# Supplementary Material - Detailed Description of MAAS and TILDA Measures

*MAAS Measures*

EF Indicators

The *Stroop Colour-Word Test* (Stroop, 1935; van der Elst, van Boxtel, van Breukelen, & Jolles, 2006c) was used to measure selective attention, response inhibition, and error monitoring. Card 1 depicts colour words in a random order (red, blue, yellow, and green) printed in black ink. Card 2 shows patches of solid colour in one of these four colours. Card 3 displays colour words printed in an incongruous ink colour (e.g., the word blue printed in yellow ink). Participants were instructed to read the words (card 1), name the colours (card 2), and name the ink colour of the printed words (card 3). Speed and accuracy were recorded. Participants’ selective attention (STR3) was measured as the total time taken to complete the colour-word card (card 3) in seconds. Participants’ response inhibition (STR-RI) was calculated as the time needed to complete the colour-word card (card 3) minus the average time needed to complete the word card (card 1) and the colour card (card 2). Many participants spontaneously corrected themselves when they noticed an error so the number of spontaneous corrections made was used as a measure of error monitoring.

The *Fluency* test measures strategy-driven retrieval of information from semantic memory (Lezak, Loring, & Howieson, 2004; van der Elst, van Boxtel, van Breukelen, & Jolles, 2006a). Participants were required to produce as many animal names as possible in one minute. The number of correct responses was taken as a measure of semantic fluency.

The *Concept Shifting Test* (CST) (van der Elst, van Boxtel, van Breukelen, & Jolles, 2006b; Vink & Jolles, 1985) is a modified version of the Trail Making Test (Reitan, 1958). The test comprises three cards with 16 small circles grouped in a larger circle. The small circles contain digits (CST A), letters (CST B) or both digits and letters (CST C). Participants were required to cross out the digits as quickly as possible in ascending order (CST A), the letters in alphabetical order (CST B), and the digits and letters in alternating order (CST C). A measure of cognitive switching (CST) was calculated by subtracting the time in seconds needed to complete CST A and CST B from the time needed to complete CST C.

PR Indicators

The *Letter-Digit Modalities Test* (LDMT) is an adapted version of the Digit-Symbol Substitution Test (Smith, 1968). Participants were instructed to replace random letters with the appropriate digits according to a given key. The number of correctly completed letters in 90 seconds served as a measure of processing speed.

The *Word Learning Test* (Brand & Jolles, 1985; van der Elst, van Boxtel, van Breukelen, & Jolles, 2005) is a modified version of the word-list learning test by Rey (1958). In five consecutive trials, a list of 15 monosyllabic words were presented. Immediately after presentation participants were asked to recall these words. This test of immediate recall is believed to tap short-term memory. According to Kane and Engle (2002), the representational components of short-term memory plus a general executive attention component are involved in working memory capacity. Traditionally, “span” tasks, and other tasks that measure short-term memory, have been used as measures of working memory. As this immediate recall task was the closest to a measure of working memory in the MAAS dataset, the total number of correctly recalled words after the five trials was used as a measure of immediate working memory. This is in line with previous research using MAAS data, where the verbal learning test was used as a measure of passive working memory (van Gerven, van Boxtel, Meijer, Willems, & Jolles, 2007).

CMA Indicators

*Level of education* was determined by categorising formal education according to a scale used in the Netherlands (De Bie, 1987). The scale is comparable to the International Standard Classification of Education (United Nations Educational Scientific and Cultural Organisation, 1976). The levels of education were defined as follows: 1 (*primary education*), 2 (*lower vocational education*), 3 (*intermediate general secondary education*), 4 (*intermediate vocational education*), 5 (*higher general secondary education*), 6 (*higher vocational education*), 7 (*higher professional education*), and 8 (*university education*).

*Level of Occupational Attainment* was based on a seven-point scale that estimates the highest level of professional activity (Directoraat-Generaal voor de arbeidsvoorziening, 1989). Information for this classification was derived from the reported occupation and a description of the work performed. Occupation level was defined as follows: 1 (*work requiring little or no insight and thought*), 2 (*work requiring some insight and thought*), 3 (*work requiring insight and thought*), 4 (*work requiring considerable experience*), 5 (*work requiring considerable theoretical knowledge as well as considerable experience*), 6 (*work requiring extensive and thorough theoretical knowledge*), and 7 (*work requiring scientific knowledge of scientific work*).

IQ Indicators

The *Groningen Intelligence Test* (GIT) is a test of general intelligence used as frequently as the Wechsler Adult Intelligence Scale (WAIS) in the Netherlands (Luteijn & Van der Ploeg, 1983). The vocabulary subtest of the GIT (GIT2) is a multiple choice test where participants are instructed to indicate which of five alternative words is exactly synonymous with a given word. The total score on the GIT2 was used as a measure of crystallised IQ (vocabulary). The mental rotation subtest of the GIT (GIT3) requires participants to indicate which two-dimensional shapes from a larger set are needed to fill a given space on a test page. This requires participants to mentally rotate each of the shapes as they are not presented in proper orientation. This test typically measures fluid abilities and the total score was used as a measure of fluid IQ.

*TILDA Measures*

EF Indicators

The *Sustained Attention to Response Task* (SART) (Robertson, Manly, Andrade, Baddeley, & Yiend, 1997) was used as a measure of response inhibition. This task tests a participant’s ability to sustain attention and inhibit prepotent responses. Although originally developed as a measure of sustained attention, recent research suggests that the SART places high response inhibition demands on participants (Carter, Russell, & Helton, 2013). During this computer-based task the numbers 1-9 were presented one at a time in a fixed order. Participants were instructed to respond to every number except the number ‘3’ by pressing a key. The number of errors of commission (pressing in response to the number ‘3’) was used as a measure of response inhibition.

The *Fluency* test is a measure of self-initiated activity, categorisation and mental flexibility (Barrett et al., 2011). Participants were asked to produce as many animal names as possible in 1 minute. The number of correct responses was taken as a measure of verbal fluency.

The *Colour Trails Tasks 1 and 2* (CTT1 and CTT2) (D’Elia, 1996) were used to derive a measure of cognitive switching. Colour Trail 1 mainly reflects visual scanning and sustained attention, and Colour Trail 2 requires mental flexibility. A measure of cognitive switching (CTT) was calculated by taking the time required to complete Colour Trail 1 from the time require to complete Colour Trail 2 (CTT2 – CTT1).

PR Indicators

*Choice Reaction Time* (CRT), or speed of processing, was measured using a computer-based CRT test that was developed in-house for TILDA using E-Prime software (Cronin, O’Regan, Finucane, Kearney, & Kenny, 2013; Schneider, Eschman, & Zuccolotto, 2002). During the CRT task participants are required to press a keyboard button until a stimulus (yes/no) appears on the screen. Participants must respond to the stimuli by pressing the corresponding yes/no button on the keyboard. Mean intra-individual reaction time in milliseconds was used as a measure of processing speed.

The *Word List Learning Test* (WLLT) required participants to recall 10 aurally presented words both immediately after presentation and again after a delay, over two trials. Immediate recall is believed to tap short-term memory. As this immediate recall task was the closest to the measure of working memory selected from MAAS, the total number of correctly recalled words over both trials was used as a measure of immediate working memory.

CMA Indicators

*Level of education* was determined by asking participants to indicate their highest level of education completed. The levels of education were defined as follows: 1 (*some primary – not complete*), 2 (*primary or equivalent*), 3 (*intermediate/junior/group certificate or equivalent*), 4 (*leaving certificate or equivalent*), 5 (*diploma/certificate*), 6 (*primary degree*) and 7 (*postgraduate/higher degree*).

*Occupation level* was based on a six-point scale that estimates the highest level of professional activity. Occupation level was determined as follows: 1 (*professional workers*), 2 (*managerial and technical*), 3 (*non-manual*), 4 (*skilled manual*), 5 (*semi-skilled*), and 6 (*unskilled*).

# Supplementary Material - References

Barrett, A., Burke, H., Cronin, H., Hickey, A., Kamiya, Y., Kenny, R. A., … Whelan, B. (2011). *Fifty plus in Ireland 2011: First results from the Irish Longitudinal Study on Ageing (TILDA)* (pp. 1–322). Trinity College Dublin. Retrieved from http://epubs.rcsi.ie/psycholrep/45/

Brand, N., & Jolles, J. (1985). Learning and retrieval rate of words presented auditorily and visually. *The Journal of General Psychology*, *112*(2), 201–210. https://doi.org/10.1080/00221309.1985.9711004

Carter, L., Russell, P. N., & Helton, W. S. (2013). Target predictability, sustained attention, and response inhibition. *Brain and Cognition*, *82*(1), 35–42. https://doi.org/10.1016/j.bandc.2013.02.002

Cronin, H., O’Regan, C., Finucane, C., Kearney, P., & Kenny, R. A. (2013). Health and aging: development of the Irish Longitudinal Study on Ageing health assessment. *Journal of the American Geriatrics Society*, *61*(s2), S269–S278. https://doi.org/10.1111/jgs.12197

De Bie, S. E. (1987). *Voorstellen voor uniformering van vraagstellingen naar achtergrondkenmerken en interviews [Standard questions 1987: Proposal for uniformization of questions regarding background variables and interviews]*. Leiden, NL: Leiden University Press.

D’Elia, L. F. (1996). *Color Trails Test*. Psychological Assessment Resources.

Directoraat-Generaal voor de arbeidsvoorziening. (1989). *Handleiding voor de functie-analyse [Manual for job analysis]*. Den Haag, NL: SDU Uitgeverij.

Kane, M. J., & Engle, R. W. (2002). The role of prefrontal cortex in working-memory capacity, executive attention, and general fluid intelligence: An individual-differences perspective. *Psychonomic Bulletin & Review*, *9*(4), 637–671.

Lezak, M. D., Loring, D. W., & Howieson, D. B. (2004). *Neuropsychological assessment* (4th ed.). Oxford, UK: Oxford University Press.

Luteijn, F., & Van der Ploeg, F. (1983). *Handleiding Groninger Intelligentietest (GIT) [Manual Groningen Intelligence Test]*. Lisse, NL: Swets and Zeitlinger.

Reitan, R. M. (1958). Validity of the trail making test as an indicator of organic brain damage. *Perceptual and Motor Skills*, *8*(3), 271–276. https://doi.org/10.2466/pms.1958.8.3.271

Rey, A. (1958). *L’examen clinique en psychologie [The clinical examination in psychology]*. Oxford, England: Presses Universitaries De France.

Robertson, I. H., Manly, T., Andrade, J., Baddeley, B. T., & Yiend, J. (1997). Oops!’: Performance correlates of everyday attentional failures in traumatic brain injured and normal subjects. *Neuropsychologia*, *35*(6), 747–758. https://doi.org/10.1016/S0028-3932(97)00015-8

Schneider, W., Eschman, A., & Zuccolotto, A. (2002). *E-Prime reference guide*. Pittsburgh, PA: Psychology Software Tools, Incorporated.

Smith, A. (1968). The Symbol Digit Modalities Test: A neutopsychologic test for economic screening of learning and other cerebral disorders. In J. Hellmuth (Ed.), *Learning Disorders* (Vol. 3, pp. 93–135). Seattle, WA: Special Child Publications.

Stroop, R. J. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, *18*(6), 643–662. https://doi.org/10.1037/h0054651

United Nations Educational Scientific and Cultural Organisation. (1976). *International standard classification of education*. Paris, FR: UNESCO.

van der Elst, W., van Boxtel, M. P. J., van Breukelen, G. J. P., & Jolles, J. (2005). Rey’s Verbal Learning Test: Normative data for 1855 healthy participants aged 24-81 years and the influence of age, sex, education, and mode of presentation. *Journal of the International Neuropsychological Society*, *11*(3), 290–302. https://doi.org/10.1017/S1355617705050344

van der Elst, W., van Boxtel, M. P. J., van Breukelen, G. J. P., & Jolles, J. (2006a). Normative data for the animal, profession and letter M naming verbal fluency tests for Dutch speaking participants and the effects of age, education, and sex. *Journal of the International Neuropsychological Society*, *12*(1), 80–89. https://doi.org/10.1017/S1355617706060115

van der Elst, W., van Boxtel, M. P. J., van Breukelen, G. J. P., & Jolles, J. (2006b). The Concept Shifting Test: Adult normative data. *Psychological Assessment*, *18*(4), 424–432. https://doi.org/10.1037/1040-3590.18.4.424

van der Elst, W., van Boxtel, M. P. J., van Breukelen, G. J. P., & Jolles, J. (2006c). The Stroop Color-Word Test: Influence of age, sex, and education; and normative data for a large sample across the adult age range. *Assessment*, *13*(1), 62–79. https://doi.org/10.1177/1073191105283427

van Gerven, P. W. M., van Boxtel, M. P. J., Meijer, W. A., Willems, D., & Jolles, J. (2007). On the relative role of inhibition in age-related working memory decline. *Aging, Neuropsychology, and Cognition*, *14*(1), 95–107. https://doi.org/10.1080/138255891007038

Vink, M., & Jolles, J. (1985). Abstracts of platform and poster presentations: A new version of the trail making test and an information-processing task. *Journal of Clinical and Experimental Neuropsychology*, *7*(2), 162. https://doi.org/10.1080/01688638508401250