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A Comparison Of Paper-pencil Versus Video-conferencing Administration Of A Neurobehavioral Screening Test

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A COMPARISON OF PAPER-PENCIL VERSUS VIDEO-CONFERENCING ADMINISTRATION OF A NEUROBEHAVIORAL SCREENING TEST

by

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ABSTRACT

Regardless of the reason, many patients/clients do not have access to face-to-face medical, neuropsychological, or mental health consultation, assessment, or treatment (Cowain, 2001). The term Remote Neuropsychological Assessment (RNA) has been proposed by Browndyke to denote the general use of telecommunication and Internet-based technologies in neuropsychological assessment and practice (as cited in Schatz & Browndyke, 2002). RNA (Telemedicine) offers a plausible, potentially cost-effective solution to individuals in need of medical, neuropsychological, or mental health consultation, assessment, or treatment that are located in geographical areas away from the specialist (Armstrong, 2006; Berman, 2005; Cowain, 2001; Jacobsen, Sprenger, Andersson, & Krogstad, 2003). The purpose of this study was to examine if test performance for RNA administration of the Cognistat is comparable to test performance for the pencil-paper administration. A one-way repeated measures multivariate analysis of variance (MANOVA) was used to analyze the data. The main effect for administration modality was not significant, $F(9, 126) = .375$, $p = .945$. The present study demonstrated the utility of a widely used neurobehavioral screening test that provides a differentiated profile of cognitive status can now reliably be used through a video-conferencing administration. The importance of this finding is that a more comprehensive detection of deficits in multiple domains of cognitive functioning for screening purposes is now possible remotely.

This thesis is dedicated to my family: Mom, Dad, Jordan, and Sam.

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LIST OF ACRONYMS/ABBREVIATIONS

BPRS-A	Brief Psychiatric Rating Scale-Anchored Version
DSM-IV	Diagnostic and Statistical Manual Four
FSIQ	Full Scale Intelligence Quotient
GDS	Geriatric Depression Scale
HAM-D	Hamilton Depression Scale
ICC	Intra-class correlations
ID	Intellectual Disabilities
IQ	Intelligence Quotient
LCVC	Low-Cost Video-Conferencing System
MacCAT-CA	MacArthur Competence Assessment Tool-Criminal Adjudication
MMSE	Mini-Mental State Examination
RNA	Remote Neuropsychological Assessment
SPMSE	Short Portable Mental Status Exam
TMH	Tele-Mental Health
VMI	Beery-Buktenica Test of Visual-Motor Integration
WASI	Wechsler Abbreviated Scale of Intelligence
WMS	Wechsler Memory Scale

INTRODUCTION

All careers that that involve humans interacting utilize some form of measurement to obtain data to answer a question, solve a problem, or make a decision. This frequently involves testing and assessment. Psychological testing is defined as "the process of measuring psychology-related variables by means of devices or procedures designed to obtain a sample of behavior" (Cohen & Swerdlik, 2010, p. 2). Psychological assessment is defined as "the gathering and integration of psychology-related data for the purpose of making a psychological evaluation that is accomplished through the use of tools such as tests, interviews, case studies, behavioral observation, and specially designed apparatuses and measurement procedures" (Cohen & Swerdlik, 2010, p. 2).

The beginnings of contemporary psychological assessment can be traced back to the first experimental psychology laboratory founded by Wilhelm Max Wundt at the University of Leipzig in Germany in the late 19^{th} century. The laboratory tested such variables as reaction time, perception, and attention span in an attempt to develop an archetype of human sensory abilities. James McKeen Cattell, one of Wundt's students, created the term "mental test" in an 1890 publication. Many other students of Wundt's went on to impact the progression of psychological testing. In 1905 Alfred Binet and Theodore Simon published an intelligence scale to identify mentally retarded children in the Paris school system. This intelligence scale is credited for commencing the clinical testing movement. Receptivity to intelligence testing was the impetus for the development of many other types of psychological testing (i.e. personality, achievement, aptitude, diagnostic, psychoeducational, career, neuropsychological, etc.) and by the end of the 1930's there were approximately four thousand different psychological tests in print (Cohen & Swerdlik, 2010). Clinical psychology almost became synonymous with psychological testing. Neuropsychology, formerly just a specialty area of clinical psychology, and primarily involved with testing, began to evolve into its own specialty in the late 20th century (Groth-Marnat, 2009).

Today, there are specific neuropsychology doctoral programs (although many are clinical neuropsychology), certifying bodies, and subspecialty areas within neuropsychology (Groth-Marnat, 2009). Neuropsychology is the branch of psychology that is concerned with the relationship between the brain and behavior. Neuropsychological assessment is "the evaluation of brain and nervous system functioning as it relates to behavior" (Cohen & Swerdlik, 2010, p. 512).

Neuropsychologists typically administer a battery of tests. They may administer a fixed battery, which entails a specific set of neuropsychological tests being administered regardless of the reason for testing (e.g., the Halstead-Reitan or Luria-Nebraska batteries), or a flexible (i.e., individualized) battery, which consists of the neuropsychologist choosing to administer various tests that are relevant to the reason for testing (e.g., the Benton approach) (Cohen & Swerdlik, 2010; Groth-Marnat, 2009).

Cohen & Swerdlik (2010) assert that neuropsychologists must be prepared to evaluate individuals with disabilities and other special populations and that there will always be new tools being developed to meet the need for testing and assessment of individuals from these special populations.

Regardless of the reason, many patients/clients do not have access to face-to-face medical, neuropsychological, or mental health consultation, assessment, or treatment (Cowain, 2001). Telemedicine, Telconsultation, Tele-health, or Tele-mental health (TMH) offers a plausible, potentially cost-effective solution to military personnel, prison inmates, individuals living in rural areas, and/or individuals with transportation issues (e.g. the impoverished and disabled), etc. in need of medical, neuropsychological, or mental health consultation, assessment, or treatment (Armstrong, 2006; Berman, 2005; Cowain, 2001). It is reasonable to assume that it is economical for individuals to be tested remotely in that it would save time (e.g. not needing to take time off work for an appointment that requires commuting) and money to pay for transportation. This might not be the situation for all individuals, but logically it would benefit most economically.

Telemedicine refers to various applications of telecommunication technology used to provide medical services to patients located in different geographical areas than the clinician (Jacobsen, Sprenger, Andersson, & Krogstad, 2003). The term Remote Neuropsychological Assessment (RNA) has been proposed by Browndyke to denote the general use of telecommunication technologies in neuropsychological assessment and treatment (as cited in Schatz & Browndyke, 2002).

Hailey, Roine, and Ohinmaa (2008) reviewed 72 published studies that described 65 published projects addressing TMH. Of the 65 reviewed studies, 32 (49%) of the studies were considered by the authors to be of high or good quality and a further 20% were considered fair-to-good quality. In 62% of the reviewed studies, further work was needed to provide reliable evidence of benefit, and further follow-up work seemed desirable for another 20%. TMH was judged to have been successful in just over 50% of the studies reviewed and as potentially successful in a further 28%. Evidence was stronger for Internet- and telephone-based interventions than for video-conferencing interventions. There was evidence of success with TMH in various populations including: child psychiatry, posttraumatic stress, depression, dementia, schizophrenia, panic disorders, substance abuse, suicide prevention, eating disorders, and smoking prevention. Further study was judged to be necessary or desirable in 53 (82%) of the studies. The authors conclude that the evidence of benefit from TMH applications is encouraging, though still limited and in need of further research.

It is important to consider if individuals seeking neuropsychological assessment are capable of participating in RNA or TMH. Bergquist, Gehl, Lepore, Holzworth, and Beaulieu (2008) addressed whether individuals with cognitive impairments or traumatic-brain injuries have the ability to engage in telecommunication assessment methods. The authors provided evidence that Internet-based cognitive rehabilitation is likely feasible, even among individuals with severe memory impairments, following acquired brain injury. The results of this study indicated that persons with documented memory impairment after acquired brain injury are able to reliably and independently use an instant messaging system to participate in cognitive rehabilitation following initial training. Cognitive rehabilitation outcomes were not assessed.

The application and clinical research of RNA is limited (Schatz & Browndyke, 2002). Ball, Scott, McLaren, and Watson (1993) compared the Mini-Mental State Examination (MMSE) scores of 12 acute psychiatric patients when the test was performed face-to-face and over a Low-Cost Video-Conferencing System (LCVC). The order of testing was randomly allocated and the retesting was performed within 48 hours in order to minimize the effect of changing mental state, although this carried some risk of a learning effect. The study showed face-to-face and video-conferencing (VL-1) scores were highly correlated (r = .89) and rescoring of illegible material (VL-2) resulted in an improvement of the correlation (r = .92). There was no significant difference between VL-1 and Vl-2, $t(10) = 1.936$, $p = .0816$. This suggests that the MMSE can be satisfactorily transferred to the LCVC in this population with only small modifications to sections of the test. The three part command (take the paper in your right hand, fold it in half and place it on the floor) of the Confrontation Naming Test in the MMSE required modification as the placement on the floor could not be seen by the researcher. The subject was instead asked to place the paper on his/her head. Stimulus materials were also modified (font, positioning) so that they occupied the whole of the subject's screen and were easily visible. This study provided evidence that a standardized cognitive screening test can be reliably carried out using the LCVC system in an adult population with acute psychiatric illness. It must now be demonstrated that this finding is more generally applicable to a wider age group, across a greater range of diagnostic categories, and cognitive states.

Temple, Drummond, Valiquette, and Jozsvai (2010) assessed 19 individuals with intellectual disabilities (ID) between the ages of 23 and 63 years via face-to-face and video-conferencing (there was a minimum interval of 5 months and a maximum interval of 21 months between testing sessions, with a mean interval of 10.4 months). These authors used the Wechsler Abbreviated Scale of Intelligence (WASI) and the Beery-Buktenica Test of Visual-Motor Integration (VMI). In addition to examining video-conferencing assessment of individuals with ID, the authors intended to further examine tests where the individual must demonstrate their cognitive skill directly by manipulating materials, or more performance based tests. For the video-conferencing condition, a nonregistered staff member from a local community agency, previously trained in basic testing procedures, was present with the participant. For performance tasks that required manipulation of materials or hands-on activity, directions were given by a remotely located psychologist (via the video-conferencing feed), but materials were presented by the assistant. Also, all timing, scoring, interpretation, and evaluation was done by the psychologist. WASI Full Scale Intelligence Quotient (FSIQ) scores varied by an average of less than one intelligence quotient (IQ) point across administration conditions. On the VMI, results deviated by less than one standard score across administration conditions. Correlations between the two modes of administration were high for both the WASI and VMI with all results over 0.9. The authors concluded that video-conferencing administration does not appear to be significantly different for the overall score on a brief intelligence test or a test of visual-motor integration compared to a face-to-face administration. Additionally, the authors asserted that participant activity during the assessment and other clinical observations occurring out of the view of the camera can affect test results and may not be identified by the remote assessor. For this reason, the authors recommended having a knowledgeable and experienced staff member present at the remote site during the assessment is important.

Lexcen, Hawk, Herrick, and Blank (2006) used a similar research design (present observer for video-conferencing assessment) to assess if structured forensic interviews conducted via video-conferencing assessment are comparable with interviews conducted face-to-face. Inter-rater reliabilities for two video-conferencing interview conditions were compared with those for face-to-face interviews with the Brief Psychiatric Rating Scale-Anchored Version (BPRS-A), and the MacArthur Competence Assessment Tool-Criminal Adjudication (MacCAT-CA). Seventy-two forensic inpatients from the maximum-security forensic unit of a state hospital served as participants. Most participants were detained after being found not guilty by reason of insanity, while some participants were detained pretrial. All participants had *DSM-IV* Axis I diagnoses of severe mental illnesses and many also had Axis II diagnoses. The BPRS-A provides an estimate of the presence and severity of psychopathology as measured by a 7-point rating of symptoms on a Likert scale. The MacCAT-CA is used to assess competence to stand trial. The MacCAT-CA consists of three subscales: (1) an "understanding" subscale to assess the defendant's knowledge of courtroom procedures and roles of trial participants; (2) a "reasoning" subscale to assess the defendant's recognition of the relevance of factual information for a defense; and (3) an "appreciation" subscale to assess whether a defendant's perceptions of his or her own legal situation are unduly influenced by symptoms of a thought disorder. Items are scored as the following: 0, no credit; 1, partial credit; or 2, full credit. The study used three administration and observation conditions. The first condition (local administration, remote observation) entailed face-to-face administration, with observation via video-conferencing. The second condition (remote administration, local observation) entailed administration via video-conferencing and observation by the present researcher. The third condition (local administration, local observation) entailed face-to-face administration and observation. In each condition, the MacCAT-CA and BPRS-A were administered by a single researcher. Instruments were scored independently by both the interviewer and the observer. Three researchers were clinical psychologists, and one was a senior graduate student in clinical psychology. All researchers were trained and experienced in performing clinical evaluations with the BPRS-A, and forensic evaluations with the MacCAT-CA. Rater pairs were counterbalanced for administration and observation status within and across conditions. Intra-class correlations (ICCs) for the BPRS-A total scores in the local administration-remote observation and local administration-local observation conditions were .82 and .78, respectively. The ICC for the remote administration-local observation condition was just lower, at .69. The differences between the three conditions were statistically non-significant as indicated by overlap among the three confidence intervals calculated for each ICC. ICCs for the subscales of the MacCAT-CA were greater than .75 in all conditions except for the appreciation subscale in the local administration-local observation condition, which was .69. Again, the differences between the three conditions were statistically non-significant as indicated by overlap among the confidence intervals calculated for each ICC. The authors stated that their results provided support for the reliability of structured interviews administered via video-conferencing.

Kirkwood, Peck, and Bennie (2000) investigated a range of cognitive abilities in 27 participants with a history of alcohol abuse. Utilizing alternate forms (one administered face-to-face and the other via video-conferencing) the authors found, for most of the outcome measures, cognitive assessment via video-conferencing produced similar results compared to face-to-face assessment. The authors suggested that the findings imply that it is unnecessary for patients and neuropsychologists to be present at the same location for cognitive assessments to be conducted.

Menon et al. (2001) examined depression and cognitive state in elderly medically ill inpatients using a low-cost video-conferencing (LCVC) system. Of 24 inpatients, 12 patients were assigned to two in-person interviews, and 12 patients were assigned to one in-person interview and one remote interview via videophones using the Geriatric Depression Scale (GDS) short version, the Hamilton Depression Scale (HAM-D), and the Short Portable Mental Status Exam (SPMSE). The coefficients of variation for the GDS and HAM-D were approximately the same for the in-person group and the remote group. The coefficients of variation for the SPSME were significantly different; however the authors were in agreement that the remote group was better than the in-person group. The authors concluded that overall the assessment of depression and cognitive status using LCVC is comparable to in-person assessment.

Hill, Theodoros, Russell, Ward, and Wootton (2009) found that the reliability and validity of video-conferencing language assessment is not significantly influenced by the severity level of the language impairment. Thirty-two participants with an acquired aphasia (mild, moderate, severe) were assessed simultaneously via video-conferencing and face-to-face methods on the Boston Diagnostic Aphasia Examination 3rd Edition Short Form (BDAE-3) and the Boston Naming Test (BNT) (2nd Edition Short Form). Two speech and language pathologists (SLP) conducted simultaneous scoring of the face-to-face and video-conferencing assessment of the aphasic participants. One of the SLPs was randomly assigned to lead the assessment, either in the face-to-face environment or the video-conferencing environment, while the other SLP silently scored the assessment in the alternative environment. No significant difference was found between face-to-face and video-conferencing assessments for 6 of the 8 BDAE-3 subtest clusters (Conversational speech, Auditory Comprehension, Recitation, Repetition, Reading, Writing). A significant difference was found for the Naming cluster and the Paraphasia tally cluster of the BDAE- 3 subtests, indicating that severity of aphasia may influence the ability to score these two clusters of subtests in the video-conferencing environment. However, post-hoc analysis of the naming cluster and paraphasia tally cluster revealed very good agreement within each of the severity levels (mild, moderate, severe). The authors asserted that while severity of aphasia may have a general affect on these two subtest clusters, the naming and paraphasia tally clusters did exhibit very good agreement between the face-to-face and video-conferencing assessments within each of the three aphasia severity levels. Thus suggesting that accurate video-conferencing assessment of these two subtest clusters was possible within each severity level. The findings indicate severity of aphasia does not greatly influence the ability to assess language skills via video-conferencing assessment.

Jacobsen, Sprenger, Andersson, and Krogstad (2003) administered 12 visual, verbal, and performance neuropsychological measures face-to-face and via videophones to 32 cognitively intact participants. The tests administered included: Grooved Pegboard dominant, Grooved Pegboard non-dominant, Visual Object and Space Perception Silhouettes, Benton-correct response, Benton-error responses, Symbol Digit Modalities Test oral, Symbol Digit Modalities Test written, Seashore Rhythm Test, Wechsler Adult Intelligence Scale/Wechsler Memory Scale Digit Span, Wechsler Adult Intelligence Scale Vocabulary, Wechsler Memory Scale-Logical Memory I, and the Wechsler Memory Scale-Logical Memory II. The obtained reliability coefficients of the 12 measures ranged from .37 to .86 with a median value of .74. The only measures that differed significantly from face-to-face and videophone application were verbal learning (WMS- Logical Memory I) and auditory attention (Seashore Rhythm Test) due to administration format. An interaction effect was found for both tests when the tests were administered face-to-face and then via videophones. The findings were interpreted as implying that administration format does not appear to affect the reliability of measurement, but neuropsychological test performance is significantly higher for the measures on attention and memory when delivered via videophone. The authors suggested additional research on these cognitive domains to examine if observed differences due to testing format on attention and memory are noted in other research. The authors asserted that separate normative data via telecommunication will be required if future research reveals similar findings pertaining to attention and memory. For most neuropsychological tests, however, the performance via telecommunication was highly consistent with face-to-face administration and the reliability coefficients obtained were comparable to other findings.

Security of data transmission and storage must also be considered. Barak and Buchanan (2003) addressed discussions of the "hacker threat," or risk of unauthorized interception of, or access to, test data by third parties. The extent to which this is a problem is open to debate and this problem may be exaggerated (Barak & Buchanan, 2003). Barak and Buchanan acknowledge that it is possible to intercept data transmitted via computers, but it is also possible to tap telephones, listen to therapy dialogue outside the door, break the lock to a secure filing cabinet, etc. The authors indicated that to date the "hacker threat" has not been anything other than a hypothetical problem to their knowledge. Barak and English asserted that the risk is therefore probably no greater than in general assessment contexts (as cited Barak & Buchanan, 2003).

To date, there is no research concerning the RNA application of the widely used neurobehavioral screening instrument, the Cognistat (Mueller, Kiernan, & Langston, 2001). The Cognistat is a neurobehavioral screening instrument designed to assess intellectual functioning in five major ability areas: Language, Construction, Memory, Calculations, and Reasoning. Attention, Level of Consciousness, and Orientation are assessed independently. Reading and writing are not assessed (Mueller, Kiernan, & Langston, 2001).

All but the memory section are administered utilizing a screen and metric paradigm. The patient is first presented with the screen, which is a demanding test item that requires skill in the particular ability. Normal individuals can fail screen items, which in and of itself does not imply abnormality. If the patient passes the screen the ability involved is assumed normal and no further testing is administered in that section. If the screen is failed, the examiner administers the metric (a series of test items of increasing difficulty). This approach allows intact areas of functioning to be tested briefly, while areas of disability are examined in greater detail. Performance on the metric determines whether - and to what degree - ability is impaired (Mueller, Kiernan, & Langston, 2001).

Normative data provided in the Cognistat manual includes 30 normal subjects (ages 20-30, "young"), 30 normal subjects (ages 40-66, "old"), and 30 neurosurgical subjects with documented brain lesions (i.e. stroke, brain tumor, etc.). Macualay, Lebby, Battista, and Mueller collected normative data (provided in manual) from a geriatric population consisting of 112 subjects (ages 60-84) (as cited in Mueller, Kiernan & Langston, 2001). Wuethrich, Lebby, Ammen, and Canfield collected normative data (provided in manual) from an adolescent population consisting of 263 subjects (ages 12-19) (as cited in Mueller, Kiernan, & Langston, 2001).

The usual reliability criteria do not appropriately apply to this type of screening examination. The Cognistat does not attempt to discriminate average from superior performance and therefore does not capture the full range of cognitive performance. The Cognistat was designed to determine degree of disability. Consequently, the range of performance within the normal population is minimal and normal subjects often answer all subtests correctly. Due to this ceiling effect, test-retest studies in normal populations would yield uniformly high correlations of no relevance. Split-half reliability is inappropriate because the Cognistat has too few items as a screening instrument. Additionally, the instability of reliability studies in neuropathological populations makes interpretation of results difficult (Mueller, Kiernan, & Langston, 2001).

Strickland, Longobardi, Alperson, and Andre (2005) asserted that the Cognistat is a promising alternative to the MMSE (another widely utilized test of cognitive functioning) by purportedly assessing multiple domains of cognitive functioning providing a differentiated profile of mental status in comparison to the MMSE where only one summary score is obtained. Starratt, Fields, and Fishman (1992) found the Cognistat to have similar sensitivity in the detection of dementia as the MMSE in older populations. The Cognistat was found more sensitive than the MMSE to known neuropathology in stroke and traumatic brain-injured younger populations, however. Osato and colleagues compared the psychometric properties of the Cognistat and the MMSE in an older psychiatric sample of adults. They found that using a cutoff of two or more subtests in the impaired range the Cognistat provides greater sensitivity than the MMSE by providing the maximal discrimination between depressed patients and those with organic mental disorders. Specificity was lower than that for the MMSE (as cited in Strickland, Longobardi, Alperson, & Andre, 2005). In a healthy sample of older adults, Drane, Yuspeh, Huthwaite, Klingler, Foster, Mrazik, et al. (2003) found the Cognistat to have greater sensitivity to normal aging than the MMSE. The authors also asserted that the Cognistat is likely more sensitive than the MMSE to memory dysfunction due to the lengthier period of delay and the presentation of more intervening distracter items in the verbal memory subtest of the Cognistat.

Statement of Significance

This research project will add to the field of neuropsychological assessment by examining if the RNA application of the Cognistat is comparable to the pencil-paper administration. If there is no significant difference found between the administration modalities, individuals who would be potentially unable to participate in a face-to-face neuropsychological screening now would have a convenient possibility to be tested. The importance of RNA administration of the Cognistat is that it provides psychometric evidence whether a patient should be referred to a neuropsychologist, physician, or rehabilitation specialist. It also allows for convenient re-evaluation after hospital discharge to measure any change in neuropsychological status (Jacobsen, Sprenger, Andersson, & Krogstad, 2003).

Experimental Variables

The present study employed one independent variable; administration modality as a within-subject factor with two levels (RNA and paper-pencil). The dependent variables were subtest scores (orientation, attention, comprehension, repetition, naming, construction, verbal memory, calculations, similarities, and judgment). Subtest scores were converted to z-scores to maintain a consistent metric.

Statement of Hypothesis

It was hypothesized that participants' neuropsychological data from the pencil-paper administration of the Cognistat will not differ significantly from the neuropsychological data obtained from the RNA administration.

METHOD

Participants

The study sample included 15 cognitively intact undergraduate student volunteers from the University of Central Florida, Eastern Region, Daytona Beach campus. The age range of the sample was 20 years to 53 years (M = 33.80, SD = 10.82). The sample consisted of 5 males between the ages of 23 and 53 years of age with a mean age of 37.60 (SD = 13.59) and 10 females between the ages of 20 and 47 years of age with a mean age of 31.90 (SD = 9.39).

All 15 participants were high school graduates. Eleven participants had completed an Associate's degree. Two participants had completed a Bachelor's degree. One participant had completed a Master's degree.

The distribution of race/ethnicity of the 15 participants included 10 white participants, 2 Black or African-American participants, 1 Asian participant, and 2 Hispanic/Latino participants. This race/ethnicity distribution is consistent with the 2010 Census (United States Census Bureau, 2010). Handedness of the sample included 12 right-handed participants and 3 left-handed participants.

Student volunteers received extra credit from their instructor for participation. All participants were treated in accordance with the "Ethical Principles of Psychologists and Code of Conduct" (American Psychological Association, 2002).

Materials and Apparatus

A hard copy of the Cognistat (Mueller, Kiernan, & Langston, 2001) and stimulus materials were used for each participant. A stopwatch was used for the timed sections of the Cognistat. A questionnaire developed specifically for this study was used to obtain demographic information on the participants.

Six Dell Latitude D630 laptops were used for video-conferencing and data collection. The Dell Latitude D630 laptops contain: Processor: T7300 – 2.0Ghz processor; Memory: 2gb; Graphics: Intel Media Accelerator X3100; Wireless: Intel PRO/Wireless 3945AG (802.11a/g). Logitech 9000 webcams were used for video-conferencing. The UCF Daytona wireless connection: Average Download Speed: 18.76 Mbps; Average Upload Speed: 18.24 Mbps.

Procedure

Following acquisition of informed consent, participants were administered the Cognistat using a face-to-face modality; two weeks later the Cognistat was administered via a RNA modality. The order of mode of administration was counterbalanced across participants. The two week test-retest interval was selected to potentially minimize practice effects.

RNA administration of the Cognistat involved the participant and researcher in different rooms in the same UCF Daytona regional campus building, each alone. Each participant was escorted to a room with one of the Dell Latitude D630 laptops that had a video-conferencing connection in progress with the researcher in the other room. The researcher verified if visual and audio settings were satisfactory for perception and then testing began.

The researcher utilized two Dell Latitude D630 laptops for data collection. One of the laptops was used for the video-conferencing feed with participants. The second laptop was used for data input of the demographic questionnaire and the Cognistat with websites that were built for the current study. Both websites were built to submit all data to form manager upon completion of each instrument.

All administration standardization was maintained for the Cognistat. All Cognistat stimulus materials were presented directly in front of the webcams. Only the Construction screen stimulus was used for that subtest. Using the metric for the Construction subtest would require individuals being remotely tested to possess the metric stimulus materials (the screen stimulus is on a card like the naming subtest stimuli, while the metric stimulus materials are blocks), which is not practical.

Administration of the paper-and-pencil application required the participant and researcher to be in the same UCF campus room. Participants were escorted to a testing room and were seated at a table opposite and facing the researcher.

RESULTS

An initial standardization of the subtest scores was performed. This was necessary because performance scores on each subtest are discrete and not of a standard metric. Each subtest score was converted to a z-score utilizing the descriptive statistics presented in the normative section of the Cognistat manual. The normative data contained in the Cognistat Manual only includes ages 20-30 (young) and ages 40-66 (old) for normal subjects (Mueller, Kiernan, & Langston, 2001). Participants whose age was between 30 and 40 years of age z-scores were calculated using the “young” normative data. Descriptive statistics of the converted subtest scores by administration modality can be seen in Table 1.

The primary analysis was directed at determining whether there was a difference in performance as a function of mode of administration (i.e., paper-pencil versus RNA). A one-way repeated measures multivariate analysis of variance (MANOVA) was used to analyze the data. The main effect for administration modality was not significant, $F(9, 126) = .375$, $p = .945$. Univariate ANOVAs addressing the administration modality for each of the Cognistat subtests can be seen in Appendix E. Ceiling effects were not relevant as administration modality, not test performance per se, was examined.

DISCUSSION

The purpose of this study was to examine if test performance for RNA administration of the Cognistat is comparable to test performance for the pencil-paper administration. It was hypothesized that participants' neuropsychological data from the pencil-paper administration of the Cognistat would not differ significantly from the neuropsychological data obtained from the RNA administration. The present data supported the hypothesis in that there was no significant difference between the RNA administration of the Cognistat and the paper-pencil administration. This finding is consistent with the research to date regarding RNA, or video-conferencing assessment, compared to face-to-face or paper-pencil assessment (Ball, Scott, McLaren, & Watson, 1993; Hill, Theodoros, Russell, Ward, & Wootton, 2009; Jacobsen, Sprenger, Andersson, & Krogstad, 2003; Kirkwood, Peck, & Bennie, 2000; Lexcen, Hawk, Herrick, & Blank, 2006; Menon et al., 2001; Temple, Drummond, Valiquette, & Jozsvai, 2010). This research supports Kirkwood, Peck, and Bennie's (2000) assertion that such findings imply that it is not necessary for patients and neuropsychologists to be present at the same location for cognitive assessments to be carried out.

The current research addressed Jacobsen, Sprenger, Andersson, and Krogstad (2003) recommendation that additional research be conducted on the cognitive domains of attention and memory to examine if observed differences due to testing format persisted on attention and memory. The authors found neuropsychological test performance was significantly higher for the measures of attention and memory when delivered via videophone. In contrast, the current findings showed no significant difference between the RNA and paper-pencil administration of the attention and verbal memory subtests. However, Jacobsen, Sprenger, Andersson, and Krogstad (2003) used full neuropsychological measures to assess memory and attention (WMS-Logical Memory I and the Seashore Rhythm Test). Thus, caution should be exercised in comparing results from a screening instrument's subtests and full neuropsychological measures designed to measure attention and memory.

Similar to Ball, Scott, McLaren, and Watson (1993), a small modification to administration of one subtest of the psychometric instrument was required. Only the Construction screen stimulus was used for assessment of visuoconstructional ability in the present study. Using the metric for the Construction subtest would require individuals being remotely tested to possess the metric stimulus materials (the screen stimulus is on a card like the naming subtest stimuli, while the metric stimulus materials are blocks), which is not practical. The Construction screen stimulus card only requires individuals being tested to reproduce the figures on the stimulus card (being presented via webcam) and present their drawing to the webcam for scoring. The screen does not require individuals being tested to possess stimulus materials, and thus was solely used for administration of this subtest in both modalities. However, this resulted in individuals not being further tested that failed the screen; that is, the metric could not be administered utilizing a RNA administration modality. Despite this limitation, no significant difference was found between RNA administration and paper-pencil administration of the Construction subtest.

This research differed from Ball, Scott, McLaren, and Watson (1993) in interval between RNA administration and paper-pencil administration. Retesting was performed within 48 hours in order to minimize the effect of changing mental state (due to a psychiatric sample), although this carried some risk of a learning effect. A strength of the present study is that retesting was performed two weeks following initial testing to potentially minimize practice effects, or learning effects, and thus less likelihood that results can be attributed to such effects.

Also similar to Ball, Scott, McLaren, and Watson (1993), the present study found that a standardized cognitive screening test can be reliably carried out using RNA administration. The importance of this finding is in the comparison of the Cognistat to the MMSE. The Cognistat assesses multiple domains of cognitive functioning providing a differentiated profile of mental status in comparison to the MMSE where only one summary score is obtained. The Cognistat demonstrates similar sensitivity in the detection of dementia as the MMSE in older populations, and greater sensitivity than the MMSE to known neuropathology in stroke and traumatic brain-injured younger populations. It shows greater sensitivity (comparing psychometric properties) than the MMSE using a cutoff of two or more subtests in the impaired range as providing the maximal discrimination between depressed patients and those with organic mental disorders. It also demonstrates greater sensitivity to normal aging than the MMSE and is likely more sensitive than the MMSE in memory dysfunction due the lengthier period of delay and the presentation of more intervening distracter items in the verbal memory subtest of the Cognistat (Drane et al., 2003; Starratt, Fields, & Fishman, 1992; Strickland, Longobardi, Alperson, & Andre, 2005). Thus, an optimal cognitive screening instrument (the Cognistat) can now be reliably used for remote cognitive screening compared to the MMSE.

One limitation of this research was not administering the metric portion of the Construction subtest to participants. The stimulus is visually available during the metric portion (block design), but not during the screen (figure production) (Fouty & Brzezinski, 2009). The stimulus screen is shown to the individual being tested for 10 seconds and then removed (Mueller, Kiernan, & Langston, 2001). This administration for the screen differs from other visuoconstructional tests (Wechsler Block Design subtest, the Rey-Osterreith Complex Figure Test, and the three-dimensional block construction) that allow unlimited stimulus exposure (Fouty & Brzezinski, 2009). Additionally, the screen is confounded by the cognitive processes of concentration and visual memory by removing the stimulus card. Fouty and Brzezinski (2009) asserted that providing unlimited visual access to the screen stimulus card, the confounding processes of concentration and visual memory are removed and a more pure assessment of constructional ability is achieved (the authors also suggest always administering both portions of the test as the screen and metric tasks measure different neuropsychological functions). Thus, only administering the Construction screen potentially confounds a true measurement of constructional ability of an individual being tested (as occurred in the current research). This has strong implications for the clinical use and interpretation of the Construction subtest of the Cognistat via RNA administration. This also has implications for the use of more performance based tests in general being administered via video-conferencing as Temple, Drummond, Valiquette, and Jozsvai (2010) called attention to. A participant showing his or her block design to an assessor for the metric of the Construction subtest is far more practical if assessed by a present staff member, as opposed to a remotely located neuropsychologist via a video-conferencing feed. This author agrees with Temple, Drummond, Valiquette, and Jozsvai (2010) that having a trained staff member with the individual being assessed is important for more performance based tasks such as the Construction subtest metric. However, availability of a trained staff member is likely unrealistic for much remote testing (e.g. a soldier requires a cognitive screening after being in the proximity of a grenade blast in Afghanistan) and requires the individual being assessed or the trained staff member to possess testing materials, which is also highly unrealistic. Thus, although not administering the Construction metric is a limitation of the study, it is also more realistic for the clinical application of the Cognistat for real-world video-conferencing cognitive screening.

A second limitation of this research was a small number of participants. Although, of the sample collected, participants were highly representative in regards to age and race/ethnicity demographics.

It could also be argued that the use of cognitively intact, highly educated individuals also poses a threat to external validity with the current study's findings potentially not being able to generalize to populations with neurological insult. First, education is not a demographic variable that the Cognistat controls for and is therefore a non-issue. Secondly, this research was methodological in nature and the primary objective was to show that the Cognistat can reliably be administered using this new modality. This reliability first needs to be established before the utility of the modality with brain injured individuals can be assessed. Additionally, the use of brain-injured subjects creates many problems when attempts to make inferences about normal functioning or comparing test-retest performance are made (Fouty & Yeo, 1995). Many short-term, intermediate, and long-term changes in the brain can occur and the result of neurological insult (e.g. neurotransmitter release variations, electrical activity variations, degeneration, necrosis). The brain's attempt to return to homeostasis may result in recovery of function, typically in a sequential fashion, by means of regeneration, resprouting, and substitution. However, a return to normal functioning may be impeded at any stage in the recovery process.

Therefore, a complete return to a premorbid level of functioning may not occur (Kolb & Whishaw, 1985). In regards to this research though, the use of brain-injured participants could possibly have demonstrated test-retest differences as a result of the actual brain injury, or recovery from the injury and not the difference between administration modalities. Furthermore, brain injured individuals may use novel or different behavioral strategies to compensate for a lost behavior secondary to the brain injury, which potentially could have affected test-retest findings (Fouty & Yeo, 1995). It is therefore recommended, "Use of brain-damaged subjects may not provide a complete picture of brain-behavior relationships as a result of post insult physiological and behavioral changes. It is, therefore, necessary to confirm finding using normal brains" (Fouty & Yeo, 1995, p. 547).

Future research should examine if the current study's results regarding the RNA administration of the Cognistat generalize to other populations, such as individuals with intellectual disabilities, forensic/psychiatric patients, substance abuse patients, medically ill patients, and patients with acquired language and cognitive deficits (Ball, Scott, McLaren, & Watson, 1993; Hill, Theodoros, Russell, Ward, & Wootton, 2009; Kirkwood, Peck, & Bennie, 2000; Lexcen, Hawk, Herrick, & Blank, 2006; Menon et al., 2001; Temple, Drummond, Valiquette, & Jozsvai, 2010). Future research should also examine the actual cost-effectiveness of RNA (rather than the potential) on the populations who can benefit the most from this modality (i.e. military personnel, prison inmates, individuals living in rural areas, and/or individuals with transportation issues) now that the methodological utility has been established.

In conclusion, the present study demonstrated the utility of a widely used neurobehavioral screening test that provides a differentiated profile of cognitive status in that it can now reliably be used through a video-conferencing administration. The importance of this finding is that a more comprehensive detection of deficits in multiple domains of cognitive functioning for screening purposes is now possible remotely. Individuals who would be potentially unable to participate in a face-to-face neuropsychological screening now would have a convenient possibility to be tested. This is not a substitute for a face-to-face full neuropsychological battery. However, this research provides an improvement to the very reason for telemedicine's inception; to offer a plausible, potentially cost-effective solution to military personnel, prison inmates, individuals living in rural areas, and/or individuals with transportation issues (e.g. the impoverished and disabled), etc. in need of medical consultation, assessment, or treatment that are located in different geographical areas than the neuropsychologist, physician, therapist, clinician, etc. (Armstrong, 2006; Berman, 2005; Cowain, 2001; Jacobsen, Sprenger, Andersson, & Krogstad, 2003).

APPENDIX A: IRB APPROVAL LETTER

University of Central Florida

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Tyler C. Duffield**

Date: **September 27, 2010**

Dear Researcher:

On 9/27/2010, the IRB approved the following activity as human participant research that is exempt from regulation:

Type of Review:	Exempt Determination
Project Title:	Administration Modality of a Neurobehavioral Screening Test
Investigator:	Tyler C Duffield
IRB Number:	SBE-10-07130
Funding Agency:	
Grant Title:	
Research ID:	N/A

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Joseph Bielitzki, DVM, UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 09/27/2010 11:32:56 AM EDT

Joanne Muratori

IRB Coordinator

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APPENDIX B: EXPLANATION OF RESEARCH

EXPLANATION OF RESEARCH

Title of Project: Administration Modality of a Neurobehavioral Screening Test

Principal Investigator: Tyler Duffield, B.S.

Faculty Supervisor: H. Edward Fouty, Ph.D.

You are being invited to take part in a research study. Whether you take part is up to you.

- The purpose of this study is to compare neuropsychological test data obtained during different administration modalities.
- You will be asked to complete several tasks that involve remembering things, calculations, and speaking. You will also be asked a few questions about yourself and your history. The research will take place in a private setting at the University of Central Florida.
- You will interact with a faculty member and/or a graduate student in the Clinical Psychology M.A. program at the University of Central Florida.
- Your participation will require two sessions lasting between 20 and 40 minutes each.
- You do not have to answer any question, or complete any task, that makes you feel uncomfortable. You will not lose any benefits if you skip questions or tasks.
- You may receive extra credit for your participation in this study (the amount, if any, will be at the discretion of your class instructor). In the event that you desire to earn extra credit but does not wish to participate in this study, an alternative task is available.

You must be 18 years of age or older to take part in this research study. You must also be English speaking to participate in this research study.

Study contact for questions about the study or to report a problem: If you have questions, concerns, or complaints contact Tyler Duffield, a graduate student, at (406) 860-6058 or by e-mail at: tduffield2009@knights.ucf.edu. Or contact Dr. H. Edward Fouty at the University of Central Florida, Department of Psychology, 1200 International Speedway Blvd., Bldg. 140 Suite 310, Daytona Beach, FL 32120-2811, by phone: (386) 506-4060, or by email: hfouty@mail.ucf.edu.

IRB contact about your rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). This research has been reviewed and approved by the IRB. For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901.

APPENDIX C: DEMOGRAPHIC QUESTIONNAIRE

Demographic Questionnaire

Gender: Male Female

Age:

Which hand do you write with? Right Left

Highest level of education completed:

<12 _____ Bachelors degree

High School Masters degree

Associates degree Doctoral degrees (Ph.D., M.D., J.D.)

Race/Ethnicity

White (i.e., origins in any of the original peoples of Europe, the Middle East, or North Africa)

Black or African American

American Indian or Alaska Native

Asian

Native Hawaiian and other Pacific Islander

Hispanic/Latino

Some other race ____________________

Two or more race (check the appropriate ones above)

Have you had a significant head injury in the past 3 years? Yes No

Have you had any recent surgeries involving general anesthesia in the past 3 months?
Yes No

Do you have any significant medical problems or illnesses (e.g., brain, heart, lungs, kidneys, liver)? Yes No

Are you taking any medications? Yes No

Medication	Purpose

APPENDIX D: TABLES

Table 1

Subtest Descriptive Statistics by Administration Modality

	Administration Modality			
	Paper-Pencil		RNA	
Subtest	*M*	*SD*	*M*	*SD*
Orientation	-.333	1.708	-.333	1.708
Attention	.586	.341	.502	.463
Comprehension	.220	.161	.220	.161
Repetition	-.699	.382	-.795	.561
Naming	-1.170	.337	-1.170	.337
Construction	-4.404	5.222	-4.880	5.116
Memory	-1.550	3.072	-2.581	4.023
Calculations	.110	1.278	.110	1.278
Similarities	-.234	1.087	-.323	.112
Judgment	.400	1.363	.667	1.418

NOTE: Measures of central tendency and variability are presented as z-scores.

Table 2

MANOVA: DV(10)*COND(2)

Source	df	SS	MS	F
DV*COND	9	8.674	.964	.375
Error(DV*Cond)	126	323.396	2.567	

Table 3

ANOVA: Orientation as a Function of Mode of Administration

Source	df	SS	MS	F
COND	1	.000	.000	.000
Error(COND)	14	25.000	1.786	

Table 4

ANOVA: Attention as a Function of Mode of Administration

Source	df	SS	MS	F
COND	1	.053	.053	1.000
Error(COND)	14	.741	.053	

Table 5

ANOVA: Comprehension as a Function of Mode of Administration

Source	df	SS	MS	F
COND	1	.000	.000	.000
Error(COND)	14	.000	.000	

Table 6

ANOVA: Repetition as a Function of Mode of Administration

Source	df	SS	MS	F
COND	1	.068	.068	1.000
Error(COND)	14	.954	.068	

Table 7

ANOVA: Naming as a Function of Mode of Administration

Source	df	SS	MS	F
COND	1	.000	.000	.000
Error(COND)	14	.000	.000	

Table 8

ANOVA: Construction as a Function of Mode of Administration

Source	df	SS	MS	F
COND	1	1.699	1.699	.132
Error(COND)	14	180.040	12.860	

Table 9

ANOVA: Memory as a Function of Mode of Administration

Source	df	SS	MS	F
COND	1	7.967	7.967	.834
Error(COND)	14	133.778	9.556	

Table 10

ANOVA: Calculations as a Function of Mode of Administration

Source	df	SS	MS	F
COND	1	.000	.000	.000
Error(COND)	14	25.000	1.786	

Table 11

ANOVA: Similarities as a Function of Mode of Administration

Source	df	SS	MS	F
COND	1	.060	.060	.111
Error(COND)	14	7.518	.537	

Table 12

ANOVA: Judgment as a Function of Mode of Administration

Source	df	SS	MS	F
COND	1	.533	.533	2.154
Error(COND)	14	3.467	.248	

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