Teleneuropsychological Assessment During the COVID-19 Pandemic: Where Do We Go from Here?

Manu Sharma¹, Himanthri Weerawardhena¹, Alexandra K. Wall¹, Baeleigh VanderZwaag¹, Daniel L. Andruchow¹, Hawra Al-Khaz’Aly¹, Daniel R. Cunningham¹, and Brandy L. Callahan#

¹University of Calgary, Calgary, AB, CA
#Advisor

ABSTRACT

Objective: With the rapid spread of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which causes the coronavirus disease 2019 (COVID-19), and the subsequent alterations to the delivery of health care, telehealth has become an essential service worldwide. Neuropsychology is similarly attempting to adopt telecommunication to deliver neuropsychological services to clients. The purpose this article is to review the utility and value of teleneuropsychological assessment, discuss practical issues and possible barriers related to its implementation and use, and propose considerations and achievable goals to increase the use, acceptance, and clinical utility of teleneuropsychological evaluations.

Method: We reviewed the published literature to extract information about the efficacy and limitations of the methods that are currently used to deliver teleneuropsychological services, as well as current guidelines and ethical principles most salient to teleneuropsychological practice.

Conclusions: Current literature suggests that teleneuropsychological assessment is feasible and acceptable in many patient populations. Practitioners wishing to implement teleneuropsychological assessment should consider using secure testing platforms, participate in continuing education on the topic of remote/online evaluation, and become familiar with alternative technologies. We implore clinicians, researchers, and trainees who have successfully integrated teleneuropsychology into their current practice to keep detailed records of their methods and results in hopes of adding this data to a larger data repository or to publish these results to add to the small, but growing, teleneuropsychology literature. Future research should focus on generating new normative datasets for tests administered remotely, which will involve the pooling of data from multiple sources using teleneuropsychological assessment.

Introduction

The COVID-19 pandemic, caused by SARS-CoV-2, has pushed neuropsychologists to embrace teleneuropsychological practice which, when appropriately used, can decrease risk of client and staff exposure to SARS-CoV-2 and increase accessibility to healthcare in remote areas. Further, the threat of future pandemics cannot be ignored, as risk may increase in coming years as industrial food animal production increases human’s proximity to animals and animal-borne illnesses (e.g., Graham et al., 2008; Jones et al., 2008). Therefore, it is imperative that we be well-prepared for future pandemic situations that will require reduced physical access to healthcare, physical distancing, and other measures taken to reduce risk of virus contraction. At this point, neuropsychologists, researchers, and trainees must forge a path to overcome barriers and limitations to teleneuropsychology. Through the use of technology, updated psychometric theories, and large data repositories and data sharing, effective teleneuropsychological assessment practices can be achieved.
In this commentary, we briefly describe current teleneuropsychological practice and its limitations and barriers to its adoption in clinical settings. We propose some considerations and achievable goals to increase the use, acceptance, and clinical utility of teleneuropsychological evaluations.

The Current State of Teleneuropsychology

In the context of the COVID-19 pandemic, the ideal neuropsychological evaluation is one that minimizes exposure risk for both client and staff. In this respect, teleneuropsychological evaluation is a worthwhile investment because it allows for the remote (i.e., no-contact) assessment of many aspects of cognition. Remote neuropsychological assessments can be broadly categorized by administration environment: within a supervised remote site or in-home. In a supervised remote site setting, clients are assessed in-person in a facility, such as a satellite clinic, by a trained psychometrist, often using computerized measures or document cameras, and are supervised remotely over videoconferencing platforms (VC; e.g., Skype) by a neuropsychologist (Domen et al., 2019). Thus, supervised remote sites allow access to neuropsychological services in areas that do not have that level of specialty care, with the benefit of controlling the client's environment. In contrast, in-home assessments include tests conducted in one's home such as web-based measures that can be entirely self-administered, evaluations completed over the phone, and some standard paper and pen measures administered over VC. However, in-home teleneuropsychological evaluations lack any control over the client’s environment (noise, interruptions, etc.). Both assessment methods therefore have the potential to allow access of neuropsychological assessment services to those in rural and underserved locations, with the added advantage of increased environmental control in supervised remote sites.

While previous research shows strong utility for administration of neuropsychological measures via VC (Brearly et al., 2017; updated by Marra et al., 2020), aspects of teleneuropsychology remain underrepresented in research (e.g., validity and clinical utility of self-administered web-based assessment measures, and computerized testing). We will briefly provide an overview of the teleneuropsychology literature for VC administered neuropsychological measures, self-administered web-based measures, measures administered via telephone, with the specific objective to provide directions and achievable goals for the future of teleneuropsychological practice.

Videoconference Neuropsychological Evaluation

VC involves the live online administration of neuropsychological tests using a camera-embedded computer or tablet to allow the examiner to view, communicate with, and assess the individual. In-home assessments using VC typically contain high-quality audio and full-motion video for a two-way view of the individual and examiner (Adjorlolo, 2015; Brearly et al., 2017; Castanho et al., 2017).

When compared to in-person assessments, neuropsychological assessments via VC yield similar scores across several standard verbally mediated tasks, including digit span, verbal fluency, and list learning measures (Brearly et al., 2017), and common screening measures (e.g., Montreal Cognitive Assessment [MoCA]; Abdolahi et al., 2016; Chapman et al., 2019). An inherent limitation to VC administered neuropsychological measures is the difficulty with real-time supervision and scoring of visually mediated and motor dependent tasks (e.g., Clock Drawing Test). However, these limitations can be overcome by validating task performance with webcams (e.g., having the webcam repositioned to capture the client’s work area, or having the client hold up the response sheet to the webcam; Cullum et al., 2006; Lindauer et al., 2017; Cullum et al., 2014). It is also important to consider computer resolution when administering VC assessments. Images presented in-person may not be the same size or resolution as those administered via VC. In addition, studies involving participants with high-speed internet connections noted negligible differences in videoconference and on-site conditions; however, there was greater variability in studies utilizing poorer internet speed and older participants (Brearly et al., 2017).

VC neuropsychological evaluations have been successfully applied to individuals with stroke, cancer, dementia, mild cognitive impairment, major depressive disorder, anxiety, post-traumatic stress disorder, autism spectrum disorders.
disorder, as well as with school-based cognitive and achievement testing (Galusha-Glasscock et al., 2016; Godleski et al., 2012; Grosch et al., 2011; Hess & Audebert, 2013; Parmanto et al., 2013; Smith et al., 2017; Wadsworth et al., 2017). In fact, large percentages of clients (up to 98%) show acceptance and satisfaction for VC neuropsychological assessments (Dang et al., 2018; DeYoung & Shenal, 2019; Feenstra et al., 2018; Harrell et al., 2014; Parikh et al., 2013), with 90% of caregivers of mildly cognitively impaired patients preferring it to traditional in-clinic assessments (Dang et al., 2018). However, those with greater cognitive impairment show preference for in-person evaluation (Parikh et al., 2013). Overall, VC is an accepted and effective method of assessment for many clients, making this a viable alternative for traditional assessment.

Self-Administered Web-Based Instruments

Self-administered online instruments are web-based measures that can be completed without supervision. A multitude of online instruments have been developed for self-administration and are generally used as screening tools and assessments of general cognition (e.g., Domen et al., 2019; Feenstra et al., 2018; Mackin et al., 2018; Trustram Eve & de Jager, 2014), with some also designed to specifically monitor longitudinal changes in cognition (e.g., Ruano et al., 2016; Wesnes et al., 2017; Zakzanis & Azarbehi, 2014). Several of these self-administered online instruments have been validated in multiple patient populations (e.g., Biagianti et al., 2019; Trustram Eve & de Jager, 2014; Zakzanis & Azarbehi, 2014). Additionally, widely used and clinically-validated computerized cognitive assessments, such as the Cambridge Neuropsychological Test Automated Battery (CANTAB; Cambridge Cognition Ltd., 2019), have the potential to be offered in a web-based self-administered setting (see www.cambridgecognition.com). Access and use of these online validated tools can increase the efficiency of a teleneuropsychological assessment, in that the patient can complete the screening before meeting with the neuropsychologist.

Telephone Assessments

Some neuropsychological measures can be administered over the phone as a convenient way to provide general screening. Individuals do not need access to the internet, which makes telephone assessments especially attractive for use with patient populations who are less likely to have reliable internet access (e.g., those living in remote locations). However, without the ability to directly observe clients, these telephone assessments are limited to verbal components. Some traditionally face-to-face neuropsychological measures have been adapted for use over the phone, such as the MoCA, by reweighting items and removing visual components (Wong et al., 2015). Other neuropsychological assessments such as the Cognitive Telephone Screening Instrument (COGTEL; Kliegel et al., 2007) and Telephone Interview for Cognitive Status (TICS; Brandt et al., 1988) have been designed specifically for telephone administration. The COGTEL and the TICS (modified) have demonstrated moderate to high degrees of agreement between cognitive assessments delivered in person and conducted over the telephone (Castanho et al., 2016; Kliegel et al., 2007). Thus, telephone assessments may serve as useful screening tools when computer access is limited or is not preferred.

Current Barriers and Limitations of Teleneuropsychology

Teleneuropsychology is not without its limitations. Relatively minor shortcomings of VC include restrictions on the practitioner’s view of the client and the testing environment, which limit the observations that can be made about a client’s subtle behaviors. The practitioner is also unable to identify distractors that may be present in the client’s environment and prevent interruptions and excessive noise that may interfere with complete attention to the task. The practitioner is not able to take in qualitative observations and develop a more personal relationship with the client. There are also logistical difficulties in administering motor-based tasks, or measures that require the client to manipulate stimuli (e.g., Block Design; Wechsler, 2008). It is important to consider clients’ individual situations which may
affect their ability to complete the assessment in a home environment, such as computer access, internet quality, and ability to download programs as needed for certain tasks (Bauer et al., 2012).

More major limitations related to teleneuropsychological assessment include difficulty in emergency management, limited variability in populations that can be assessed using this method, deviations from standardized protocols, and issues related to copyright infringement. First, emergency management is important to consider as many patients may suffer from a range of mental illnesses and health conditions, and may express suicidal thoughts or encounter a medical emergency such as a seizure. Clinicians should consider establishing an emergency protocol prior to beginning assessment, which may involve obtaining the contact information of a third party who can assist in an emergency, as well as ascertaining the patient’s exact location in the event that medical help is required. Second, some populations may not be suitable for teleneuropsychological assessment, for example those with behavioral dysregulation or severe cognitive impairment. A third challenge is that deviating from standardized procedures (i.e., moving paper-and-pencil tests online) essentially render the procedures experimental, though a recent review and meta-analysis suggest negligible differences in scores between in-person and VC administration (Brearly et al., 2017). An associated problem is that interpretive normative data is no longer applicable for reference; increasing use of teleneuropsychological practices will require the development of normative data specific to online tests. Lastly, copyright issues and protection of testing materials can prevent the use of certain tests through an online platform. It is the duty of the neuropsychologist to identify when copyright infringement might occur and find a way to appropriately move the task online or identify an alternate, appropriate, online neuropsychological measure. For instance, testing materials can be protected to some extent by using platforms containing test materials which are password protected, or in a format which is not easily duplicated, such as through screen-sharing during a VC assessment.

Several barriers hamper the successful implementation and integration of teleneuropsychological services. Ethical considerations include concerns regarding privacy, breaches in confidentiality, or lapses in test security (Lanagarizadeh et al., 2017; Stoll et al., 2020). It is critical that practitioners maintain the confidentiality and security of patient data in terms of data transmission (e.g., emails) and data storage. To mitigate the risk of compromised data security and breaches of confidentiality, neuropsychologists should keep abreast of developments in security and update security measures at their practice as appropriate (American Psychological Association, 2013; Stoll et al., 2020). In addition, practitioners should take care to use VC applications like Skype for Business, that do meet requirements for security set out by the Health Insurance Portability and Accountability Act, instead of Skype, which does not (HIPAA Journal, 2017). Overall, with thoughtful consideration for best practices, these ethical concerns can be addressed.

Legal barriers such as practicing across state lines (for example) also affect the implementation of these services. Neuropsychologists should be trained in the technical and legal aspects of teleneuropsychology prior to administering teleneuropsychological services to clients (Brearly et al., 2017). The Telebehavioral Health Institute (https://telehealth.org), for example, offers online training courses on these aspects of telepsychology, such as How to Legally Practice Over State Lines, and Essential Telehealth Technologies.

Furthermore, teleneuropsychological practice has been limited by the lack of desire or willingness on part of clinicians to use technological modalities to provide services (Chakrabarti, 2015; Fantus & Mishna, 2013; Rogove et al., 2012; Stoll et al., 2020), potentially due to concerns regarding privacy, establishing rapport, technological limitations, education and training, as well as licensing and credentials (Cowan et al., 2019). The American Psychological Association’s Guidelines for the Practice of Telepsychology acknowledge that “the psychologist’s knowledge and competence in the use of the telecommunication technologies being utilized” (APA, 2013, p. 791) is a significant barrier to telepsychology and, therefore, teleneuropsychology. As such, it becomes the responsibility of neuropsychologists to ensure their competency through professional training, educational experience such as attending professional training programs, consultation with other neuropsychologists, and risk management practices (APA, 2013). Further, to ensure clinician competency, clinical psychology training programs could implement modules on online
assessment as part of the regular curricula. Similarly, psychology regulatory bodies could mandate that neuropsychologists complete modules in telepsychology (e.g., Telepsychology Best Practices 101 series offered through APA) and online test administration as part of continuing education practices and professional training. Practitioners and trainees may also choose to enroll in telemental health training programs, such as the Texas A&M Telebehavioral Care Program, to learn to provide neuropsychological services through technological means (McCord et al., 2015). To improve the utility of teleneuropsychology, clinicians must not only ensure their own competency, but also become more accepting of this service modality.

Considerations to Improve Teleneuropsychology

**Computerized Tests & Technology**

While technological advances may seem daunting, we believe they will ultimately allow for improvements to neuropsychological assessment. One such opportunity lies in the use and development of computerized testing, which has several benefits. While there are significant initial costs of transitioning to using computerized cognitive measures (e.g., purchasing devices, software, and continued licenses; Kessels, 2019), it is a worthwhile investment. First, the reliance on human administration is substantially reduced, thereby reducing human error that is inherent in administering neuropsychological measures. For example, current paper-and-pencil neuropsychological measures require adjustments to administration based on reversal and discontinuation rules (e.g., subscales of the Wechsler Adult Intelligence Scale [WAIS]). This can be automated with computerized adaptive testing, which makes these adjustments based on the individual’s performance (see Bilder & Reise, 2019).

A further benefit of computerized testing is the potential for incorporating more modern psychometric theories to obtain more nuanced data. For example, item response theory is a statistical modelling approach that assumes that latent traits are responsible for an individual’s response on each item of a test. That is, different responses on a measure with multiple possible responses hold different meaning (Preston & Reise, 2014), which may be due to some latent factor within an individual (Bilder & Reise, 2019; Reise & Waller, 2009). Similarly, when presented with multiple options on a given measure, such as Matrix Reasoning (Wechsler, 2008) which has five possible responses, each of the four incorrect responses would have different meaning. Thus, an emphasis is placed on analysis of errors and strategies used to complete tasks, rather than just total scores on a measure. In fact, research into errors and task completion strategies has been conducted on several regularly used neuropsychological measures, showing improved sensitivity to detect traumatic brain injury using the Digit Span test (Díaz-Orueta et al., 2020; Woods et al., 2011), and ability to distinguish between subjective cognitive impairment, mixed dementia and Alzheimer’s disease on verbal fluency tasks (Díaz-Orueta et al., 2020; König et al., 2018). Incorporating item response theory while developing computerized neuropsychological measures will then increase the efficiency of neuropsychological evaluations as greater information can be gathered at the item level of a measure. Thus, a shift in the neuropsychological assessment paradigm is warranted. Specifically, we must adopt a culture of openness to change where resources are allocated to create, validate and train clinicians on using computerized neuropsychological assessment measures.

The future of teleneuropsychological assessment will benefit from technologies that provide supplementary objective data that can be used to assist with diagnosis and interpretation. One such tool is eye tracking, for which cognitive measures exist and are being developed. For example, the visual paired comparison task records eye movement patterns during exposure to different visual stimuli and can differentiate between cognitively healthy individuals and those with amnestic mild cognitive impairment (Seligman & Giovannetti, 2015) and Alzheimer’s disease (Bott et al., 2018; Zola et al., 2013). While eye tracking is customarily measured in the laboratory environment, there is evidence to support eye tracking measurement using device-embedded cameras (e.g., camera in a laptop; Bott et al., 2018), which could be convenient to implement in teleneuropsychological assessments. With further research into the clinical uses of eye tracking, certain eye movement profiles may be identified in different patient populations (e.g., concussion; Bin Zahid et al., 2018; Samadani et al., 2016), which can further be used to help confirm a suspected deficit or diagnosis.
Other technologies show merit in providing supplementary health information to assist in teleneuropsychological evaluation and can be conveniently worn by the client. Emerging research using electroencephalography (EEG), typically acquired in a laboratory setting, shows promise as an assessment tool for cognitive impairment, with good clinical utility (Ghosh Hajra et al., 2016), and can also be measured using a portable wearable device (Fickling et al., 2019). Other wearable accessories can provide similar physiological information such as heart rate and electrocardiogram data (Bilder & Reise, 2019). Other technologies include a digitizing pen that is used in a digitized version of the Clock Drawing Test (i.e., the Digital Clock Drawing Test), often used as a screening tool for a wide range of neurological disorders, including Alzheimer’s disease (Freedman et al., 1994). The digitizing pen can detect pauses in drawing, pen strokes, time, and minor tremors while drawing, and takes advantage of machine learning to create prediction models (Davis et al., 2014). The Digital Clock Drawing Test shows clinical utility in differentiating healthy controls from mild cognitive impairment and Alzheimer’s disease (Davis et al., 2014) and offers possible significant improvements in accuracy to detect early cognitive impairment (Souillard-Mandar et al., 2016). We should expect and strive for the future of teleneuropsychological assessment to incorporate these multimethod measurement tools to be used in home and at remote assessment sites. In the context of a teleneuropsychological evaluation, these tools can provide supplementary information of testing experience that might go unnoticed over VC.

The development and continued improvement of computerized assessments in combination with incorporating new technologies for teleneuropsychological assessments in the near future will result in shorter teleneuropsychological assessments that optimized to provide practitioners with adequate data to make diagnoses and interpretations. It will further result in greater access to neuropsychological assessments for individuals in remote areas or who are unable to leave their home (e.g., those at higher risk of complications from COVID-19).

New Norms and Data Sharing
The development of computerized tests and use of newer technologies requires rigorous research to develop appropriate normative data for comparison and new standardized administration methods. Specific attention must be placed on hardware (i.e., differences between touchscreen, mouse, trackpad, and keyboard, and differences between desktop, laptop, and tablet) and software (e.g., latency differences in presentation of stimuli between devices; Germine et al., 2019). For example, the Trail Making Test requires the client to connect circles containing numbers or circles containing numbers and letters in ascending order, in which scoring is based on time to completion (Reitan, 1958). Time to completion is significantly impacted by screen size and type of device (touchscreen tablet vs. desktop; Germine et al., 2019).

A task of this magnitude requires significant resources. The National Institute of Mental Health (NIMH) has already developed the infrastructure for this work and is currently collecting normative data for the most widely used neuropsychological measures via the NIMH Data Archive (NDA; https://nda.nih.gov/). In support of this initiative, the National Neuropsychology Network (NNN; https://www.sistat.ucla.edu/NNNWeb/index.html) is currently conducting a demonstration program, acquiring neuropsychological data in an effort to aggregate item-level data from the most widely used neuropsychological measures into the NDA (see Bilder & Reise, 2019). The list of neuropsychological measures for which data is being acquired is extensive but does not yet include teleneuropsychological instruments. While these may not soon be added to the NDA, we, as a first step, encourage collaborative discussion and hope to increase awareness of this viable option in conducting neuropsychological evaluations that extend access to care and reduce disease exposure risk for the vulnerable.

Conclusion

The COVID-19 pandemic has forced clinicians and researchers to embrace teleneuropsychological assessment practice in order to increase access to healthcare and to continue time sensitive research (e.g., clinical trials). Although teleneuropsychological evaluation may not be suitable for all clients, its precipitated integration into the field of neuropsychology provides a unique opportunity for continued professional learning, improvement or development of
computerized measures, collaborative pooling of data to allow for development of norms, and new avenues of research on the reliability and validity of teleneuropsychological measures. We implore researchers and clinicians alike to maintain detailed records of neuropsychological test administration conducted during the COVID-19 pandemic, in hopes of adding data to the NDA and contributing valuable data to this nascent body of literature.

References


CANTAB® [Cognitive assessment software]. Cambridge Cognition (2019). All rights reserved. www.cantab.com


