7; and the raw score corresponding to a scaled score 13 minus the mean raw score were added and divided by two; the resulting value was considered as the standard deviation for that particular subtest. When the scaled scores 7 and 13 corresponded to a range (e.g., 22–25) the mean value was considered as the scaled score (e.g., 23.5).
(3) Finally, the ratio *Percentage of the mean* = "(standard deviation/mean) × 100" (that is, the percentage of the mean represented by the standard deviation) was calculated. This "percentage of the mean" ratio informs about the heterogeneity (dispersion) of the scores. As a matter of fact, the standard deviation is not informative by itself; it only has meaning with regard to the mean. A standard deviation of 3 can be very low if the mean is 50, but very high if the mean is 5. At the best of my knowledge, the ratio *Percentage of the mean* is not frequently used.

The WAIS-III was standardized and normalized using 2450 American adults divided into 13 age ranges (16–17, 18–19, 20–24, 25–29, 30–34, 35–44, 45–54, 55–64, 65–69, 70–74, 75–79, 80–84, and 85–89), and taken from four different geographical areas (Northeast, North Central, South and West). About 79% (1925 participants) of the sample is referred to as "Whites", about 11.4% (279 participants) is referred to as "African-Americans", about 7.4% (181 participants) is referred to as "Hispanics", and about 2.6% (65 participants) is referred to as "Others". Four education groups are distinguished (<8, 9–11, 12, 13–15 and >16). About 11.5% of the sample had an education less or equal to 8 years, and about two thirds of the subjects had 12 or more years of education. Education at the different age ranges is not mentioned (for a detailed description of the sample and sample selection, see Wechsler, 1997).

2. General results

Table 1 presents the general results of the verbal subtests. Because the WAIS-III standardization data were not available only descriptive statistics (mean scores, standard deviations, and the ratio *Percentage of the mean*) were used.

2.1. Vocabulary

Middle age ranges show higher dispersion. Higher scores (about 30% higher) are observed during the 45–54 years range. Scores in the first and last age ranges are similar. Dispersions are variable across-ages.

2.2. Similarities

Similarities subtest scores tend initially to mildly increase. Highest scores are found in the 30–54 range. Later, a slow decrease in scores is observed. Lowest mean score in the age range of 85–89 is about 30% lower than at the 30–54 range. The ratio *Percentage of the mean* increases about 50%. This means, some increased heterogeneity in scores is evident.

2.3. Arithmetic

Scores increase up to the 45–54 years. Further slow decrease is observed. Standard deviations remain relatively unchanged.

2.4. Digits

Raw scores present a slow but continued decrease observed beginning in the early 30s. Dispersions remain quite stable.

Table 1
Calculated raw scores in the different verbal WAIS-III subtests

	16–17	18–19	20–24	25–29	30–34	35–44	45–54	55–64	65–69	70–74	75–79	80–84	85–89
Vocabulary													
Mean	33.5	36.0	36.0	40.0	42.5	44.4	46.5	41.0	41.0	41.0	40.5	35.5	35.0
S.D.	11.7	12.7	12.7	12.2	12.5	13.0	13.0	13.8	13.8	13.5	12.5	13.5	13.0
% of the mean	34.9	35.2	35.2	30.5	29.4	29.3	27.9	33.6	33.6	32.9	30.9	38.0	37.1
Similarities													
Mean	22.0	22.5	22.5	22.5	23.5	23.5	23.5	21.0	20.0	20.0	19.5	17.5	16.5
S.D.	5.5	5.5	5.5	5.7	5.7	5.7	6.5	6.7	6.5	6.0	6.0	6.2	6.0
% of the mean	25.0	24.4	24.4	25.3	24.2	24.2	27.6	31.9	32.5	30.0	30.7	35.4	36.3
Arithmetic													
Mean	12.0	12.0	12.5	12.5	13.0	13.5	14.5	13.5	12.5	12.5	12.0	11.0	10.0
S.D.	3.5	3.5	4.0	4.5	4.0	4.0	4.0	4.0	4.0	4.0	3.7	3.0	3.0
% of the mean	29.2	29.2	32.0	36.0	30.7	33.7	27.5	33.7	31.2	31.2	32.4	27.2	33.3
Digits													
Mean	17.5	17.5	17.5	17.5	17.0	17.0	17.0	16.0	16.0	15.0	15.0	14.5	14.0
S.D.	4.2	4.2	4.5	4.5	4.2	4.2	4.2	4.5	4.2	3.2	4.0	3.7	3.2
% of the mean	24.0	24.0	25.7	25.7	24.7	24.7	24.7	28.1	26.2	21.3	26.6	25.5	22.8
Information													
Mean	14.5	14.5	14.5	14.5	15.5	16.5	17.5	16.5	16.5	16.5	15.5	13.5	13.5
S.D.	5.5	5.7	5.7	5.7	6.0	5.7	5.7	6.0	6.0	5.7	6.0	5.5	5.5
% of the mean	37.9	29.3	29.3	29.3	38.7	34.5	32.5	36.3	36.3	34.5	38.7	40.7	40.7
Comprehension													
Mean	17.5	18.5	18.5	19.5	20.5	21.5	22.5	20.5	20.5	20.5	19.5	17.5	16.5
S.D.	5.7	5.7	6.0	5.7	6.0	5.5	5.7	6.0	6.0	5.7	5.7	6.0	5.7
% of the mean	32.5	30.8	32.4	29.3	29.2	25.8	25.3	29.2	29.2	27.8	29.2	34.2	34.5
L-N Sequencing													
Mean	11.0	11.0	11.0	11.0	11.0	11.0	10.0	9.0	9.0	8.0	8.0	7.0	6.0
S.D.	2.5	3.0	3.0	2.7	2.5	2.5	3.0	2.5	2.7	2.5	2.5	3.0	3.0
% of the mean	22.7	27.2	27.2	24.5	22.7	22.7	30.0	27.7	30.0	31.2	31.2	42.8	50.0

Means and standard deviations (in parenthesis) as well as the "percentage of the mean" ratios are presented.

2.5. *Information*

As in the Vocabulary subtest, an inverted U-shaped curve between the 16–17 and 85–89 years is shown for the Information subtest. Higher scores (about 20% higher) are observed during the 45–54 years range. Scores in the first and last age ranges are similar. Standard deviations are relatively high.

2.6. *Comprehension*

Comprehension is another subtest presenting an inverted U-shaped curve between the 16–17 and 85–89 years. Higher scores (about 20% higher) are observed during the 45–54 years range. Scores in the first and last age ranges are similar. Dispersions are stable.

2.7. *L-N Sequencing*

Mean scores remained stable up to the 35–44 age range. Further, continuous decline is observed. Scores at the oldest age range are about 40% of the scores at 33–44 range. Dispersions steadily increase from the 55–64 up to the oldest range.

Table 2 presents the general results of the performance subtests.

Table 2
Calculated raw scores in the different performance WAIS-III subtests

	16–17	18–19	20–24	25–29	30–34	35–44	45–54	55–64	65–69	70–74	75–79	80–84	85–89
Picture Completion													
Mean	20.5	20.5	20.5	20.5	20.5	20.5	20.0	19.5	17.5	16.5	16.5	15.5	14.5
S.D.	3.0	3.0	3.0	3.0	2.7	2.7	3.0	4.2	5.2	4.7	4.2	4.7	4.7
% of the mean	14.6	14.6	14.6	14.6	13.1	13.1	15.0	21.5	29.7	28.4	25.4	30.0	32.4
Digit-Symbol													
Mean	77.0	81.0	80.0	78.0	77.0	75.0	70.0	61.0	54.0	51.0	47.0	42.0	35.0
S.D.	15.7	16.0	16.2	15.5	16.0	16.5	15.2	15.0	15.0	14.7	14.5	15.0	14.2
% of the mean	20.3	19.7	20.2	19.8	20.7	22.0	21.7	26.0	27.7	34.6	30.8	35.7	40.5
Block Design													
Mean	41.5	41.5	41.5	41.5	41.0	40.5	36.5	33.5	29.5	28.5	26.5	25.0	24.0
S.D.	13.5	13.5	13.5	13.5	13.2	13.0	12.0	12.0	11.7	10.0	9.0	8.0	8.0
% of the mean	32.5	32.5	32.5	32.5	32.1	32.1	33.8	35.8	39.6	35.0	33.9	32.0	33.3
Matrix Reasoning													
Mean	17.5	16.5	16.5	16.5	16.5	15.5	13.5	12.5	10.5	9.0	9.0	7.5	7.0
S.D.	4.0	4.7	4.7	4.7	5.0	5.2	5.5	6.0	4.5	4.5	4.0	3.7	3.2
% of the mean	22.8	28.4	28.4	28.4	30.3	33.5	40.7	48.5	42.8	50.0	44.4	49.3	45.7
Picture Arrangement													
Mean	15.5	15.5	15.5	15.5	15.5	14.5	13.5	12.5	10.5	8.5	8.0	6.5	4.5
S.D.	4.2	4.2	4.2	4.5	4.2	4.7	5.0	4.7	5.7	5.0	4.2	4.5	3.7
% of the mean	27.0	27.0	27.0	29.0	27.0	32.4	37.0	37.6	54.2	58.8	52.5	69.2	82.2
Symbol Search													
Mean	34.0	35.5	34.5	34.5	33.0	32.5	29.0	26.0	22.5	22.0	19.5	16.0	15.0
S.D.	9.7	9.5	9.2	9.2	9.0	8.5	7.5	8.0	8.7	7.5	6.0	7.0	7.0
% of the mean	28.5	26.7	26.6	26.6	27.2	26.1	25.8	30.7	38.6	34.1	30.7	43.7	46.6
Object Assembly													
Mean	34.5	35.0	35.0	35.0	35.0	33.5	29.0	27.5	23.5	22.5	21.5	18.5	18.5
S.D.	10.0	10.2	10.2	10.2	10.2	11.5	7.5	10.0	9.5	8.0	7.7	6.5	6.2
% of the mean	28.9	29.1	29.1	29.1	29.1	34.3	25.8	36.3	28.3	35.5	35.8	35.1	33.5

Means and standard deviations (in parenthesis) as well as the “percentage of the mean” ratios are presented.

2.8. Picture Completion

Highest scores are found in the 16–34 age range. At 85–89 age range, scores are about 70% of these highest scores. Dispersions virtually duplicates between the youngest and oldest groups (14.6 and 32.4).

2.9. Digit-Symbol

Scores at the oldest range are less than half of the scores found in younger. Dispersion duplicates.

2.10. Block Design

Scores at the oldest age range are about 60% of the scores at the youngest age range. Dispersion in scores, however, remains virtually identical.

2.11. Matrix Reasoning

Scores at the oldest age range are about 40% of the scores at the youngest age range. Dispersion is about twice in the oldest than in the youngest participants.

2.12. *Picture Arrangement*

Scores at the oldest age range are about 29% of the scores at the youngest age range. Dispersion is about three times in the oldest than in the youngest participants.

2.13. *Symbol-Search*

Scores at the highest age range are about 45% of the scores at the lowest age range. Dispersion is about one and half times higher in the oldest than in the youngest participants.

2.14. *Object Assembly*

Scores at the oldest age range are about 50% of the scores at the youngest age range. Dispersion presents just a mild increase when becoming older.

3. Age-dependent changes in cognition

Two groups were selected to analyze the age-dependent changes in WAIS-III subtest scores: (1) the age group in which the highest scores were found; and (2) the age group where the lowest scores were found. Lowest scores for all the subtests were found in the oldest group (Table 3). Highest scores, however, were observed at different ages. In general, for verbal abilities highest scores were observed during the 40s and 50s, whereas for non-verbal abilities highest scores were found in the 16–34 years range. Dispersion increased in most subtests, but important differences in the magnitude of this increase were noted. The sequence of decline and the sequence of heterogeneity were analyzed.

3.1. *Sequence of decline*

In some subtests, scores were apparently associated with age. In others, the association with age was mild. Consequently, a hierarchy of age-related cognitive decline can be proposed (Table 4). The scores in Digits, Information, Vocabulary, Picture Completion, and Similarities subtests decreased less than 30% during aging (highest and lowest scores), whereas in Symbol Search, Digit-Symbol, Matrix Reasoning, and Picture Arrangement, decreases were over

Table 3
Variations in the means and dispersions (percentage of the mean)

Subtest	First Group (G1) at the age of the highest score			Second Group (G2) at 85–89 years		Comparing G1 and G2	
	Age	Mean	% of the mean	Mean	% of the mean	Variation in the mean	Variation in the % of the mean
Vocabulary	45–54	46.5	27.9	35.0	37.1	75%	133%
Similarities	30–54	23.5	24.2–27.6	16.5	36.3	70%	140%
Arithmetic	45–54	14.5	27.5	10.0	33.3	69%	121%
Digits	16–29	17.5	24.0–25.7	14.0	22.8	80%	92%
Information	45–54	17.5	32.5	13.5	40.7	77%	116%
Comprehension	45–54	22.5	25.3	16.5	34.5	73%	136%
L-N Sequencing	16–44	11.0	22.7–27.4	6.0	50.0	54%	200%
Picture Completion	16–44	20.5	13.1–14.6	14.5	32.4	71%	234%
Digit-Symbol	18–19	81.0	19.7	35.0	40.5	43%	206%
Block Design	16–29	41.5	32.5	24.0	33.3	58%	102%
Matrix Reasoning	16–17	17.5	22.8	7.0	45.7	40%	200%
Picture Arrangement	16–34	15.5	27.0–29.0	4.5	82.2	29%	293%
Symbol Search	18–19	35.5	26.7	15.5	46.6	44%	174%
Object Assembly	18–34	35.0	29.1	18.5	33.5	53%	115%

Note: (G1) age group in which the highest scores were found; (G2) age group where the lowest scores were found (85–89 years). Variations (in percentages) for the means and standard deviations are presented.

Table 4
Hierarchy of age-related cognitive decline

Subtest	Percentage of score difference between the highest and lowest score
Digits	80% (Mild decline with aging)
Information	77%
Vocabulary	75%
Comprehension	73%
Picture Completion	71%
Similarities	70%
Arithmetic	69%
Block Design	58%
L-N Sequencing	54%
Object Assembly	53%
Symbol Search	44%
Digit-Symbol	43%
Matrix Reasoning	40%
Picture Arrangement	29% (Strong decline with aging)

Table 5
Changes in dispersion in the different WAIS-III subtests

	Percentage of dispersion at the oldest range with regard to the highest score range
Digits	92% (No heterogeneity with aging)
Block Design	102%
Object Assembly	115%
Information	116%
Arithmetic	121%
Vocabulary	133%
Comprehension	136%
Similarities	140%
Symbol Search	174%
Matrix Reasoning	200%
L-N Sequencing	200%
Digit-Symbol	206%
Picture Completion	234%
Picture Arrangement	293% (Strong heterogeneity with aging)

50% (that is, the lowest score was less than half of the highest score). This sequence of decline can be useful in understanding the effects of aging on cognition.

3.2. Sequence of heterogeneity

It was found that score dispersions increased in all subtests—excepting Digits; however, in some subtests increase in dispersion was less than 20% (Block Design, Object Assembly, and Information), whereas in others, increase in dispersion was over 200% (Matrix Reasoning, L-N Sequencing, Digit-Symbol, Picture Completion, and Picture Arrangement) (Table 5). Consequently, there is a test-dependent heterogeneity associated with aging.

4. Conclusions

Interpreting cross-sectional studies when analyzing age-related changes in cognition can be problematic, because there is a “cohort effect” potentially obscuring the results. People at different ages may significantly differ in education, life experiences, environmental conditions and even nutrition. Obviously, longitudinal studies may provide the most accurate way to look for age trends, but from the practical point of view they may be extremely difficult to carry out.

Different limitations to this study should be pointed out: it represents a secondary analysis of some available data; statistical analyses are simply descriptive; many details regarding the sample selection are not available; means and standard deviations are deduced from the information presented in the WAIS-III Manual; etc. Regardless these limitation, however, some tentative conclusions can be drawn.

Highest scores in different subtests were observed at different ages. In general, highest scores were found at an earlier age in those tests tapping non-verbal "fluid" abilities. However, decline in scores occurred earlier in these non-verbal than in verbal subtests. Frequently, but not necessarily, these subtests were timed tests. Highest scores in the non-verbal subtests were found below the mid 30s; later, score decline was found. In one subtest (Matrix Reasoning) score decline was apparent as early as the 18–19 years range. For verbal tests, highest scores were most frequently found around the late 40s and early 50s.

Taking the age when the highest score is found, the two subtests with the highest dispersions were Information and Block Design, whereas the subtest with the lowest dispersions was Picture Completion. Dispersion in the last one was less than half of the dispersion found in Information and Block Design. For the rest of the tests, dispersions were similar at the age of the highest scores.

Some subtests were extremely sensitive to the aging effect, whereas in others, aging had just a mild effect on scores. Decline in scores (difference between the highest and lowest) ranged between 20% (Digits) and over 70% (Picture Arrangement).

In all the subtests—except Digits, it was found that score dispersions increased during aging. However, in some subtests increase in dispersion was less than 20% (Block Design, Object Assembly, and Information), whereas in others, increase in dispersion was over 200% (Matrix Reasoning, L-N Sequencing, Digit-Symbol, Picture Completion, and Picture Arrangement). It was proposed that cognitive heterogeneity during normal aging is related to those abilities measured with these latter subtests, basically, executive functions, attention, and some non-verbal abilities. In other abilities (e.g., working memory, visuoconstructive abilities, and fund of general information) normal aging is associated with a more homogenous pattern of decline.

Some association between age-related dispersion and age-related decline can be conjectured. For example, the greatest dispersion appears to be seen on the same measures that show the greatest decline (e.g., Picture Arrangement), whereas the lowest dispersion was generally observed in those measures with the lowest decline (e.g., Digits).

A note of caution should be introduced. Comparing scores at different age ranges has a potentially major confounding effect: educational level at each age-rage is not reported in the WAIS-III Manual (Wechsler, 1997). Quite likely, however, younger people had a higher education than older participants. Consequently, differences observed across age-ranges may be due to an educational rather than age effect. Observed age differences probably are significantly inflated due to this uncontrolled educational artifact. Nonetheless, the focus of the previous analysis was the score dispersions, not the mean scores. Education is clearly correlated with increased scores in cognitive test performance (e.g., Ardila, Ostrosky-Solis, Rosselli, & Gomez, 2000), but seemingly, education has not ever been reported to be correlated with decreased score dispersion. Consequently, the educational differences do not seem to be affecting the age-related changes in score dispersions.

In conclusion, current results support the assumption that aging is not only associated with a general decline in cognitive test scores, but also with increase in test scores heterogeneity. With aging, individuals become more intellectually heterogeneous. This observation can be especially useful not only from a clinical but also theoretical point of view for accurately understanding the effects of aging on cognition. Analyzing the scores dispersion in different cognitive tests may significantly further our understanding of age-related changes in cognition.

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