Tele-Neuropsychological Assessment using Video-Conferencing

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This document was developed by Erika Nolan (McGill University) and Rachel Downey (Concordia University), doctoral practicum students under the supervision of Drs. Lisa Koski and Marco Sinai at the Allan Memorial Institute, Neuropsychology Department in Montreal.

The information included in this document is based upon an extensive literature search, representing the most up-to-date research to the best of our knowledge.

If you have any questions or would like for us to include any additional research in this document, please feel free to contact us directly at Teleneuropsychology.AMI@gmail.com.

Table Notes / Considerations:

- **VTC** = Videoteleconferencing; **FF**= Face to Face
- ***** Indicates that the owner of this test material has not opened their copyright
- "Open copyright" indicates that the publisher has *temporarily* suspended certain aspects of their copyright to facilitate remote assessments: Because this situation could change at any time and without warning, the authors of this document (and the AQNP) disclaim responsibility for any negative legal consequences arising from the use of the information in this table.
- The suggested modifications included in this document are intended for complete remote assessment, where both the clinician and patient remain at home. Moreover, the suggested modifications are intended to be used for patients with cognitive difficulties who retain sufficient functioning to be able to use computer technology independently.
- Tests requiring written responses should have the response booklets mailed to the patient with an extra envelope and stamps, so that the patient can mail it back (copy of response booklets should not be emailed to the patient even if copyrights are opened during this time).
- Small effect sizes can be statistically significant without being associated with differences in clinical presentation or interpretation (Jacobsen et al. 2003).
- All oral responses given by the patient should be recorded by the examiner and saved in a password protected document, including screenshots taken of the patient's performance on some tests.

Tests by Domain	Study References	Research Findings	Considerations / Modifications	Copyright Info.
Verbal Abilities				
WAIS - Vocabulary	Hildebrand, R., Chow, H., Williams, C., Nelson, M., & Wass, P. (2004). Feasibility of neuropsychological testing of older adults via videoconference: implications for assessing the capacity for independent living. *Journal of Telemedicine and Telecare*, *10*(3), 130-134. Jacobsen, S. E., Sprenger, T., Andersson, S., & Krogstad, J. M. (2003). Neuropsychological assessment and telemedicine: a preliminary study examining the reliability of neuropsychology services performed via telecommunication. *Journal of the International Neuropsychological Society*, *9*(3), 472-478. DOI: 10.10170S1355617703930128 Temple, V., Drummond, C., Valiquette, S., & Jozsvai, E. (2010). A comparison of intellectual assessments over video conferencing and in-person for individuals with ID: preliminary data. *Journal of Intellectual Disability Research*, *54*(6), 573-577.	Hildebrand et al., (2004) found a mean difference of 0.03 (SD = 1.55) between VTC and FF on the WAIS-III Vocabulary (no statistical significance test done- just mean comparison, but authors state that this represents a small difference). Jacobsen et al., (2003) found no statistically significant differences between VTC and FF on the WAIS Vocabulary - Norwegian version. Temple et al., (2010) examined the Verbal IQ (combination of Vocabulary and Similarities subtests) on the WASI and found that it was significantly higher in person than VTC (however, they did not report the results of the separate subtests that makeup verbal IQ). Also, while the administration was done remotely, there was a facilitator in the room with the patient to present the materials).	The examiner should share their screen with the patient to show the vocabulary words. The examiner should point with the mouse to the stimuli on the screen for the first few items. The examiner should record the patient's responses in a password protected document.	Pearson - open copyright

WAIS - Similarities	Temple, V., Drummond, C., Valiquette, S., & Jozsvai, E. (2010). A comparison of intellectual assessments over video conferencing and in-person for individuals with ID: preliminary data. *Journal of Intellectual Disability Research*, *54*(6), 573-577.	No other studies besides Temple et al., (2010) have compared Similarities done via VTC or FF. In this study, Verbal IQ (combination of Vocabulary and Similarities subtests) on the WASI was higher in FF than VTC, but they did not report the results of the separate subtests.	The examiner should record the patient's responses in a password protected document.	Pearson - open copyright
Verbal Fluency - Phonemic	Brearly, T. W., Shura, R. D., Martindale, 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. *Neuropsychology review*, *27*(2), 174-186. Wadsworth, H. E., Galusha-Glasscock, J. M., Womack, K. B., Quiceno, M., Weiner, M. F., Hynan, L. S., et al. (2016). Remote neuropsychological assessment in rural American Indians with and without cognitive impairment. Archives of Clinical Neuropsychology, acw030. doi:10.1093/arclin/acw030. Vestal,L.,Smith-Olinde,L.,Hicks,G.,Hutton,T.,& Hart,J.J.(2006).Efficacy of language assessment in Alzheimer's disease:Comparing in-person examination and telemedicine. Clinical Interventions in Aging, 1, 467 471. Hildebrand, R., Chow, H., Williams, C., Nelson, M., & Wass, P. (2004). Feasibility of neuropsychological testing of older adults via videoconference: implications for assessing the capacity for independent living. *Journal of Telemedicine and Telecare*, *10*(3), 130-134. Cullum, C., Weiner, M., Gehrmann, H., & Hynan, L. (2006). Feasibility of telecognitive assessment in dementia. *Assessment, 13*(4), 385-390. Cullum, C. M., 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.	In a meta-analysis comparing VTC and FF, Brearly et al., (2017) identified 5 studies that assessed phonemic fluency (Wadsworth et al., 2016; Vestal et. al, 2006; Hildebrand et al., 2004; Cullum et al., 2006; Cullum et al., 2014). The authors found similar mean scores between testing modalities (ICC range: .83-.93). Wadsworth et al., (2018) compared VTC and FF in healthy and cognitively impaired older adults, and found no main effect of administration modality (ANCOVA controlling for age, education, gender, and depression scores p = .814). Vahia et al., 2015 administered the spanish version of phonemic verbal fluency to a latino population and found no differences between VTC and FF.	The examiner should record the patient's responses in a password protected document.	D-KEFS version (FAS) Pearson - open copyright COWAT - PAR - open copyright

	Wadsworth, H. E., Dhima, K., Womack, K. B., Hart Jr, 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*(8), 1040-1045. Vahia, I. V., Ng, B., Camacho, A., Cardenas, V., Cherner, M., Depp, C. A., … Agha, Z. (2015). Telepsychiatry for neurocognitive testing in older rural latino adults. *The American Journal of Geriatric Psychiatry*, *23*(7), 666–670. https://doi.org/10.1016/j.jagp.2014.08.006			
Verbal Fluency - Semantic	Brearly, T. W., Shura, R. D., Martindale, 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. *Neuropsychology review*, *27*(2), 174-186. Wadsworth, H. E., Galusha-Glasscock, J. M., Womack, K. B., Quiceno, M., Weiner, M. F., Hynan, L. S., et al. (2016). Remote neuropsychological assessment in rural American Indians with and without cognitive impairment. Archives of Clinical Neuropsychology, acw030. doi:10.1093/arclin/acw030. Cullum, C., Weiner, M., Gehrmann, H., & Hynan, L. (2006). Feasibility of telecognitive assessment in dementia. *Assessment, 13*(4), 385-390. Cullum, C. M., 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. Wadsworth, H. E., Dhima, K., Womack, K. B., Hart Jr, J., Weiner, M. F., Hynan, L. S., & Cullum, C. M. (2018). Validity of tele-neuropsychological assessment in older patients with cognitive disorders. *Archives of Clinical Neuropsychology*, *33*(8), 1040-1045. Vahia, I. V., Ng, B., Camacho, A., Cardenas, V., Cherner, M., Depp, C. A., … Agha, Z. (2015). Telepsychiatry for neurocognitive testing in older rural latino adults. *The American Journal of Geriatric Psychiatry*, *23*(7), 666–670. https://doi.org/10.1016/j.jagp.2014.08.006	In a meta-analysis comparing VTC and FF, Brearly et al., (2017) identified 3 studies that assessed semantic fluency (Wadsworth et al., 2016; Cullum et al., 2006; Cullum et al., 2014). The authors found similar mean scores between testing modalities (ICC range: .58 - .79). Wadsworth et al., (2018) compared VTC and FF in healthy and cognitively impaired older adults, and found a significant effect of treatment modality, whereby performance was worse in VTC, but only for the cognitively impaired older adults (i.e., MCI or AD). The authors note that while this was statistically significant, it may not be clinically significant, as the mean decrease in performance was only 1-point. Vahia et al., 2015 administered the spanish version of phonemic verbal fluency to a latino population and found no differences between VTC and FF.	The examiner should record the patient's responses in a password protected document.	D-KEFS version (Animals, Boy's Names) owned by Pearson - open copyright

Boston Naming Test	Brearly, T. W., Shura, R. D., Martindale, 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. *Neuropsychology review*, *27*(2), 174-186. Vestal,L.,Smith-Olinde,L.,Hicks,G.,Hutton,T.,& Hart,J.J.(2006).Efficacy of language assessment in Alzheimer's disease:Comparing in-person examination and telemedicine. Clinical Interventions in Aging, 1, 467 471. Cullum, C. M., 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. Cullum, C., Weiner, M., Gehrmann, H., & Hynan, L. (2006). Feasibility of telecognitive assessment in dementia. *Assessment, 13*(4), 385-390. Wadsworth, H. E., Galusha-Glasscock, J. M., Womack, K. B., Quiceno, M., Weiner, M. F., Hynan, L. S., et al. (2016). Remote neuropsychological assessment in rural American Indians with and without cognitive impairment. Archives of Clinical Neuropsychology, acw030. doi:10.1093/arclin/acw030. Vahia, I. V., Ng, B., Camacho, A., Cardenas, V., Cherner, M., Depp, C. A., … Agha, Z. (2015). Telepsychiatry for neurocognitive testing in older rural latino adults. *The American Journal of Geriatric Psychiatry*, *23*(7), 666–670. https://doi.org/10.1016/j.jagp.2014.08.006 Barton,C.,Morris,R.,Rothlind,J.,&Yaffe,K.(2011).Video-telemedicine in a memory disorders clinic: Evaluation and management of rural elders with cognitive impairment. Telemedicine and e-Health, 17, 789 793.	In a meta-analysis comparing VTC and FF, Brearly et al., (2017) identified 4 studies that used either the full BNT or the BNT- 15 item (Vestal et al., 2006; Cullum et al., 2014, Cullum et al., 2006; Wadsworth et al., 2016). The authors found a statistically significant but small summary effect, reducing the score by about 1/10th of a standard deviation. The distribution of scores was homogenous across studies, indicating that this was a consistent finding. BNT-15 VTC 13.1 (2.43) vs FF 13.3 (2.16) 0.812 (ICC). Vahia et al., 2015 administered the spanish version of the BNT (i.e., Ponton-Satz Spanish Naming Test) to a latino population and found no differences between VTC and FF. Barton et al. 2011 is a feasibility study and used the 60 item version of the BNT.	The examiner should present stimuli of pictures via share screening or holding the stimuli in front of the screen (should develop a standardized procedure to ensure image size and quality are kept constant).	Pearson - open copyright
Visuo-Perceptual Abilities				
WAIS - Matrix Reasoning	Hildebrand, R., Chow, H., Williams, C., Nelson, M., & Wass, P. (2004). Feasibility of neuropsychological testing of older adults via videoconference: implications for assessing the capacity for independent living. *Journal of Telemedicine and Telecare*, *10*(3), 130-134.	Hildebrand et al., (2004) found a mean difference of 0.76 (SD = 2.56) between VTC and FF on the WAIS-III matrix reasoning (no	The examiner should present stimuli of pictures via share screening or holding the stimuli in front of the screen (should develop a standardized	Pearson - open copyright

	Barton,C.,Morris,R.,Rothlind,J.,&Yaffe,K.(2011).Video-telemedicine in a memory disorders clinic:Evaluation and management of rural elders with cognitive impairment. Telemedicine and e-Health, 17, 789 793.	statistical significance test done- just mean comparison, but authors state that this represents a small difference). Barton et al. 2011 is a feasibility study.	procedure to ensure image size and quality are kept constant). The patient can use the mouse or touchpad to point at choices if the teleconference platform allows the examiner to pass control of the mouse. Or alternatively, the patient can verbally indicate the number that corresponds to their choice if they are unable to take control of the mouse. The examiner should record the patient's responses in a password protected document.	
Rey-Osterrieth Complex Figure	Galusha-Glasscock, J. M., Horton, D. K., Weiner, M. F., & Cullum, C. M. (2016). Video Teleconference Administration of the Repeatable Battery for the Assessment of Neuropsychological Status. *Archives of clinical neuropsychology : the official journal of the National Academy of Neuropsychologists*, *31*(1), 8–11. https://doi.org/10.1093/arclin/acv058 de Haan, G. A., Tucha, O., & Heutink, J. (2020). Effects of low visual acuity on neuropsychological test scores: A simulation study. *The Clinical Neuropsychologist*, *34*(1), 140-157.	No studies have been done comparing VTC to FF using the Rey figure; however, Galusha-Glasscock et al. (2016) found no significant differences in performance between the RBANS figure copy in VTC vs. FF. de Haan, Tucha & Heutink, 2020 showed that low visual acuity reduced performance on the Rey copy.	The examiner should present stimuli of pictures via share screening or holding the stimuli in front of the screen. The importance of developing a standardized procedure to ensure image size and quality are kept constant is even greater when using visual memory tests that focus on small details. An enlarged picture on a computer screen may change the impression of the picture, which could result in responses deviating from the normative data. The patient should tilt the camera towards their drawing in order to observe their organizational structure. Once completed, the patient should show their drawing to the camera for the examiner to take a screenshot. They would then need to destroy their copy, or send the envelope to the examiner.	PAR - open copyright

WAIS - Block Design	Temple, V., Drummond, C., Valiquette, S., & Jozsvai, E. (2010). A comparison of intellectual assessments over video conferencing and in-person for individuals with ID: preliminary data. *Journal of Intellectual Disability Research*, *54*(6), 573-577.	Temple et al., (2010) examined the Performance IQ (combination of Block Design and Matrix Reasoning subtests) on the WASI and found that it was slightly higher in VTC (M = 70.5) than FF (M = 68.4), but was non-significant (p = .11) (however, they did not report the results of the separate subtests that makeup the Performance IQ). Also, while the administration was done remotely, there was a facilitator in the room with the patient to present the materials.	Not feasible unless the patient is provided with the blocks.	Pearson - open copyright
Judgement of Line Orientation	Turner, T. H., Horner, M. D., VanKirk, K. K., Myrick, H., & Tuerk, P. W. (2012). A pilot trial of neuropsychological evaluations conducted via telemedicine in the Veterans Health Administration. *Telemedicine and e-Health*, *18*(9), 662-667.	No studies directly comparing performance between VTC and FF; however, Turner et al., (2012) used the JOLO in a clinical remote setting, where the stimuli were presented on the screen. The authors reported that it was feasible and appeared comparable to FF administration.	The examiner should present the stimuli via screen sharing, such that the array of lines are at the top of the screen, and the test lines are at the bottom of the screen (i.e., prevent scrolling to a new page). The patient should be discouraged from using their hands or other materials (e.g., the use of a ruler) to help them identify the orientation of the lines. The patient should indicate their choices out loud (i.e., the two numbers corresponding to the lines), rather than pointing to the lines.	PAR - open copyright
Hooper Visual Organization Test	N/A	There is no research on the use of this test in the context of VTC, so it is unknown whether performance is comparable to FF testing.	The examiner should present the stimuli (i.e., the object pieces) via screen sharing and the patient should say what they believe the object to be aloud.	WPS* Request must be made

Visual Object and Space Perception Battery (VOSP) (Shape detection, incomplete letters, silhouettes, object decision, progressive silhouettes, dot counting, position discrimination, number location, cube analysis; Warrington & James, 1990; Rapport et al. 1998)	Jacobsen, S. E., Sprenger, T., Andersson, S., & Krogstad, J. M. (2003). Neuropsychological assessment and telemedicine: a preliminary study examining the reliability of neuropsychology services performed via telecommunication. *Journal of the International Neuropsychological Society*, *9*(3), 472-478. DOI: 10.10170S1355617703930128 de Haan, G. A., Tucha, O., & Heutink, J. (2020). Effects of low visual acuity on neuropsychological test scores: A simulation study. *The Clinical Neuropsychologist*, *34*(1), 140-157.	Jacobsen et al. (2003) found that the Silhouette subtest of the VOSP did not significantly differ between VTC and FF testing (r = .64). de Haan, Tucha & Heutink (2020) showed that low visual acuity reduced performance on the VOSP object decision subtest. No other studies have examined the other subtests in the context of VTC, so it is unknown whether performance is comparable to FF testing	The VOSP consists of a screening test to establish requisite sensory acuity and contains eight clinical tests. Object perception is measured by the Incomplete Letters, Silhouettes, Object Decision, and Progressive Silhouettes tests, whereas space perception is measured by the Dot Counting, Position Discrimination, Number Location, and Cube Analysis tests. For all of the subtests, the stimuli should be presented via screen sharing or shown to the camera (the patient should ensure that the screen brightness is at the maximum), and the responses should be recorded in a password protected document. *Additional modifications required for the Position Discrimination subtest*: the test consists of 20 cards each showing two squares containing dots. The patient has to decide which square has the dot in the center (can use the mouse or touchpad to point at choices if the teleconference platform allows the examiner to pass control of the mouse, or the patient can indicate their choice by indicating the square on the left or right of the screen).	Pearson - open copyright

Neuropsychological Assessment Battery (NAB): Map Reading Subtest (Stern & White, 2003)	N/A	There is no research on the use of this test via VTC, so it is unknown whether performance is comparable to FF testing.	In this test, examinees view a city map with avenues and boulevards traversing north–south and streets and roads traversing east–west. Participants use the map to answer 12 questions regarding the mileage legend, the compass rose, and right–left orientation (measures visuospatial skill, spatial/directional and left/right orientation, and visual scanning). The examiner should present the stimuli (i.e., the city map with compass and legend) via screen sharing. The questions should be stated orally and in writing (underneath the map).	PAR - open copyright
Clock Drawing Test	Brearly, T. W., Shura, R. D., Martindale, 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. *Neuropsychology review*, *27*(2), 174-186. Wadsworth, H. E., Galusha-Glasscock, J. M., Womack, K. B., Quiceno, M., Weiner, M. F., Hynan, L. S., et al. (2016). Remote neuropsychological assessment in rural American Indians with and without cognitive impairment. Archives of Clinical Neuropsychology, acw030. doi:10.1093/arclin/acw030. Montani,C.,Billaud,N.,Tyrrell,J.,Fluchaire,I.,Malterre,C.,& Lauvernay,N.,et al. (1997). Psychological impact of a remote psychometric consultation with hospitalized elderly people. Journal of Telemedicine and Telecare, 3, 140 145. Hildebrand, R., Chow, H., Williams, C., Nelson, M., & Wass, P. (2004). Feasibility of neuropsychological testing of older	In a meta-analysis comparing VTC and FF, Brearly et al., (2017) identified 5 studies that used the clock drawing test (Wadsworth et al., 2016; Montani et al., 1997; Hildebrand et al., 2004; Grosch et al., 2015; Cullum et al., 2006). The authors concluded that it was not possible to estimate an effect of VTC due to the high level of variability between studies. The clock drawing test, being a motor-dependent test, yielded the largest negative effect for VTC. Although, the largest calculated effect was	The patient should tilt the camera towards their drawing in order to observe their organizational structure. Patients could show the copy to the camera and we could take a screenshot (they would then need to destroy their copy), or they could place it in an envelope to be sent to us afterwards.	N/A - Open Source

	adults via videoconference: implications for assessing the capacity for independent living. *Journal of Telemedicine and Telecare*, *10*(3), 130-134. Grosch, M. C., Weiner, M. F., Hynan, L. S., Shore, J., & Cullum, C. M. (2015). Video teleconference-based neurocognitive screening in geropsychiatry. *Psychiatry research*, *225*(3), 734-735. Cullum, C., Weiner, M., Gehrmann, H., & Hynan, L. (2006). Feasibility of telecognitive assessment in dementia. *Assessment, 13*(4), 385-390. Cullum, C. M., 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. Vahia, I. V., Ng, B., Camacho, A., Cardenas, V., Cherner, M., Depp, C. A., … Agha, Z. (2015). Telepsychiatry for neurocognitive testing in older rural latino adults. *The American Journal of Geriatric Psychiatry*, *23*(7), 666–670. https://doi.org/10.1016/j.jagp.2014.08.006 Barton,C.,Morris,R.,Rothlind,J.,&Yaffe,K.(2011).Video-telemedicine in a memory disorders clinic: Evaluation and management of rural elders with cognitive impairment. Telemedicine and e-Health, 17, 789 793.	7/10ths of a SD below on-site scores (Grosch et al., 2015), another study by Cullum et al., 2014 found a null effect). Grosch et al., (2015) found that performance tended to be worse in VTC compared to FF, but this was not significantly different (ICC = .44) Cullum et al., (2014) did not find any statistically significant differences between testing modalities: VTC (M = 5.6, SD = 0.89) vs FF (M = 5.6, SD = 0.80; ICC = 0.709). Similar conclusions were drawn by Cullum et al. 2006. Vahia et al., 2015 administered the spanish version of the clock drawing test to a latino population and found no differences between VTC and FF. Barton et al. 2011 Vahia et al., 2015 administered the spanish version of the WAIS-III digit span to a latino population and found no differences between VTC and FF.is a feasibility study.		
Beery-Buktenica Test of Visual- Motor Integration (VMI)	Temple, V., Drummond, C., Valiquette, S., & Jozsvai, E. (2010). A comparison of intellectual assessments over video conferencing and in-person for individuals with id: Preliminary data. *Journal of Intellectual Disability Research, 54*(6), 573-577. doi:10.1111/j.1365-2788.2010.01282.x	Results for the VMI were non-significant, suggesting a high level of similarity between methods (*p*=0.44).	Option 1: The examiner would mail the stimuli booklet to the patient. The patient would copy the drawings below the stimuli, as normally instructed.	Pearson- open copyrights

			Option 2: Show the stimuli on the screen and have them copy the figures NOT below the stimuli, as is normally instructed in the original protocol, but on a separate sheet of paper. Once completed the patient would show their drawing to the camera for the examiner to take a screenshot and would then place it in an envelope to be sent to us afterwards or destroy the envelope	
Processing Speed				
Symbol Digit Modalities Test / Coding (Written)	Jacobsen, S. E., Sprenger, T., Andersson, S., & Krogstad, J. M. (2003). Neuropsychological assessment and telemedicine: a preliminary study examining the reliability of neuropsychology services performed via telecommunication. *Journal of the International Neuropsychological Society*, *9*(3), 472-478. DOI: 10.10170S1355617703930128	Jacobsen et al., (2003) found comparable performance for the symbol digit motor test between VTC and FF ($p = .77$), and was moderately correlated ($r = .69$).	The patient should be sent a copy of the response sheet via mail. The examiner can complete the demonstration items in the patient's response booklets prior to sending, and can point to the stimuli displayed on the shared-screen. The examiner must ensure that the patient stops at the task time limit. This requires high quality video, which should be directed towards the patient's response booklet and written responses. The patient would be required to mail back their completed response form.	SDMT: PAR - open copyright Coding subtest of WAIS: Pearson - open copyright
Symbol Digit Modalities Test (Oral)	Jaywant, A., Barredo, J., Ahern, D. C., & Resnik, L. (2018). Neuropsychological assessment without upper limb involvement: a systematic review of oral versions of the trail making test and symbol-digit modalities test. *Neuropsychological rehabilitation*, *28*(7), 1055-1077.	Jaywant et al., (2018) suggest that the oral SDMT test has good psychometric properties,	The examiner should present the stimuli via screen sharing. In order to ensure that the examiner is following where	PAR

	Fellows, R. P., & Schmitter-Edgecombe, M. (2020). Symbol digit modalities test: regression-based normative data and clinical utility. *Archives of Clinical Neuropsychology*, *35*(1), 105-115. Jacobsen, S. E., Sprenger, T., Andersson, S., & Krogstad, J. M. (2003). Neuropsychological assessment and telemedicine: a preliminary study examining the reliability of neuropsychology services performed via telecommunication. *Journal of the International Neuropsychological Society*, *9*(3), 472-478. DOI: 10.10170S1355617703930128 Settle, J. R., Robinson, S. A., Kane, R., Maloni, H. W., & Wallin, M. T. (2015). Remote cognitive assessments for patients with multiple sclerosis: a feasibility study. *Multiple Sclerosis Journal*, *21*(8), 1072-1079. DOI: 10.1177/ 1352458514559296	comparable to the written version. Jacobsen et al., (2003) found comparable performance between VTC and FF (p = .83), but had a low correlation between modalities (r = .37) Settle et al. (2015) is a feasibility study. Lower scores on computerized vs. FF. However, authors did not describe how participants made their responses (written vs. typed vs. oral).	the patient is at, the patient should take control of the examiner's screen to direct the mouse. If the teleconference program does not allow for this, the examiner can ask the patient to go slowly, and if the examiner becomes lost, he can ask the patient to redirect them (i.e., state how many boxes down and to the right they are at).	
WAIS - Symbol Search	N/A	There is no research on the use of this test in the context of VTC, therefore it is unknown whether performance is comparable to FF testing .	The patient should be sent a copy of the response sheet via mail. The examiner could share the screen with the patient to demonstrate the practice items, or alternatively, the examiner can complete the demonstration items in the patient's response booklets prior to sending, and can then point to the stimuli on the shared-screen. The camera should be directed towards the response booklet while the patient is completing the test, in order for the examiner to redirect the patient if they have skipped any, and to identify whether the patient	Pearson - open copyright

			completed any additional trials after the stop time.	
Executive Functioning				
Trail Making Test (written)	N/A Barton,C.,Morris,R.,Rothlind,J.,&Yaffe,K.(2011).Video-telemedicine in a memory disorders clinic:Evaluation and management of rural elders with cognitive impairment. Telemedicine and e-Health, 17, 789 793.	There is no research on the use of this test in the context of VTC, therefore it is unknown whether performance is comparable to FF testing. Barton et al. 2011 is a feasibility study.	Option 1: Would need to provide patients with sheets via mail, but it might be difficult to record errors/redirect when an error is made. If the patient is on a laptop, he may direct the camera to the sheet but the examiner is still limited to verbal intervention rather than pointing. This may be the most valid option. Option 2: Share the screen and give the patient control of the examiner's screen (if possible). The patient could then complete the task using the computer mouse while the examiner watches the performance and interjects when needed (however, there is limited research on this method and this will affect time scores).	D-KEFS version: Pearson - open copyright
Trail Making Test (oral)	Wadsworth, H. E., Galusha-Glasscock, J. M., Womack, K. B., Quiceno, M., Weiner, M. F., Hynan, L. S., et al. (2016). Remote neuropsychological assessment in rural American Indians with and without cognitive impairment. Archives of Clinical Neuropsychology, acw030. doi:10.1093/arclin/acw030. Mitsis, E. M., Jacobs, D., Luo, X., Andrews, H., Andrews, K., & Sano, M. (2010). Evaluating cognition in an elderly cohort via telephone assessment. *International Journal of Geriatric Psychiatry: A journal of the psychiatry of late life and allied sciences*, *25*(5), 531-539. http://dx.doi.org/10.1080/23279095.2016.1178645 Kaemmerer, T., & Riordan, P. (2016). Oral adaptation of the trail making test: A practical review. *Applied Neuropsychology:*	In comparing FF to VTC, Wadsworth et al., (2016) and Mitsis et al., (2010) found that Trails A was significantly faster in person; additionally, Kraemmerer & Riordan reported strong correlations between Trails B VTC and FF, but weak correlations for Trails A; therefore, one might consider doing both Trails A and B, but only reporting Trails B scores and B/A ratio.	Instructions: Trails A: "I would like you to count from 1 to 25 as quickly as you can. 1, 2, 3, 4, and so on. Ready? Begin." - Trails B: "Now, I would like you to count again, but this time you are to switch between numbers and letters, so you would say 1, A, 2, B, 3, C, and so on until I tell you to stop.. Ready? Begin." (timing stopped at number 13) If the patient makes an error on either task, direct them back to the last correct item	N/A - Open Source

	Adult, *23*(5), 384-389. http://dx.doi.org/10.1080/23279095.2016.1178645		and start from there. Record time to completion. Should record time and errors made on password protected documents. For scaled scores, could consider transforming raw score into "written trail score" (i.e., Written trails B = oral trails B x 2.44) and then use Heaton norms to attain t-score. However, Kaemmerer & Riordan (2015) cautioned against the use of a uniform conversion factor as other studies found the ratio of written to oral response times was 2.1 rather than 2.44, so could instead use the original article or a more recent study (e.g., Mrazrik et al., 2010) to transform into z-scores using the M and SD reported.	
Color-Word Interference Test (D-KEFS)	Turner, T. H., Horner, M. D., VanKirk, K. K., Myrick, H., & Tuerk, P. W. (2012). A pilot trial of neuropsychological evaluations conducted via telemedicine in the Veterans Health Administration. *Telemedicine and e-Health*, *18*(9), 662-667.	There have been no studies directly comparing Stroop performance between VTC and FF, but it has been used in a clinical setting where stimuli were presented on the screen - Turner et al., (2012) reported that it was feasible.	Option 1: Can display the stimuli on the screen using the share-screen option. When sharing the instructions use the cursor to point to the stimuli. Option 2: Send the stimuli to the patient beforehand. Aim the camera to the stimuli during performance. Once completed have the patient destroy the stimuli.	Pearson - open copyright
Victoria Stroop (Spreen and Strauss, 1998)	N/A	There is no research on the use of this test in the context of VTC, therefore it is unknown whether performance is comparable to FF testing.	Option 1: Can display the stimuli on the screen using the share-screen option. When sharing the instructions use the cursor to point to the stimuli.	Instructions for creating stimuli are provided in the (Spreen, Strauss) *Compendium.*

			Option 2: Send the stimuli to the patient beforehand. Aim the camera to the stimuli during performance. Once completed have the patient destroy the stimuli.	
Luria Sequencing	N/A	There is no research on the use of this test in the context of VTC, therefore it is unknown whether performance is comparable to FF testing.	Would require stimuli to be mailed to the patient (i..e., initial of 3 sequences). The camera should be directed towards their response page while the patient is drawing in order to observe the strategy used. The patient could either hold their drawing up to the screen in order for the examiner to take a screenshot, or could place the drawings in an envelope to be mailed back.	WPS* Request must be made
D-KEFS Design Fluency / Ruff Figural Fluency Test / Five-Point Test	N/A	There is no research on the use of this test in the context of VTC, therefore it is unknown whether performance is comparable to FF testing.	The examiner should mail the response booklet (i.e., the sheet with the dots to create the designs) to the patient. The camera should be directed towards the response page while the patient is drawing in order to observe any errors made and to note any additional drawings completed after the time limit. The patient can hold their designs up to the camera in order for the examiner to take a screenshot, or place the response in an envelope to be mailed back.	D-KEFS version - Pearson - open copyright RFFT- PAR- open copyright
Tower of London	N/A	There is no research on the use of this test in the	The three-dimensional, manipulative nature of the TOL	MHS*

	A computerized version of this test (Stockings of Cambridge) is available from Cambridge Neuropsychological Test Automated Battery (CANTAB) with norms (age, sex, education) and a web-based delivery option.	context of VTC, therefore it is unknown whether performance is comparable to FF testing.	allows the examiner to observe qualitative aspects of the subject's executive planning that are not afforded by a computerized measure. E.g., the manner in which a rule violation is committed can be very informative. Subjects may violate the TOL problem-solving rules without awareness vs. some with intent. This test is not feasible unless provided with the material or is completed via a computerized analog.	D-KEFS Tower: Pearson - open copyright CANTAB- purchase necessary
Attention & Working Memory				
WAIS - Digit Span	Brearly, T. W., Shura, R. D., Martindale, 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. *Neuropsychology review*, *27*(2), 174-186. Wadsworth, H. E., Galusha-Glasscock, J. M., Womack, K. B., Quiceno, M., Weiner, M. F., Hynan, L. S., et al. (2016). Remote neuropsychological assessment in rural American Indians with and without cognitive impairment. Archives of Clinical Neuropsychology, acw030. doi:10.1093/arclin/acw030. Jacobsen, S. E., Sprenger, T., Andersson, S., & Krogstad, J. M. (2003). Neuropsychological assessment and telemedicine: a preliminary study examining the reliability of neuropsychology services performed via telecommunication. *Journal of the International Neuropsychological Society*, *9*(3), 472-478. DOI: 10.10170S1355617703930128 Grosch, M. C., Weiner, M. F., Hynan, L. S., Shore, J., & Cullum, C. M. (2015). Video teleconference-based neurocognitive screening in geropsychiatry. *Psychiatry research*, *225*(3), 734-735.	In a meta-analysis comparing VTC and FF, Brearly et al., (2017) identified 5 that used Digit Span (Wadsworth et al., 2016; Jacobsen et al., 2003; Grosch et al., 2015; Cullum et al., 2006; Cullum et al., 2014). The authors found that the mean effect of VTC on digit span tests (i.e., Repeatable Battery for the Assessment of Neuropsychological Status, Wechsler Adult Intelligence Scale, Wechsler Memory Scale) was small and non-significant. Jacobsen et al., (2003) found no significant differences in performance on the WAIS- Norwegian Version. Total score between testing modalities	Examiners should speak loudly and clearly. The examiner should be careful with the pace at which the numbers are read, as there may be a tendency to read them more slowly via VTC. Do not repeat any trial unless it was not heard due to technical problems. Responses should be recorded in a password protected document.	Pearson - open copyright

	Cullum, C., Weiner, M., Gehrmann, H., & Hynan, L. (2006). Feasibility of telecognitive assessment in dementia. *Assessment, 13*(4), 385-390. Cullum, C. M., 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. Vahia, I. V., Ng, B., Camacho, A., Cardenas, V., Cherner, M., Depp, C. A., … Agha, Z. (2015). Telepsychiatry for neurocognitive testing in older rural latino adults. *The American Journal of Geriatric Psychiatry*, *23*(7), 666–670. https://doi.org/10.1016/j.jagp.2014.08.006 Barton,C.,Morris,R.,Rothlind,J.,&Yaffe,K.(2011).Video-telemedicine in a memory disorders clinic:Evaluation and management of rural elders with cognitive impairment. Telemedicine and e-Health, 17, 789 793.	(VTC: M = 12.1, SD = 2.2; FF: M = 11.8, SD = 1.8, r = .82). Cullum et al. (2014) found good agreement between VTC and FF, for both the forward (VTC: M = 6.1, SD = 1.37, FF: M = 6.2, SD = 1.45; ICC = 0.59), and backward conditions of the digit span (VTC: M = 4.7, SD = 1.26, FF: M = 4.7, SD = 1.24; ICC = 0.545). Wadsworth et al., (2016) found that performance on the digit span forward was significantly better during FF (M = 5.9, SD = 1.4), compared to VTC (M = 5.5 SD = 1.3; p = .004), but there was no significant difference between modalities on digit span backwards (p = .760). Vahia et al., (2015) administered the spanish version of the WAIS-III digit span to a latino population and found no differences between VTC and FF. Barton et al. (2011) is a feasibility study. There is no research comparing performance across VTC and FF using the most recent version of the WAIS (i.e., WAIS-IV)		

WAIS - Arithmetic	N/A	There is no research on the use of this test in the context of VTC, therefore it is unknown whether performance is comparable to FF testing	The examiner should ensure that they are speaking loudly and clearly. Do not repeat any trial unless it was not heard due to technical problems. Remind the patient that they should not record or write down any of the mathematical problems, or any mathematical equations that could help them solve the problems. The examiner should be observant to see whether they are recording anything. Responses should be recorded in a password protected document.	Pearson- open copyright
Brown-Peterson Auditory Consonant Trigram Test	N/A A computer-assisted version of this test is available as part of the French-language Memoria test battery (0, 10, 20, and 30 seconds; Belleville, Chatelois, Fontaine, & Peretz, 2002). Memoria test battery: Belleville, S., Chatelois, J., Fontaine, F., & Peretz, I. (2002). Mémoria: Batterie informatisée d'évaluation de la mémoire pour Mac et PC. Montreal: Institut Universitaire de Gériatrie de Montréal.	There is no research on the use of this test in the context of VTC, therefore it is unknown whether performance is comparable to FF testing.	The examiner should ensure that they are speaking loudly and clearly. Do not repeat any trial unless it was not heard due to technical problems. After the delay period (i.e., 9, 18, 36 sec), the examiner should give an oral cue for the patient to state the trigrams (e.g., “Go”). The patient should be reminded that they cannot write down any of the letters.The examiner should be observant to see whether they are recording anything. Responses should be recorded in a password protected document.	Sample stimuli and score sheets provided by D. Stuss in (Spreen, Strauss) *Compendium.*
Brief Test of Attention	Hildebrand, R., Chow, H., Williams, C., Nelson, M., & Wass, P. (2004). Feasibility of neuropsychological testing of older adults via videoconference: implications for assessing the	Hildebrand et al., (2004) found a mean difference between VTC and FF	The examiner should play the audio files from their own computer at a loud volume and	PAR - open copyright

	capacity for independent living. *Journal of Telemedicine and Telecare*, *10*(3), 130-134.	administration of 0.93 (SD= 3.01). No statistical significance tests were done - just mean comparison, but authors state that this represents a small difference.	test to see if the patient can hear the stimuli properly. Make sure the patient hears the audio coming from the examiner's computer prior to debuting. If the patient reports not being able to hear part of the sequence due to technical problems, the examiner should restart the audio file from the beginning (only once to avoid practice and should mention this in the report). Responses should be recorded in a password protected document.	
WMS - Spatial Span	N/A	There is no research on the use of this test in the context of VTC, therefore it is unknown whether performance is comparable to FF testing.	This test is not feasible unless the equipment is provided or is completed via a computerized analog.	Pearson - open copyright
TEA test (auditory attentional switching and inhibition, sustained attention, and working memory)	N/A	There is no research on the use of this test in the context of VTC, therefore it is unknown whether performance is comparable to FF testing.	The audio files can be easily heard by the examinee if played on the examiner's computer - no need to share the files, but must ensure excellent quality audio transmission. It is more feasible to administer the auditory subtests than the visual ones (e.g., could administer only these subtests: elevator counting, elevator counting with distraction, elevator counting with reversal, Lottery). This permits us to evaluate auditory attentional switching and inhibition,	Pearson - open copyright

			sustained attention, and working memory). Responses should be recorded in a password protected document.	
PASAT (Information processing speed, working memory, and divided attention)	N/A	There is no research on the use of this test in the context of VTC, therefore it is unknown whether performance is comparable to FF testing.	The audio files can be easily heard by the examinee if played on the examiner's computer - no need to share the files, but must ensure excellent quality audio transmission. Per NationalMSSociety.org: Designed and normed for in-person assessment, requires assessor training because "subtle changes in the administration procedures can have a significant effect on the outcome." Sensitive to practice effects. Therefore, if the patient cannot hear part of the auditory sequence due to technical difficulties, only repeat once. Gronwell 1977; Rao et al. 1989. Includes brief practice to ensure comprehension and validity of results. Interstimulus intervals vary across test versions, so verify that selected norms are for the correct version.	Copyright held by S. Rao for 3-sec and 2-sec version: Audio files and norms available at cost on request.
Balloon Test (McMillan & Edgeworth, 1998)	de Haan, G. A., Tucha, O., & Heutink, J. (2020). Effects of low visual acuity on neuropsychological test scores: A simulation study. *The Clinical Neuropsychologist*, *34*(1), 140-157.	The Balloons Test is a paper-and-pencil target cancellation task designed to detect visual inattention. The test consists of two subtests: subtest A for parallel, automatic processing and detection	Would need to send the patient the stimuli. The patient would then place it in a sealed envelope and send back to the examiner.	Published by Thames Valley Test Co, UK but current availability unknown.

		of twenty circles with an adjoining vertical line ('balloons') among a much larger number of circles as distractors. Subtest B asks for serial and effortful search of twenty circles among balloons. No studies comparing VTC to FF using this test, but research by de Haan, Tucha & Heutink, (2020) has shown that altering visual acuity (with simulation goggles) only affects part A (slower with reduced visual acuity), but not part B. This study also showed that low visual acuity reduced performance on other visual perception tests such as VOSP object decision subtest, Rey copy.	Important to consider how the quality of visual information may be degraded with VTC and how this may impact performance / interpretation with norms.	
Learning & Memory				

Verbal Memory				
California Verbal Learning Test (CVLT)	Barcellos, L. F., Bellesis, K. H., Shen, L., Shao, X., Chinn, T., Frndak, S., & Benedict, R. H. (2018). Remote assessment of verbal memory in MS patients using the California Verbal Learning Test. *Multiple Sclerosis Journal*, *24*(3), 354-357. Barton, C., Morris, R., Rothlind, J., & Yaffe, K. (2011). Video-telemedicine in a memory disorders clinic: evaluation and management of rural elders with cognitive impairment. *Telemedicine and e-Health*, *17*(10), 789-793.	Barcellos et al., (2018) found that performance across the 5 immediate trials of the CVLT-II (i.e., list learning) was similar between VTC and FF in MS patients. Barton et al., (2011) assessed the feasibility of conducting remote assessments using the CVLT- short form, which was used together with a battery of other tests to inform the diagnosis of a minor or major neurocognitive disorder. Both the patients and providers provided feedback to indicate that they were satisfied with the evaluation.	Examiners should speak loudly and clearly. The examiner should be careful with the pace at which the words are read, as there may be a tendency to read them more slowly via VTC. Do not repeat any trial unless it was not heard due to technical problems. Remind the patient that they should not record or write down any of the words to help them remember. The examiner should be observant to see whether they are recording anything. Responses should be recorded in a password protected document.	Pearson - open copyright
RAVLT	Hildebrand, R., Chow, H., Williams, C., Nelson, M., & Wass, P. (2004). Feasibility of neuropsychological testing of older adults via videoconference: implications for assessing the capacity for independent living. *Journal of Telemedicine and Telecare*, *10*(3), 130-134.	Hildebrand et al., (2004) found a mean difference between VTC and FF of: Immediate recall: 0.28 (SD = 2.71) Short-delay recall: 0.83 (SD = 2.24) Long-delay recall: 0.34 (SD = 2.44) Learning: 0.72 (SD = 3.00) No statistical significance tests were done- just mean comparison, but authors state that this represents a small difference.	Examiners should speak loudly and clearly. The examiner should be careful with the pace at which the words are read, as there may be a tendency to read them more slowly via VTC. Do not repeat any trial unless it was not heard due to technical problems. Remind the patient that they should not record or write down any of the words to help them remember. The examiner should be observant to see whether they are recording anything.	Test is public domain; Materials and handbook also available for purchase from PAR - open copyright

Rappel libre/Rappel indicé à 16 items (RL/RI-16) de Van der Linden et al. (2004) Francophone adaptation of the Free and Cued Selective Reminding Test (Buschke, 1984;Grober & Buschke, 1987; Grober, Buschke, Crystal, Bang, & Dresner, 1988).	N/A	There is no research on the use of this test in the context of VTC, however, drawing from other studies with similar list learning and memory tests (e.g., CVLT), performance may be comparable between VTC and FF.	Examiners should speak loudly and clearly. The examiner should be careful with the pace at which the words are read, as there may be a tendency to read them more slowly via VTC. Do not repeat any trial unless it was not heard due to technical problems. Remind the patient that they should not record or write down any of the words to help them remember. The examiner should be observant to see whether they are recording anything. Responses should be recorded in a password protected document.	N/A
Hopkins Verbal Learning Test- Revised (HVLT-R)	Brearly, T. W., Shura, R. D., Martindale, 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. *Neuropsychology review*, *27*(2), 174-186. Wadsworth, H. E., Galusha-Glasscock, J. M., Womack, K. B., Quiceno, M., Weiner, M. F., Hynan, L. S., et al. (2016). Remote neuropsychological assessment in rural American Indians with and without cognitive impairment. Archives of Clinical Neuropsychology, acw030. doi:10.1093/arclin/acw030. Cullum, C., Weiner, M., Gehrmann, H., & Hynan, L. (2006). Feasibility of telecognitive assessment in dementia. *Assessment, 13*(4), 385-390. Cullum, C. M., 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.	In a meta-analysis comparing VTC and FF, Brearly et al., (2017) identified 3 studies that assessed HVLT performance (total immediate recall, delayed recall, % retention, recognition; Wadsworth et al., 2016; Cullum et al., 2006; Cullum et al., 2014). Two studies reported similar mean scores between the testing modalities (Wadsworth et al., 2016; Cullum et al., 2006), and one study (Cullum et al., 2014) found that mean total scores were slightly higher in VTC compared to FF (23.4 (SD = 6.90) vs. 22.5 (SD = 6.98), p = .005).	Examiners should speak loudly and clearly. The examiner should be careful with the pace at which the words are read, as there may be a tendency to read them more slowly via VTC. Do not repeat any trial unless it was not heard due to technical problems. Remind the patient that they should not record or write down any of the words to help them remember. The examiner should be observant to see whether they are recording anything. .	PAR - open copyright

	Vahia, I. V., Ng, B., Camacho, A., Cardenas, V., Cherner, M., Depp, C. A., … Agha, Z. (2015). Telepsychiatry for neurocognitive testing in older rural latino adults. *The American Journal of Geriatric Psychiatry*, *23*(7), 666–670. https://doi.org/10.1016/j.jagp.2014.08.006 Harrell, K. M., Wilkins, S. S., Connor, M. K., & Chodosh, J. (2014). Telemedicine and the evaluation of cognitive impairment: the additive value of neuropsychological assessment. *Journal of the American Medical Directors Association*, *15*(8), 600-606. Parikh, M., Grosch, M. C., Graham, L. L., Hynan, L. S., Weiner, M., Shore, J. H., & Cullum, C. M. (2013). Consumer acceptability of brief videoconference-based neuropsychological assessment in older individuals with and without cognitive impairment. *The Clinical Neuropsychologist*, *27*(5), 808-817.	Cullum et al., (2006) found that mean scores on HVLT-R Total Recall and Recognition were similar, but slightly higher means in the FF condition on the Delayed Recall. The verbal percentage retention score showed substantial variability in each test session, suggesting that this score may not be as reliable as the other memory indices. Vahia et al., (2015) administered the spanish version of the HVLT-R to a latino population and found no differences between VTC and FF. Harrell et al., (2014) assessed the feasibility of conducting remote assessments using the HVLT, which was used together with a battery of other tests to inform the diagnosis of a minor or major neurocognitive disorder, and reported that aside from a few technical difficulties that interrupted internet connection on occasion, testing was feasible. Similarly, Parikh et al., (2014) found that the HVLT was feasible and acceptable to administer in a clinical population using VTC.	Responses should be recorded in a password protected document.	

WMS - Logical Memory	Jacobsen, S. E., Sprenger, T., Andersson, S., & Krogstad, J. M. (2003). Neuropsychological assessment and telemedicine: a preliminary study examining the reliability of neuropsychology services performed via telecommunication. *Journal of the International Neuropsychological Society*, *9*(3), 472-478. DOI: 10.10170S1355617703930128	Using the WMS-R, Jacobsen et al., (2003) found memory performance on immediate recall to be significantly better in VTC format compared to FF, but was similar for delayed recall. There is no other research using more updated versions of the WMS in the context of VTC.	Examiners should speak loudly and clearly. Do not repeat any of the story unless it was not heard due to technical problems. Remind the patient that they should not record or write down any of the story to help them remember. The examiner should be observant to see whether they are recording anything. Responses should be recorded in a password protected document.	Pearson - open copyright
WMS - III Mental Control (Short-term verbal memory and working memory)	N/A	There is no research on the use of this test in the context of VTC, therefore it is unknown whether performance is comparable to FF testing.	Examiners should speak loudly and clearly. This test is entirely verbal and easy to administer. Do not repeat any of the items unless it was not heard due to technical problems. Remind the patient that they should not record or write down any of the story to help them remember. The examiner should be observant to see whether they are recording anything. Responses should be recorded in a password protected document.	Pearson - open copyright
Visual Memory				

BVMT-R	Jacobsen, S. E., Sprenger, T., Andersson, S., & Krogstad, J. M. (2003). Neuropsychological assessment and telemedicine: a preliminary study examining the reliability of neuropsychology services performed via telecommunication. *Journal of the International Neuropsychological Society*, *9*(3), 472-478. DOI: 10.10170S1355617703930128 Vahia, I. V., Ng, B., Camacho, A., Cardenas, V., Cherner, M., Depp, C. A., … Agha, Z. (2015). Telepsychiatry for neurocognitive testing in older rural latino adults. *The American Journal of Geriatric Psychiatry*, *23*(7), 666–670. https://doi.org/10.1016/j.jagp.2014.08.006 Harrell, K. M., Wilkins, S. S., Connor, M. K., & Chodosh, J. (2014). Telemedicine and the evaluation of cognitive impairment: the additive value of neuropsychological assessment. *Journal of the American Medical Directors Association*, *15*(8), 600-606.	In the BVTR (similar to the BVMT-R), Jacobsen et al., (2003) found memory performance to be similar between VTC and FF (r = .64). Vahia et al., (2015)administered the spanish version of the BVMT-R to a Latino population and found no significant differences between VTC and FF. Harrell et al., (2014) assessed the feasibility of conducting remote assessments using the BVMT-R, which was used together with a battery of other tests to inform the diagnosis of a minor or major neurocognitive disorder, and reported that aside from a few technical difficulties that interrupted internet connection on occasion, testing was feasible.	The examiner should present the stimuli to patients by either sharing the screen or holding images up to the camera at fixed distance (would need to time 10 seconds per image). Patients would need to have blank sheets of paper (where the trial number is written in the top corner). The patient should hold up their drawings to the screen when they are finished in order for the examiner to take a screenshot, or the patient should be instructed to place their drawings inside of an envelope to be returned via mail (the camera should be turned so that we have confirmation that the drawings are in the envelope so that they cannot view the stimuli to help them remember).	PAR - open copyright
Rey-Osterrieth Complex Figure Immediate and Delayed Recall	Harrell, K. M., Wilkins, S. S., Connor, M. K., & Chodosh, J. (2014). Telemedicine and the evaluation of cognitive impairment: the additive value of neuropsychological assessment. *Journal of the American Medical Directors Association*, *15*(8), 600-606. Barton, C., Morris, R., Rothlind, J., & Yaffe, K. (2011). Video-telemedicine in a memory disorders clinic: evaluation and management of rural elders with cognitive impairment. *Telemedicine and e-Health*, *17*(10), 789-793.	Harrell et al., (2014) assessed the feasibility of conducting remote assessments using the Rey Complex Figure, which was used together with a battery of other tests to inform the diagnosis of a minor or major neurocognitive disorder, and reported that aside from a few technical difficulties that interrupted internet connection on occasion, testing was feasible.	The patient should tilt the camera towards their drawing in order to observe their organizational structure. Once their immediate recall and delayed recall drawings are completed, the patient should show their drawing to the camera for the examiner to take a screenshot. They would then need to destroy their copy, or send the envelope to the examiner.	PAR - open copyright

		Barton et al., 2011 is a feasibility study using a modified Rey-Osterrieth Complex Figure.		
Fine Motor Dexterity				
Grooved Pegboard	Jacobsen, S. E., Sprenger, T., Andersson, S., & Krogstad, J. M. (2003). Neuropsychological assessment and telemedicine: a preliminary study examining the reliability of neuropsychology services performed via telecommunication. *Journal of the International Neuropsychological Society*, *9*(3), 472-478. DOI: 10.10170S1355617703930128	Jacobsen et al. (2003) found comparable performance between VTC and FF for both the dominant (p = .19) and non-dominant hand (p = .35); however, the testing material was provided to the patient.	Not feasible unless the patient is provided with a grooved pegboard.	PAR - open copyright
Effort				
Test of Memory Malingering (TOMM)	N/A	There is no research on the use of this test in the context of VTC, therefore it is unknown whether performance is comparable to FF testing.	The examiner should present the stimuli to patients by either sharing the screen or holding images up to the camera at a fixed distance. The examiner should remind the patient not to write anything down to help them remember the images. Responses should be recorded in a password protected document.	Pearson - open copyright
Dot Counting Test (Boone et al., 2002)	N/A	There is no research on the use of this test in the context of VTC, therefore it is unknown whether performance is comparable to FF testing.	This test requires examinees to count grouped and ungrouped dots as quickly as possible, with the expectation that counting grouped dots will demand less time than ungrouped dots for valid performance populations.	Pearson - open copyright

			The examiner should present the stimuli to patients by either sharing the screen or holding images up to the camera at a fixed distance.	
Rey 15-item Memory Test	N/A	There is no research on the use of this test in the context of VTC, therefore it is unknown whether performance is comparable to FF testing.	The examiner should present the stimuli to patients by either sharing the screen or holding images up to the camera at a fixed distance. The examiner should remind the patient not to write anything down to help them remember the images. Responses should be recorded in a password protected document.	N/A
Other Batteries				
Repeatable Battery for the Assessment of Neuropsychological Status (RBANS)	Galusha-Glasscock, J. M., Horton, D. K., Weiner, M. F., & Cullum, C. M. (2016). Video Teleconference Administration of the Repeatable Battery for the Assessment of Neuropsychological Status. *Archives of clinical neuropsychology : the official journal of the National Academy of Neuropsychologists*, *31*(1), 8–11. https://doi.org/10.1093/arclin/acv058 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4718188/	Mean scores for RBANS total and all index scores were statistically similar across testing modalities. ICC for Total Score = .88 (excellent). ICC for index scores was fair visuospatial/ constructional (ICC = .59). ICC for all other index scores were excellent (ICC range .75-.90) In this study the examiner held up the stimulus in front of the camera for RBANS Figure Copy, Line Orientation, Picture Naming, and Coding. Blank paper and a pen were available in the testing room for the participant as was a copy of the Coding sheet from the test protocol.	The response booklet should be sent to the patient via mail (i.e., coding sheet, blank pieces of paper for the figure copy, and immediate and delayed memory). The stimuli for the figure copy, line orientation and picture naming subtests can be shown to the patient over share screening or holding up the stimuli in front of the camera (although the size and image quality should be standardized) After the patient completes the figure copy, they should place it inside of the envelope provided to ensure that it will not be viewed later. The same	Pearson - open copyright

			should be done for the immediate and delayed recall. For the coding subtest, the examiner can complete demonstration items in the patient's response booklets prior to sending, and can point to the stimuli on the screen. They may also choose to fill in demonstration items on the digital copy of the response booklet displayed on screen with a writing utensil tool (if a good one exists in the teleconference platform). The examiner must ensure that the patient stops at the task time limit. This requires high quality video, which should be directed towards the patient's response booklet and written responses. The patient should be reminded not to write down the words from the list or any parts of the story that could help them remember	

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General points to consider:

1. Would need a new consent form and screen for access to and familiarity with technology
2. Assessments should be done via a licensed and confidential account (e.g., MUHC Zoom) and we would create a google calendar to schedule our evaluations in order to share this account.
3. Test stimuli could be shown using Display on Zoom, or placed in front of a camera in a fixed position, or shown directly to the camera by the examiner (although this might not keep the size of the test items constant).
4. The patient's internet bandwidth should be assessed. Some common problems of VTC that are reported in the literature include poor connection, which can impact what we or the patients hear (could be a problem if they have to repeat a string from digit span or another auditory memory task), so we may wish to only assess patients who have internet above a certain bandwidth.
5. Confidentiality - Answers can be written on a word document by the examiner and screenshots of the patient's answer (e.g. rey figure/ coding) could be taken, then password protected. The patient needs to be in a room where they can be quiet and alone. Make sure the patient does not screenshot any material.
6. Should expect to book more time than what is typically required, as research has shown that VTC takes longer than FF (~10 min; Kirkwood, Peck, & Bennie, 2000). Kirkwood, K.T.,Peck,D.F.,&Bennie,L.(2000).The consistency of neuropsychological assessments performed via telecommunication and face to face. Journal of Telemedicine andTelecare, 6, 147 151.
7. Previous research has also suggested that some patients are more comfortable with remote testing than with an examiner present at the same location (Elford et al., 2000), which might reduce the anxiety as a moderating factor (e.g., performance anxiety, self-awareness) that we can typically observe in session.
8. To maintain eye contact, it may be important for the examiner to look directly at the camera instead of at their computer screen

Computerized Testing Options:

1. *CogState*
2. *CANTAB*
3. *CNSVS*
4. *NIH Toolbox* http://www.healthmeasures.net/explore-measurement-systems/nih-toolbox/intro-to-nih-toolbox - Would need an iPad
5. *Thinc-It (screener created at the Douglas; not certain about the norms) -https://progress.im/en/content/thinc-it-cognition-screening-tool-now-clinically-validated*
6. *ImPACT (typically used in context of concussion research)*

ADDITIONAL MATERIAL

Book Chapter on Teleneuropsychology:

1. **Cullum, C. M., & Grosch, M. G. (2012). Teleneuropsychology. In K. Myers & C. Turvey (Eds.), Telemental health: Clinical, technical and administrative foundations for evidence-based practice (pp. 275–294). Amsterdam: Elsevier.** https://books.google.ca/books?id=K3H4nwl4-gUC&lpg=PP1&ots=BhOuF49OU4&dq=Telemental%20health%3A%20Clinical%2C%20technical%20and%20administrative%20foundations%20for%20evidence-based%20practice.&lr&pg=PP1#v=onepage&q=Telemental%20health:%20Clinical,%20technical%20and%20administrative%20foundations%20for%20evidence-based%20practice.&f=false

Powerpoint Slides on Teleneuropsychology:

1. **Taking Neuropsychology Out of The Office: Extending Our Practice through Telehealth Technology** Munro Cullum, Gerard Gioia,and Kenneth Podell at the 39th Annual Conference of Neuropsychology in Transition (San Diego, 2019)

   https://www.the-ins.org/wp-content/uploads/2020/03/NAN_2019-Taking_Neuropsychology_Out_of_The_Office-_Extending_Our_Practice_through_Telehealth_Technology.pdf

Evidence for NP Tests administered via VC

GLOBAL COGNITIVE
MMSE, Ammons Quick Test, Camcog, NART, SPMSQ, WASI

ATTENTION / INFO PROCESSING
Digit Span, Symbol Digit Modalities, Trail Making Test, Brief Test of Attention, Seashore Rhythm Test, Adult memory & Info Processing

EPISODIC MEMORY
HVLT, CVLT-II Short form, RAVLT, Modified Rey-O Figure, WMSR Logical Memory, Benton Visual Retention Test, Adult Memory & Information Processing

LANGUAGE
Phonemic & Category Fluency, Boston Naming Test, WAIS-3 Vocabulary, BDAE Picture Description, MAE Aural Comprehension

VISUOSPATIAL
Clock Drawing, WAIS-3 Matrix Reasoning, Beery VMI, Visual Object & Space Perception

PSYCHOMOTOR
Grooved Pegboard

Article on self-reported measures via VTC

1. Rutherford, C., Costa, D., Mercieca-Bebber, R., Rice, H., Gabb, L., & King, M. (2016). Mode of administration does not cause bias in patient-reported outcome results: a meta-analysis. *Quality of Life Research : An International Journal of Quality of Life Aspects of Treatment, Care and Rehabilitation - Official Journal of the International Society of Quality of Life Research*, *25*(3), 559–574. https://doi.org/10.1007/s11136-015-1110-8

MMSE administration comparison studies:

1. Brearly, T. W., Shura, R. D., Martindale, 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. *Neuropsychology Review*, *27*(2), 174-186.
2. Ciemins, E., Halloway, B., Coon, P. J.,McClosky-Armstrong, T., & Min, S. (2009). Telemedicine and the Mini-mental state Examination: Assessment from a distance. Telemedicine and e-Health. Doi:10. 1089/tmj.2008.0144.

3. McEachern, W., Kirk, A., Morgan, D. G., Crossley, M., & Henry, C. (2008). Reliability of the MMSE administered in-person and by telehealth. Canadian Journal of Neurological Sciences / Journal Canadien des Sciences Neurologiques, 35(5), 643–646. doi:10.1017/S0317167100009458.
4. Grosch, M. C., Weiner, M. F., Hynan, L. S., Shore, J., & Cullum, C. M. (2015). Video teleconference-based neurocognitive screening in geropsychiatry. *Psychiatry research*, *225*(3), 734-735
5. Cullum, C., Weiner, M., Gehrmann, H., & Hynan, L. (2006). Feasibility of telecognitive assessment in dementia. *Assessment, 13*(4), 385-390.
6. Cullum, C. M., 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.
7. Wadsworth, H. E., Dhima, K., Womack, K. B., Hart Jr, 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*(8), 1040-1045.
8. Loh, P., Ramesh, P., Maher, S., Saligari, J., Flicker, L., & Goldswain, P. (2004). Can patients with dementia be assessed at a distance? The use of telehealth and standardised assessments. Internal Medicine Journal, 34(5), 239–242.
9. Loh, P., Donaldson, M., Flicker, L., Maher, S., & Goldswain, P. (2007). Development of a telemedicine protocol for the diagnosis of Alzheimer's disease. Journal of Telemedicine and Telecare, 13(2), 90–94. doi:10.1258/135763307780096159.

NORMS

Norms for Oral TMT

1. Ricker, J. H., & Axelrod, B. N. (1994). Analysis of an oral paradigm for the Trail Making Test. Assessment, 1 (1), 47–51.
2. Mrazik, M., Millis, S., & Drane, D. L. (2010). The oral trail making test: effects of age and concurrent validity. *Archives of Clinical Neuropsychology*, *25*(3), 236-243. https://www.researchgate.net/publication/41669117

Norms for Design Fluency

1. Jones-Gotman, M., & Milner, B. (1977). Design fluency: The invention of nonsense drawings after focal cortical lesions. *Neuropsychologia*, *15*(4-5), 653-674.
2. Carter, S. L., Shore, D., Harnadek, M. C., & Kubu, C. S. (1998). Normative data and interrater reliability of the Design Fluency Test. *The Clinical Neuropsychologist*, *12*(4), 531-534.

Norms for Brown-Petersen

1. Stuss, D. 1987, 1988, 1989. c.f. *Compendium 3rd Ed.* pp 704-13, Norms: Table 10-13.
2. Quebec Norms using the computerized version: Callahan, B. L., Belleville, S., Ferland, G., Potvin, O., Tremblay, M.-P., Hudon, C., & Macoir Joël. (2014). Normative data for a computer-assisted version of the auditory three-consonant brown-peterson paradigm in the elderly french-quebec population. *The Clinical Neuropsychologist*, *28*(2), 317–332. https://doi.org/10.1080/13854046.2013.873082
3.

Norms for Rappel Libre/Indice (Quebec Norms)

1. Dion, M., Potvin, O., Belleville, S., Ferland, G., Renaud, M., Bherer, L., & Lecomte, S. (2015). Normative data for the Rappel libre/Rappel indicé à 16 items (16-item Free and Cued Recall) in the elderly Quebec-French population. *The Clinical Neuropsychologist*, *28*(sup1), 1-19.