Utrecht University

The effect of physical presence of the examiner on memory task performance through video teleconferencing

Master thesis Neuropsychology

Utrecht University

Name: **Selma Ankersmit**

Studentnumber: **0209724**

Date: **15-07-2022**

Supervisors

Dr. Barbara Montagne

Eline Kruithof, PhD Candidate

Abstract

The demand for digital and remote neuropsychological assessment is increasing. Before reliable remote and digital neuropsychological assessment through video teleconferencing (VTC) is possible, it is important to know whether the norms that are currently used for interpreting the test results (which are obtained in face-to-face (FTF) assessment) are appropriate for digital and remote testing as well. Physical presence is one of the differences between FTF and VTC assessment that might contribute to differences in outcome measures. The current study was conducted to investigate the influence of physical presence of the examiner on clinically relevant outcome measures of an online version of a widely used verbal memory task in the Netherlands: the Dutch Auditory Verbal Learning Task (AVLT). Scores on immediate recall, delayed recall and delayed recognition of the AVLT were compared within participants (N=40) with the examiner physically present and with the examiner physically absent. No significant differences were found between both ways of administration on any of the outcome measures. This might suggest that currently available norms don't have to be adjusted. Nevertheless, further studies investigating the effect of examiner presence in a larger sample and studies investigating other possible interfering factors will be necessary.

Introduction

The outbreak of the coronavirus has far-reaching consequences for providing psychological care. There has been an enormous increase in the demand for psychological assessment and treatment by video teleconferencing (VTC). This also concerns neuropsychological assessment. Besides reducing virus transmitting, assessing neuropsychological functioning by VTC has other advantages in comparison to traditional face-to-face (FTF) assessment as well. It can provide convenience, reduce costs and enable access to assessment services when they are otherwise unavailable (Luxton ea, 2014). The use of computers in cognitive assessment has been found to be more efficient and better standardized than FTF assessment (Bauer ea, 2012). Despite several challenges, digital biomarkers (such as neuropsychological data) collected remotely have significant potential for diagnosis and symptom management in older adults (Owens ea, 2020).

Several studies showed good agreement between VTC- and FTF assessment. In a review and meta-analysis, Brearly ea (2017) found that overall, videoconference administration of tests did not yield a significant change in test scores on adult neurocognitive tests. Marra ea (2020) builded on the work of Brearly ea. In general, they found that the validity of neuropsychological assessment by video connection is good. Neuropsychological tests relying upon verbal instructions and responses are considered most suitable for assessment by VTC (Cullum, 2014).

Looking specifically at memory tasks, Marra ea (2020) reviewed five studies that investigated a widely used verbal memory task, the Hopkins Verbal Learning Test – Revised (HVLT-R). Concerning the total amount of words recalled immediately, different results were found. Four of the five studies found no differences between both ways of administration (Wadsworth ea, 2016; Cullum ea, 2006; Vahia ea, 2015; Wadsworth ea, 2018). One study did find a significant difference in the advantage of VTC-administration (Cullum ea, 2014). Possible explanations for this difference are that the investigators spoke more clearly or presented the stimuli at a slightly different rate in the VTC-condition (Cullum ea, 2014), or that the patients were better concentrated (Brearly ea, 2017). Of the studies reviewed by Marra ea (2020) that investigated the HVLT-R, only three investigated the delayed recall (Cullum ea, 2006; Wadsworth ea, 2016;

Wadsworth ea, 2018); none of which found a significant difference between both conditions. Only one study (Cullum ea, 2006) also looked at the delayed recognition. They found a slight, but not significant, higher score for the FTF condition.

As there are multiple differences between FTF assessment and VTC assessment, it is not easy to determine why a significant difference in the advantage of VTC-administration has been found (Cullum ea, 2014). Historically, neuropsychological testing has implicitly assumed that the examinee responds to test stimuli exclusive of other stimuli. Nevertheless, a large body of research has found that environmental conditions, such as the presence of another person, influences neuropsychological test performance (Barnett ea, 2018). Social facilitation refers to the impact of another person on an individual's performance. Social facilitation in the form of mere presence of another individual is enough to cause changes in behavioral outcomes (Barnett ea, 2018). Specifically in neuropsychological testing, social facilitation has been found to lead to poorer performances on the Stroop task, digit span, the Paced Auditory Serial Addition Test and the Controlled Oral Word Association Test (Horwitz & McCaffrey, 2008; Huguet ea, 1999). Memory assessment shows a particular vulnerability (Constantinou ea, 2005; Gavett & McCaffrey, 2007), meaning that the presence of the examiner can negatively influence memory task performance.

In the Netherlands, not much research has been done to investigate neuropsychological assessment by VTC. The current professional standard states that neuropsychological assessment should take place face-to-face (NIP sectie Neuropsychologie, 2020). Findings so far suggest that it is possible to conduct neuropsychological assessment by VTC, but more research is needed to reach further conclusions about reliability and validity (van den Heuvel ea, 2020). A commonly used verbal memory test in the Netherlands is the Dutch version of the Auditory Verbal Learning Test, the so called 15-woordentest (Brand & Jolles, 1985). This test is designed to examine episodical memory; it is used to examine whether a person is capable of learning verbal information and recalling and recognizing it over a longer period (Bouma ea, 2012). Age, gender and education level of the examinee are known to influence performance on this test (Bouma ea, 2012; van der Elst ea, 2005; van der Elst ea, 2008). Van der Elst ea (2008) found that, with the

visual version of this test, the retest effect in the immediate recall and the delayed recall conditions was almost half a standard deviation, despite a time-interval of three years and the use of parallel tests. It has been investigated whether a digital tablet assessment of cognitive performance obtains the same results as a paper and pencil assessment of these same tasks in a memory clinic patient population (Schreurs, 2014). For the 15-woordentest, trends to significant improvement of the total recall and the delayed recall between the first and second administration were found. However, this improvement can be declared by a learning effect: in both conditions the investigators used the same set of words.

Altogether, it can be concluded that Dutch research on memory assessment by VTC is limited. Internationally, different results have been found in studies investigating differences between FTF and VTC memory assessment. Different explanations have been suggested for a better performance in a VTC situation. Because there are multiple differences between FTF and VTC assessment, it is hard to decide what the reason might be. There is evidence that the presence of the examiner might contribute to the differences.

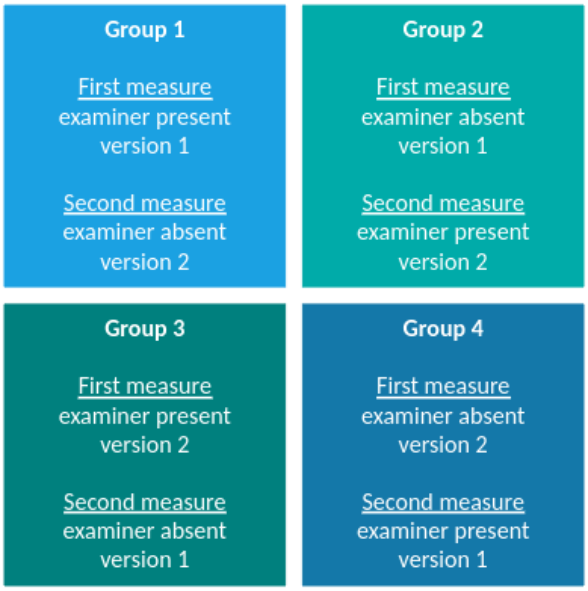
This leads to the following research question: does the physical presence of the examiner influence outcome measures of the Duch version of the Auditory Verbal Learning Task through VTC? It is hypothesized that the physical absence of the examiner will lead to a higher score on the immediate recall. As the delayed recall and the delayed recognition are relevant measures in clinical memory assessment, these scores will be looked at as well. Not much research has been done on these topics. Nevertheless, based on the same theoretical arguments as for the immediate recall, it is hypothesized that physical absence of the examiner will lead to higher scores on these measures as well.

Methods

Design

The hypothesis was tested with a within-subjects design. Every participant was tested twice: once with the examiner physically present and once with the examiner physically absent. Besides, every participant was assessed with version 1 on one occasion and version 2 on the other occasion. The dependent variables were the scores on the selected outcome measures. The presence of the examiner was the independent variable. To make sure no sequence effect (of both the test version and absence or presence of the examiner) would take place, subjects (men and women apart) were randomly assigned to one of four experimental groups. This way, the retest effect demonstrated by van der Elst ea (2008) was similar for the absent and present condition and so, controlled for. The experimental groups are shown in figure 1. Forty-two people agreed upon participating in the study. Two participants couldn't come for a first appointment, they were excluded. This resulted in a skewed distribution of number of men and women included in the different groups, therefore it was decided to assign one subject to another group to attain an equal number of 3 men and 7 women in each group.

Figure 1. The four experimental groups



Participants

An a-priori power analysis was conducted using G*Power 3.1.9.7 for Windows[1] (Faul ea, 2007) to determine the number of participants needed to find a statistically significant effect based on the findings by Cullum ea (2014). Expected effect size (dz) was set at 0,13, α at .05 and 1-β at 0.95. It turned out that 642 participants were needed to find such an effect. Given the time limits of the current study, participants were 40 adults aged 18-65 years. They were recruited by the investigator and included family members, friends, neighbors, acquaintances and colleagues. Inclusion criteria were normal or corrected to normal vision and hearing, native Dutch speaker and mental competence to give an informed consent. Vision and hearing abilities were checked by asking the participants. Mental competence to give an informed consent was judged by the examiner in the first session: participants were asked whether they understood the aim of the study.

Materials

Participants used a Windows-operated Acer laptop with an Intel(R) Core(TM) i5 processor. The examiner used a Windows-operated Lenovo ThinkBook 15 G2 ITL with an Intel(R) Core(TM) i7 processor. A digital publisher for psychological tests, Metrisquare B.V., provided the software for the system. The tests were conducted and scored by means of DigiDiagweb version 4.3.0.4. An expansion module called 'Remote Testing' was used[2]. Participants used the browser version of Microsoft Teams in the ‘absent-condition’. The examiner used the desktop version of Microsoft Teams. Two versions of the 15-woordentest (Brand & Jolles, 1985) were used to prevent for a learning effect to take place: the original version and a parallel-version. The complete word lists for both versions can be found in appendices 1 and 2.

Procedure

[1] this software is free available through Heinrich Heine Universität Düsseldorf (https://www.psychologie.hhu.de/arbeitsgruppen/allgemeine-psychologie-und-arbeitspsychologie/gpower)

[2] this software is available through Metrisquare B.V. (www.metrisquare.nl)

The study as described above was approved by the Ethical Review Board of the Faculty of Social and Behavioral Sciences of Utrecht University. Informed consent was asked prior to the first administration. Appointments for the administrations were made such that, if possible, there would be four weeks between both appointments. Both administrations took place in the same undisturbed office in a nursing home. In the 'present-condition', the examiner sat opposite the participant, like they would in face-to-face neuropsychological assessment. In the 'absent-condition', the examiner took place in an office nearby. All other circumstances were the same in both conditions.

The test instructions were read aloud by the examiner. Participants were instructed to listen carefully to a list of words that would be presented auditory because, immediately afterwards, they would be asked to recall all the words they could remember by saying them out loud. The words were presented by the software program five times and after each time ('trial') the participant was asked to recall all the words he or she remembered by saying them out loud. After twenty minutes, participants were asked which words they still remembered. Immediately after completing the delayed recall, a list of thirty words was presented auditory. The participant was asked to say 'yes' or 'no' after each word presented: 'yes' when the word was one of the words they had to remember and 'no' when it was another word.

To make sure that the participants would not do anything interfering and would be kept busy during the twenty minutes between the fifth trial of the immediate recall and the delayed recall, they were subjected to a non-verbal task that didn't contain any words in this mean time. This task was based on the Bourdon-Wiersma test.

Data-analysis

Statistical analyses were conducted using IBM SPSS Statistics for Windows, version 28. Outcome measures that were looked at, were the immediate recall (the total number of correctly recalled words immediately throughout the five trials), the delayed recall (the number of

correctly recalled words after the 20-minute delay) and the delayed recognition (the number of correctly classified words as being one of the words that had to be remembered or not after the delay). Means and standard deviations were calculated for both conditions. Repeated measures ANOVA's were conducted to test whether the absence of the examiner yielded higher scores on the outcome measures than the presence of the examiner.

Results

40 subjects, 11 men and 29 women, were included in the data analysis. Due to missing data as a result of a poor Internet connection at some moments during the assessments, not all subjects were included in the analyses of all dependent variables. The assessment process went undisturbed, but some data of some participants were not processed correctly while other scores of the same participant were processed correctly. As a result, 38 subjects were included in the analysis of the immediate recall, 40 subjects were included in the analysis of the delayed recall and 38 subjects were included in the analysis of the delayed recognition. Table 1 shows a description of the number of included subjects per dependent variable in terms of age and education level.

Table 1. The number of included subjects (N) per dependent variable by age group and education level (according to Verhage[3])

Age	21-30 (N=4)		31-40 (N=12)			41-50 (N=10)		51-60 (N=8)		61-65 (N=6)		
Education level	5	6	5	6	7	5	6	5	6	2	5	6
Immediate recall	1	3	3	7	1	6	4	3	3	1	1	4
Delayed recall	1	3	3	8	1	6	4	5	3	1	1	4
Delayed recognition	1	3	3	7	1	6	4	5	3	1	1	4

Mean scores and standard deviation on the three dependent variables of the VTC- and FTF-testing conditions are presented in table 2. One-way repeated measures ANOVA's were conducted on the three dependent variables. There was no statistically significant difference between the two groups in any of the dependent variables: immediate recall $F(1,37)=.007$, $p=.932$; delayed recall $F(1,39)=.457$, $p=.503$; delayed recognition $F(1,37)=1.606$, $p=.213$.

Table 2. mean scores (SD) per dependent variable in the VTC- and FTF-conditions

	VTC	FTF
immediate recall	51.62 (7.103)	51.79 (6.940)

[3] an overview of education level coding can be found in appendix 3

delayed recall	11.2 (2.244)	11.43 (2.037)
delayed recognition	29.65 (.622)	29.47 (.893)

Discussion

The aim of the present study was to investigate whether the presence of the examiner influences clinically relevant outcome measures of an online version of a widely used verbal memory task in the Netherlands: the Dutch Auditory Verbal Learning Task (AVLT). As far as known, this is the first study to investigate whether the mere presence or absence of the investigator influences task performance in VTC-based testing. It was hypothesized that physical absence of the examiner would yield higher scores on all clinically relevant outcome measures of this test; the immediate recall, the delayed recall and the delayed recognition. Results show that the presence of the examiner did not have any significant influence on the performance on any of the outcome measures. Against expectations, mean scores on the immediate recall and delayed recall were slightly (but not significantly) higher in the FTF condition while the mean scores on the delayed recognition were slightly higher in the VTC-condition.

These results are not consistent with results from another study comparing VTC- and face-to-face-testing. (Cullum ea, 2014), who did find a significantly higher score in the VTC-condition. In their discussion, it was mentioned that it was possible that the examiners may have enunciated more clearly or presented stimuli at a slightly different rate to adapt to the VTC condition, resulting in slightly higher scores. In the present study, adaptation of the way the stimuli were presented was not possible because the stimuli were presented by a software program and, as a result, similar in the VTC and FTF condition. This might explain why the expected effect was not found in this study. Nevertheless, the found lack of a significant difference between FTF- and VTC-testing is consistent with other previous studies (Wadsworth ea, 2016; Cullum ea, 2006; Vahia ea, 2015; Wadsworth ea, 2018).

Several methodological limitations may have contributed to the lack of significant results. In the first place, the sample size might just have been too small to find an existing significant effect in the population. As calculated a-priori, to find the same-sized effect as Cullum ea (2014), over 600 participants had to be included in the sample. This was not possible in the current master thesis research project as it would take way too much time to assess so many people.

Besides, when comparing the current study to the one by Cullum ea (2014), it shows that the sample was considerably different. The current sample consisted of 40 healthy adults with a mean age of 45 years while the Cullum sample consisted of 202 healthy controls and patients with MCI or Alzheimer's disease with a mean age of 69 years. Although the ALVT is primarily a memory task, selective attention and executive functioning are prerequisites for a good performance on this task. It is plausible that contact through VTC appeals for more executive functioning than FTF contact and that a memory task through VTC might ask for less selective attention, because there is no distraction by the physical presence of the examiner. From literature, there is evidence that increased chronological age is associated with significantly poorer executive functioning (Mahoney ea, 2010; Verhaeghen & Cerella, 2002). Therefore, it is plausible that lower ALVT-scores will be obtained by older participants in a VTC setting compared to a FTF setting, especially if they have executive functioning deficits.

In future research, a larger sample should be investigated to find out whether there is an effect of examiner presence on task performance of this specific test. Besides, it would be interesting to find out whether there are differences in the effect of physical presence of the examiner on test scores between different age groups and various levels of cognitive health or impairment. Sex seems less interesting for further examination; van Hooren ea (2007) found no evident sex difference for neuropsychological tasks other than verbal memory tasks.

Conclusion

Before reliable remote and digital memory assessment with this widely used verbal memory test is possible, it is important to know whether the norms that are currently used for interpreting the outcome measures (which are obtained in FTF-assessment) are appropriate for VTC-assessment as well. This study focused specifically on the effect of the physical absence of the examiner during neuropsychological memory assessment by an online version of the Dutch Auditory Verbal Learning Task (ALVT). As far as known, this was the first study to investigate this specific difference in this test in a controlled setting. Results showed that there were no significant differences for any of outcome measures (the immediate recall, the delayed recall and the delayed recognition) between a setting in which the examiner was physically present and a setting where the examiner was physically absent. These results might suggest that the currently available norms can be used in VTC assessment. It is, however, important to note that the sample size was rather small and that the participants were solely cognitively healthy and relatively young and highly educated adults. Future studies should investigate the effect in a larger sample. Also, it would be interesting to discover whether there are differences in the effect of physical presence or absence of the examiner between different age and education groups and various levels of cognitive health.

References

Barnett, M.D., Parsons, T.D., Reynolds, B.L. & Bedford, L.A. (2018). Impact of rapport on neuropsychological test performance. *Applied Neuropsychology: Adult, 25*(3), 258-265. https://doi.org/10.1080/23279095.2017.1293671

Bauer, R.M., Iverson, G.L., Cemich, A.N., Binder, L.M., Ruff, R.M. & Naugle, R.I. (2012). Computerized Neuropsychological Assessment Devices: Joint Position Paper of the American Academy of Clinical Neuropsychology and the National Academy of Neuropsychology. *Archives of Clinical Neuropsychology, 27*, 362-373. https://doi.org/10.1093/arclin/acs027

Bouma, A., Mulder, J., Lindeboom, J. & Schmand, B. (2012). *Handboek neuropsychologische diagnostiek* (2 ed.). Pearson Assessment and Information B.V.: Amsterdam.

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

Brearly, T.W., Shura, R.D., Marindale, S.L., Lazowski, R.A., Luxton, D.D., Shenal, B.V. & Rowland, J.A. (2017). Neuropsychological Test Administration by Videoconference: A Systematic Review and Meta-Analysis. *Neuropsychological Rev, 27*(2), 174-186. https://doi.org/10.1007/s11065-017-9349-1

CBS (2004). *De Nederlandse samenleving 2004 – Sociale trends*. OBT bv.

Constantinou, M., Ashendorf, L. & McCaffrey, R.J. (2005). Effects of a Third Party Observer During Neuropsychological Assessment: When the Observer Is a Video Camera. *Journal of Forensic Neuropsychology, 4*(2), 39-47. https://doi.org/10.1300/J151v04n02_04

Cullum, C.M., Weiner, M.F., Gehrmann, H.R. & Hynan, L.S. (2006). Feasibility of Telecognitive Assessment in Dementia. *Assessment, 13*(4), 385-390. https://doi.org/10.1177/1073191106289065

Cullum, M.C., Hynan, L.S., Grosch, M., Parikh, M. & Weiner, M.F. (2014). Teleneuropsychology: Evidence for video teleconference-based neuropsychological assessment. *Journal of the International Neuropsychological Society, 20*(10), 1028-1033. https://doi.org/10.1017/s1355617714000873

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*, 290-302. https://doi.org/10.1017/S1355617705050344

van der Elst, W., van Boxtel, M.P.J., van Breukelen, G.J.P. & Jolles, J. (2008). Detecting the significance of changes in performance on the Stroop Color-Word Test, Rey's Verbal Learning Test, and the Letter Digit Substitution Test: The regression-based change approach. *Journal of the International Neuropsychological Society, 14,* 71-80. https://doi.org/10.1017/S1355617708080028

Faul, F., Erdfelder, E., Lang A.-G. & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*, 175-191.

Gavett, B.E. & McCaffrey, R.J. (2007). The influence of an adaptation period in reducing the third party observer effect during a neuropsychological evaluation. *Archives of Clinical Neuropsychology, 22*, 699-710. https://doi.org/10.1016/j.acn.2007.05.002

van den Heuvel, D.M.J., van den Berg, E. & Montagne, B. (2020). Neuropsychologie in tijden van COVID-19: Overwegingen bij neuropsychologische diagnostiek via beeldbellen bij volwassenen. *Tijdschrift voor Neuropsychologie, 15*(2), 79-90.

van Hooren, S.A.H., Valentijn, A.M., Bosma, H., Ponds, R.W.H.M., van Boxtel, M.P.J. & Jolles, J. (2007). Cognitive Functioning in Healthy Older Adults Aged 64-81: A Cohort Study into the Effect of Age, Sex, and Education. Aging, Neuropsychology and Cognition, *14*(1), 40-54. https://doi.org/10.1080/138255890969483.

Horwitz, J.E. & McCaffrey, R.J. (2008). Effects of a third party observer and anxiety on tests of executive function. *Archives of Clinical Neuropsychology, 23*, 409-417. https://doi.org/10.1016/j.acn.2008.02.002

Huguet, P., Galvaing, M.P., Monteil, J.M. & Dumas, F. (1999). Social presence effects in the Stroop task: Further evidence for an attentional view of social facilitation. *Journal of Personality and Social Psychology, 77*(5), 1011-1025. https://doi.org/10.1037/0022-3514.77.5.1011

Luxton, D.D., Pruitt, L.D. & Osenbach J.E. (2014). Best practices for remote psychological assessment via telehealth technologies. *Professional Psychology: Research and Practice, 45*(1), 27-35. https://doi.org/10.1037/a0034547

Mahoney, J.R., Verghese, J., Goldin, Y., Lipton, R. & Holtzer, R. (2010). Alerting, orienting, and executive attention in older adults. *Journal of the International Neuropsychological Society, 16*, 877-889. https://doi.org/10.1017/S1355617710000767

Marra, D.E., Hamlet, K.M., Bauer, R.M. & Bowers, D. (2020). Validity of teleneuropsychology for older adults in response to COVID-19: A systematic and critical review. *The Clinical Neuropsychologist, 34(*7-8), 1411-1452. https://doi.org/10.1080/13854046.2020.1769192

NIP sectie Neuropsychologie (2020). https://www.psynip.nl/secties/neuropsychologie/

Owens, A.P., Ballard, C., Beigi, M., Kalafatis, C., Brooker, H., Lavelle, G., Brønnick, K.K., Sauer, J., Boddington, S., Velayudhan, L. & Aarsland, D. (2020). Implementing remote memory clinics to enhance clinical care during and after COVID-19. *Frontiers in Psychiatry, 11*:579934. https://doi.org/10.3389/fpsyt.2020.579934

Schreurs, S. (2014). *DiagnoseIs: A computerized Form of Cognitive Testing at the Memory Clinic* (unpublished Master's thesis). Maastricht University, Maastricht.

Vahia, I.V., Ng, B., Camacho, A., Cardenas, V., Cherner, M., Depp, C.A., Palmer, B.W., Jeste, D.V. & Agha, Z. (2015). Telepsychiatry for Neurocognitive Testing in Older Rural Latino Adults. *American Journal of Geriatric Psychiatry, 23*(7), 666-670. https://doi.org/10.1016/j.jagp.2014.08.006

Verhaeghen, P. & Cerella, J. (2002). Aging, executive control, and attention: a review of meta-analyses. *Neuroscience & Behavioral Reviews,* 26(7), 849-857. https://doi.org/10.1016/s0149-7634(02)00071-4.

Wadsworth, H.E., Galusha-Glasscock, J.M., Womack, K.B., Quiceno, M., Weiner, M.F., Hynan, L.S., Shore, J. & Cullum, C.M. (2016). Remote Neuropsychological Assessment in Rural American Indians with and without Cognitive Impairment. *Archives of Clinical Neuropsychology, 31*(5), 420-425. https://doi.org/10.1093/arclin/acw030

Wadsworth, H.E., Dhima, K., Womack, K.B., Hart, J., Weiner, M.F., Hynan, L.S. & Cullum, C.M. (2018). Validity of Teleneuropsychological Assessment in Older Patients with Cognitive Disorders. *Archives of Clinical Neuropsychology, 33*, 1040-1045. https://doi.org/10.1093/arclin/acx140

Appendices

Appendix 1:

Stimuli Auditory Verbal Learning Test – Dutch Version - version 1

Recall	**Recognition**	
BLOEM	BROOD	BEER
SNOR	KAR	GOOT
KROON	BEUK	TAS
BEER	PAN	DUIM
LAP	ZWAAN	BOEF
KLOK	NET	LAP
ZWAAN	KLOK	KROON
REK	MAAG	FILM
TAS	HAK	HOEN
BERG	BLOEM	BERG
KRUIK	NAR	HAAN
HOEN	VOS	REK
GOOT	KEEL	KOE
MAAG	SNOR	ROK
KAR	POMP	KRUIK

Appendix 2:

Stimuli Auditory Verbal Learning Test – Dutch Version - version 2

Recall	**Recognition**	
KAAS	BOOM	HERT
HERT	GRAS	BAL
STOEL	STRUIK	DIEF
MAST	KNOOP	RIET
BED	DOEK	PLANK
STRUIK	MAST	STER
BAARD	VOET	KALF
LEEUW	TREIN	WIND
PLANK	LEEUW	BED
ROK	MOS	SLAAF
DIEF	PAARD	BUIK
TREIN	KAAS	BAARD
VLAM	VLAM	ROK
KIST	ZEIL	STOEL
BOOM	KIST	HEK

Appendix 3: coding education level (Verhage, 1964; CBS, 2004)

1. Minder dan 6 klassen lager onderwijs

- Minder dan 8 groepen basisonderwijs
- ZMLK-school

2. Zes klassen lager onderwijs

- Diverse vormen van gewoon lager onderwijs (6 klassen) of basisonderwijs (8 groepen), alsmede buitengewone vormen van lager en basisonderwijs die toegang geven tot het voortgezet onderwijs.
- LOM-school
- MLK-school

3. Meer dan 6 klassen lager onderwijs zonder verder afgesloten speciale opleiding

- Het vroegere 8-klassen lager onderwijs
- Niet-voltooide middelbare schoolopleiding (1 jaar MULO, 2 jaar HAVO etc.)
- VBO
- VGLO

4. Gediplomeerde schoolopleiding lager dan MULO

- LTS (A- en B-niveau)
- LEAO
- LHNO (A en B-niveau)
- Lagere Landbouw- en Tuinbouwschool
- VMBO-b • “Lagere” beroepsgerichte opleidingen (Kinderbescherming A en B, kinderverzorger, zwakzinnigenverzorger, bloemist, baggeraar, banketbakker, textielvakdiploma, slijterdiploma etc)
- Leerlingwezen
- ITO, IHNO
- Drie achtereenvolgende jaren onderwijs van code 5 met overgangsrapport naar de vierde klas (3 jaar MULO, MTS, MEAO, VMBO-t etc.)

5. MULO

- MAVO
- MBO-opleidingen (MTS, MEAO, Middelbare Detailhandelschool, Middelbare landbouwschool, etc.)
- KJV-opleiding, opleiding tot verpleger, zwakzinnigenverzorger (opleiding na 1977)
- LTS en LHNO op C-niveau
- VMBO-t • Drie achtereenvolgende jaren onderwijs van code 6 met overgangsrapport naar de vierde klas (3 jaar HAVO, VWO, HSB etc.)

6. VHMO

- HAVO
- Atheneum, Gymnasium, Lyceum, VWO
- HBS, MMS • HBO-opleidingen (HTS, HEAO, Hogere Landbouwschool, Hogere Textielschool, Pedagogische Academie, Hogere Laboratoriumschool etc.)
- Post-HBO-onderwijs
- Officiersopleiding
- Opleiding tot leraar middelbaar onderwijs (MO-akte)
- Behaald propedeutisch examen of kandidaatsexamen WO

7. Wetenschappelijk onderwijs

- Universitaire opleiding (doctoraal)
- Universitaire opleiding (bachelor- en/of master-niveau)
- Technische Hogeschool (voor 1986)
- Landbouwhogeschool (voor 1986)