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The validity of the test of memory malingering (TOMM) with deaf individuals

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ABSTRACT

Objective: Administration of performance validity tests (PVT) during neuropsychological assessments is standard practice, with the Test of Memory Malingering (TOMM) being a commonly used measure. The TOMM has been well validated in hearing populations with various medical and psychiatric backgrounds. A major gap in the literature is the use of the TOMM amongst culturally Deaf individuals who use American Sign Language (ASL) as their first and preferred language. The purpose of this study was to explore the use of the TOMM with this population to determine if there may be differences related to the use of semantic knowledge and recall using signs rather than spoken phonemes.
Method: This study recruited 30 culturally Deaf, community-dwelling adults, who self-reported that they were not involved in litigation ordisability claims. In addition to the TOMM, participants were screened for cognitive ability using non-verbal components of the Wechsler Abbreviated Scale of Intelligence, Second Edition (WASI-II) and the Mini Mental State Examination: ASL Version (MMSE:ASL).
Results: Nonverbal intelligence for this sample was within the average range of ability. No participants scored lower than the standard cut-off score for Trial 2 or the Retention Trial on the TOMM ($\leq$44 raw score to indicate invalid responding). Trial 1 performances ranged from 44 to 50, Trial 2 performances ranged from 49 to 50, and Retention performances ranged from 49 to 50.
Conclusion: These results support the use of the same standard cut-off scores established for hearing individuals in culturally Deaf individuals who use ASL.

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Neuropsychology; performance validity tests; TOMM; malingering; deaf; American sign language

Introduction

Deafness

Deafness is a complex construct that occurs across the lifespan with a wide diversity in presentation. Cultural deafness implies that the Deaf person utilizes a sign language and a shared reality with others characterized by unique values, traditions and history

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(Du Feu & Chovaz, 2014). Prevalence estimates are complicated as people may choose not to self-identify and epidemiology methods may be restrictive. In general terms, hearing loss affects about 15–26% of the world's population with roughly seven per 10,000 of those having severe-to-profound deafness (Fellinger, Holzinger, & Pollard, 2012). These numbers suggest that many neuropsychologists will likely encounter Deaf patients over the course of their practice.

Increasing this likelihood are the number of studies that have demonstrated that hearing loss is independently associated with a higher rate of accelerated cognitive decline (Lin et al., 2011). Furthermore, there is a substantially increased risk of incident all-cause dementia, with those individuals with a mild, moderate, and severe hearing impairment, respectively, having a 2-, 3-, and 5-fold increased risk of incident all-cause dementia over more than10 years of follow-up (Gallacher et al., 2012; Lin et al., 2011). In addition to the risks of cognitive decline associated with deafness, Fellinger et al. (2012) estimate about one quarter of Deaf individuals have additional disabilities and a high probability of complex mental health needs. In terms of the latter, Du Feu and Chovaz (2014) note that although Deaf people have the same range of mental health disorders as the hearing population, the risk factors are significantly greater. Adverse neurological, developmental, early childhood, and psychological factors in addition to marginalization within society result in a greater prevalence of mental health problems.

The health care system is a hearing dominant environment, and psychological and neuropsychological services are no exception. While neuropsychology training programs typically include cultural and diversity training, they often do not include training focused on the cognitive, psychological, social, and functional barriers faced by individuals who have significant hearing loss. This lack of training produces a gap in services for Deaf individuals and leaves neuropsychologists who work with this population without a framework to approach evaluations and treatment.

Neuropsychology and Deaf clients

The field of neuropsychology is not naïve to dealing with challenges associated with assessing individuals with cultural or ethnic backgrounds that differ from the normative samples established for neurocognitive tools (Agranovicha & Puente, 2007; Boone, Victor, Wen, Razani, & Ponton, 2007; Brickman, Cabo, & Manly, 2006; Manly, 2005; Pedraza & Mungas, 2008; Rivera Mindt, Byrd, Saez, & Manly, 2010; Romero et al., 2009; Veliu & Leathem, 2017). These researchers discuss the limitations of neuropsychology in different populations, the ethical responsibility clinicians have when evaluating individuals from cultural or ethnic backgrounds that differ from Caucasians, and aspects to consider when reviewing cognitive performance and providing diagnoses when testing individuals of non-Caucasian backgrounds. Considerations and limitations of assessing individuals whose first and/or only language is not English have also been explored in the literature (Ardila, Rodriguez-Menendez, & Rosselli, 2002; Ardila, Rosselli, & Puente, 1994; Artiola, Fortuny, & Mullaney, 1997; Boone et al., 2007; Casas et al., 2012; Rivera Mindt et al., 2008).

Assessing a Deaf individual's cognition has some similar challenges for neuropsychologists due to cultural differences, the language barrier and the use of an interpreter

(Hill-Briggs, Dial, Morere, & Joyce, 2007; Morere, 2013). It is important for clinicians to effectively assess a Deaf individual using culturally and linguistically appropriate and accessible assessments (Du Feu & Chovaz, 2014). To do so, the preferred language for the individual must be applied during an assessment to ensure understanding of task instructions (Hill-Briggs et al., 2007).

Assessments are most effective when the clinician interacts directly with the client. It is suggested then that the use of an interpreter during a neuropsychological assessment be avoided, if possible (Romero et al., 2009). At the same time, non-English speaking individuals, including those who use American Sign Language (ASL), should not be denied appropriate healthcare services. In order to balance these views, when necessary, the use of an ASL interpreter is often the only option clinicians have, as few mental health professionals possess developed sign language skills or knowledge of deafness (Gerber, 1980; McCay & Miller, 2001). It is important for clinicians to include a qualified and registered interpreter who understands Deaf language and culture, the importance of standardized behaviour during testing, and who will abide by the code of ethics and maintain confidentiality (Du Feu & Chovaz, 2014; Romero et al., 2009). Yet, accessing a qualified interpreter for a Deaf individual in a clinical setting may be difficult due to the low number of available sign language interpreters (Williams & Abeles, 2004), as well as limitations to the scope of their practice in terms of competency to work in a mental health setting (Du Feu & Chovaz, 2014).

Further, in theory, the presence of an ASL interpreter during neuropsychological testing may also impact the validity of the assessment. Clifford (2002) highlighted the possible limitations of a lexico-semantic approach used by interpreters. He noted how interpreters may have difficulty with meaning if the process is only to substitute target language signs for the words of the source language. In monolingual Spanish speakers, it was demonstrated that the use of an interpreter significantly affected some test scores, especially if the tests were verbally mediated (Casas et al., 2012).

Neuropsychologists need to recognize that many words in English do not have sign equivalents in ASL, leading the interpreter to explore other options of how to get the point across to the individual, which can impact the standardized process (Hill-Briggs et al., 2007). This can not only modify the test instruction portion of the neuropsychological assessment, but also impact the results and in turn, the interpretation of the individual's cognitive status. This was exemplified decades ago by Odom, Blanton, and McIntyre (1970) who compared Deaf participants with hearing fifth graders on how well 16 English words could be learned. Half of the words had a direct interpretation into ASL while the remaining words did not. The researchers found that signable words were recalled significantly better for Deaf participants than the unsignable words in the list. This illustrates how ambiguous words were more difficult for Deaf individuals to recall, as they were not encoded into something meaningful due to the lack of a linguistic cue.

Deaf individuals are also often a minority group in areas where they reside, making it likely that the interpreter and Deaf individual may be previously known to one another in a personal capacity, which can lead to excess dialogue during testing (Du Feu & Chovaz, 2014). This can create the third-party observer effect, which is a phenomenon that occurs when a third party is present during test administration

(Gavett, Lynch, & McCaffrey, 2005). In a meta-analysis by Eastvold, Belanger, and Vanderploeg (2012), it was found that overall, the presence of observers negatively impacted performance during testing, especially on tasks involving attention, learning/ immediate memory, and delayed recall. This is explained by Zajonc's theory of social facilitation, which describes how the physical presence of another person or an audience during performance increases an individual's drive or state of arousal (Platania & Moran, 2001). This effect has been shown to hinder an individual's performance on novel or difficult tasks. During a neuropsychological assessment, many if not all of the tests would likely be novel to the Deaf individual and some may be perceived as difficult.

What might further complicate a Deaf person's understanding and comfort level during a neuropsychological assessment is the lack of feedback, body language, and positively reinforcing facial expressions from the examiner that are part of standard administration of neurocognitive tests (Kirlin & Locke, 2014). With individuals who use ASL, it is part of Deaf culture to incorporate an increased used of eye contact, body language, facial expressions and grand gestures (Williams & Abeles, 2004). These types of non-verbal feedback are critical amongst individuals who use ASL and not providing this during communication with a Deaf patient violates cultural expectations.

Finally, there are limited data on the utility of commonly used neuropsychological measures in this population, in general. The dearth of data on the validity and clinical utility of commonly used neuropsychological measures in the Deaf community includes performance validity tests (PVT). Larrabee (2012) indicated that PVTs help determine whether the cognitive assessment results are consistent with the person's true cognitive abilities, or whether they represent subpar results and reflect non-credible responding. Because invalid responding negatively impacts the overall findings, full and consistent test engagement by the individual is required in order to obtain a valid estimate of the person's cognitive status (Kolb & Whishaw, 2015; Schutte, Axelrod, & Montoya, 2015).

The test of memory malingering

Over the past several decades, performance validity measures have become standard practice. In fact, there have been practice guidelines and professional position statements outlining the importance of integrating PVT into all neuropsychological assessments, regardless of the nature of the evaluation (American Academy of Clinical Neuropsychology, 2007; Bush, Heilbronner, & Ruff, 2014; Bush et al., 2005; Chafetz et al., 2015; Heilbronner, Sweet, Morgan, Larrabee, & Millis, 2009; Schutte et al., 2015). Slick and Sherman (2012) provided guidelines that are used to make a determination of malingering. These guidelines integrate information gathered during a neuropsychological assessment, including PVT results. Traditionally, when an individual performed below the standard cut-off score(s) on PVT, the person was often described by researchers and clinicians as putting forth "poor effort". However, the field is moving away from this description as it implies intent, which is not measured by PVT. Instead, terms such as "non-credible responding" or "invalid responses" are now preferred as they are more neutral in nature.

The TOMM is a non-verbal object recognition task that is a commonly used free-standing performance validity test (Tombaugh, 1996). There are two learning trials and a retention trial that is administered after a 15-minute delay. As per Tombaugh's originally proposed cut-off scores, out of a possible 50 points, scores ≥45 on the second learning trial and on the Retention Trial suggest a valid response profile. A performance of 45 or better on Trial 2 correctly identifies 95% of non-malingering individuals (as referred to then) without dementia, with a specificity of 91% of all patients (Rees, Tombaugh, Gansler, & Moczynski, 1998; Tombaugh, 2003). In short, the test requires little cognitive ability, helps determine the integrity of the individuals' symptomatic complaints for memory, and helps identify non-valid responding (Denning, 2012; Chafetz et al., 2015). Reasonably so, researchers have described the TOMM as an effortless measure of effort (Iverson, Le Page, Koehler, Shojania, & Badii, 2007).

The standard cut-off scores of the TOMM have been well validated in hearing individuals with various clinical backgrounds. These include individuals suffering from depression (Rees, Tombaugh, & Boulay, 2001), anxiety (Ashendorf, Constantinou, & McCaffrey, 2004), psychotic disorders (Duncan, 2005), fibromyalgia (Iverson et al., 2007), as well as children as young as five years old (Constantinou & McCaffrey, 2003; Donders, 2005). Below standard cut-off scores are rarely obtained by individuals who have acquired brain injuries and other neurological conditions (Rees, Tombaugh, Gansler, & Moczynski, 1998; Tombaugh, 1996). Research showing a reverse dose-response relationship in traumatic brain injury and TOMM failure rate further supports the idea that poor performance on the TOMM cannot be attributed to genuine neurological impairment. For example, Erdodi and Rai (2017) showed that individuals with mild traumatic brain injuries were four times more likely to fail the standard TOMM cut-off compared to individuals with moderate/severe traumatic brain injuries. However, individuals with moderate or severe dementia can produce false-positive results (Teichner & Wagner, 2004; Walter, Morris, Swier-Vosnos, & Pliskin, 2014).

Recently, there have been concerns raised in the literature that the standard cut-off scores as proposed by Tombaugh may be too conservative, as an invalid profile on Trial 2 of the TOMM (≤44) has been shown to be less sensitive to invalid performances on other stand-alone PVT (Greffenstein, Greve, Bianchini, & Baker, 2008; Armistead-Jehle & Gervais, 2011). Erdodi and Rai (2017) investigated whether alternative cut-offs were more appropriate. Specifically, in a mixed clinical sample of individuals assessed in a medico-legal setting, their results suggested that more liberal cut-offs on Trial 2 may improve overall classification accuracy. One error on Trial 2 was suggestive of non-credible responding.

In addition, there is growing literature on using Trial 1 of the TOMM, which was initially designed to be an inactive learning trial, as a performance validity indicator on its own. Examining the research to date that has provided specific cut-scores for Trial 1 suggests that there is no consensus as of yet. Denning in 2012 summarized this literature well. For instance, it was noted that sufficiently credible responding was found in the following in regards to Trial 1 performance: (1) community-dwelling adults who performed at or above 40 (O'Bryant et al., 2008); (2) a mixed clinical sample who performed at or above 41 (Denning, 2012; Hilsabeck, Gordon, Hietpas-Wilson, & Zartman, 2011; O'Bryant et al., 2008; Tombaugh, 1996); (3) a mixed clinical sample of veterans who performed at or above 36 (Horner, Bedwell, & Duong, 2006); (4)

individuals with fibromyalgia with depression and pain who performed at or above 40 (Iverson et al., 2007); and, (5) mild traumatic brain injury litigants who performed at or above 45 (Gavett, O'Bryant, Fisher, & McCaffrey, 2005). The cut-off scores for controls have also varied, with the minimum score being 39 on Trial 1 (Musso, Barker, Jones, Roid, & Gouvier, 2011; Etherton, Bianchini, Greve, & Ciota, 2005; Ryan, Glass, Hinds, & Brown, 2010; Vanderslice-Barr, Miele, Jardin, & McCaffrey, 2011; Yanez, Fremouw, Tennant, Strunk, & Coker, 2006). Some have suggested that Trial 1 scores ranging from 37 to 40 would indicate that additional trials of the TOMM be administered, even though a score of 41 or better had excellent observed sensitivity and specificity (Webber et al., 2018). Others have left the determination of invalid responding to the clinician, taking into consideration the appropriate balance between positive and negative predictive values for the specific setting the neuropsychological assessment is taking place in (Bauer, O'Bryant, Lynch, McCaffrey, & Fisher, 2007; O'Bryant, Engel, Kleiner, Vasterling, & Black, 2007).

The test of memory malingering and Deaf individuals

The non-verbal component of the TOMM may make it appear appropriate for use with non-English speaking individuals. However, performances of non-English speaking individuals on the TOMM have not been extensively studied. The exception is that some data have been gathered for Spanish speakers. Burton, Vilar-Lopez, and Puente (2012) found that none of the Spanish speaking controls living in the USA performed below the standard cut-off of the TOMM, and as for the individuals involved in different types of litigation (i.e., forensic non-capital cases and forensic capital murder cases), the rates of failure/below cut-off performance differed. Further, Spanish speaking individuals with traumatic brain injuries were administered the TOMM (Vilar-López et al., 2007; Strutt, Scott, Lazona, Tieu, & Peery, 2012) and while the findings generally supported the use of this PVT in these non-English speakers, some cautions were provided (e.g., using the measure with individuals with low levels of education). In 2015, the utility of the TOMM in Spanish speaking individuals was greatly expanded by the development of normative data for seven Spanish dominant countries in Central and South America (Rivera et al., 2015).

Utilizing the TOMM with Deaf individuals may present specific challenges. Deaf individuals may experience difficulty because nine of the 50 displayed objects on the TOMM do not have a direct ASL sign equivalent (spinning wheel, pail and shovel, wrench, jack-in-the-box, muffin pan, jack-0-lantern, quill pen, musical notes, stool). This could potentially disadvantage Deaf individuals compared to hearing individuals and raises concerns about the cultural appropriateness of the TOMM in individuals who use ASL as their first language. Attending and learning a large amount of visual stimuli, as is required for the TOMM, involves quick encoding of the visual stimuli. This can be aided by incorporating semantic information of the names of the objects (Koutstaal, Reddy, Jackson, Cendan, & Schacter, 2003). Although instructions on the TOMM clearly state that individuals must remember the object itself rather than its name, individuals still engage in semantic knowledge of the object to assist with recall. It is an innate process for individuals to associate images and corresponding language accurately to one another to later retrieve these images and the words (Mesnil, Bordes, Weston, Chechik, & Bengio, 2014).

In an older study by Liben (1979), profoundly Deaf children and hearing children were asked to recall black and white line drawings of objects. The participants were shown pictures and immediately after were asked to write down what they saw. Furthermore, the researchers trained half of both Deaf and hearing children to engage in semantic categorization as a memory aid (sorting pictures, pointing, counting, verbal labeling etc.). Although Deaf children used the same semantic clustering efforts as hearing children, they still performed significantly worse at the number of line drawings they could recall. The poor performance as related to difficulties with semantic labelling could be partially attributed to the fact that 90% of Deaf individuals with early profound deafness are born into hearing families, making them more susceptible to delayed and deficient oral language and reading skills if language deprived at a young age (Du Feu & Chovaz, 2014).

This, in combination with the aforementioned general concerns about neuropsychological testing with individuals who are Deaf, and the known importance of using performance validity measures routinely during a neuropsychological assessment, were the impetus for examining the validity of the TOMM in individuals who are Deaf and who use ASL as their first and/or preferred language. To our knowledge, no such study has been completed to date.

The current study seeks to answer if the standard cut-off scores for the TOMM provide valid results and if this PVT is culturally and linguistically appropriate to use with community dwelling Deaf individuals whose first language is ASL and who are not reportedly involved in litigation or a disability-related evaluation. Our research is largely exploratory as our goal was to better understand whether or not Deaf individuals will score similarly or differently on the suggested standard TOMM cut-off score ($\geq$45 for valid performance) normed for hearing individuals. Another goal of this seminal research was to provide a starting point to better understand how healthy Deaf individuals might perform on Trial 2, given the concerns noted in the literature that the standard cut-off scores are too conservative. Our final goal was to document performance on Trial 1 in this healthy Deaf sample in order to add to the literature that looks at the utility of Trial 1 as a stand-alone PVT.

Method

Participants

Ethics was obtained for this study through the King's University College Research Ethics Review Committee. The participants were recruited through community contacts of the Principal Investigator (CC) and the King's ASL professional interpreter through email, Facebook, or video-messaging. All participants were community dwellers from a mid-sized city in Southwestern Ontario, Canada.

The total sample consisted of 30 Deaf participants (11 male, 19 female) who considered ASL as their first language and use it on a daily basis. The participants (aged 18 years and older) ranged from ages 21–64 years ($M = 45.9$, $SD = 12.2$). In regards to education, 18 of the participants reported attending a Provincial School for the Deaf, 13 participants held a University degree, and three participants held a Master's degree. A total of 24 participants were right-handed, while six were left-handed.

None of the participants met exclusionary criteria of being involved in litigation or secondary gain issues (as per the participant's self-report), had suspected or possible dementia, or had vision deficits that could not be corrected with lenses. Three participants of the original sample were excluded due to possible developmental delay.

Procedure

Total participant time was approximately one hour, and a trained research assistant and a professional ASL interpreter conducted the sessions. The professional ASL interpreter graduated from an accredited three-year certificate interpreter training program from a Canadian college, and has worked as a qualified interpreter for over 25 years. While there is no regulatory body in Ontario for interpreters, the interpreter used in this study is a member of the Canadian Association of Sign Language Interpreters (a non-profit professional association that represents sign language interpreters whose members have graduated from recognized ASL-English Interpreter Education Programs).

After the consent process was completed, each participant completed a four-question, forced-choice questionnaire that gathered demographic information on age, gender, if a school for the Deaf was attended and highest level of educational achievement.

Materials

Neurocognitive test measures used in this study are noted below:

1. *Wechsler Abbreviated Scale of Intelligence, Second Edition (WASI-II).* To gain a better understanding of the sample's general intellectual abilities, as well as to ensure that impaired intellectual abilities did not affect the results, each participant's intellectual abilities were examined. The WASI-II is an abbreviated measure of intelligence that consists of four-subtests (Wechsler, 2011). Two of the subtests, Vocabulary and Similarities, assess verbal intelligence whereas the other two subtests, Block Design and Matrix Reasoning, assess nonverbal or visual intelligence.

   It should be noted that McCay (2005) examined 50 years of research on the intelligence of Deaf and hard of hearing children. He concluded without complicating disabilities and when appropriate measures are used, that Deaf and hard of hearing individuals function at approximately the same IQ level on performance intelligence tests as do hearing individuals.

   Non-verbal intelligence was assessed rather than verbal intelligence in the current study as the literature outlines that Deaf individuals may lag behind hearing individuals in English literacy abilities, given it is their second language. Specifically, it has been found that 50% of Deaf students graduate with a fourth grade reading level or less, while 30% leave school functionally illiterate (Mayer, 2007). Thus, it was a rational decision to assess intelligence in a way that did not tap into the participant's knowledge of spoken English.

   Recognizing the limitation that examining only half of the WASI-II subtests for an intellectual screen might result in skewed estimates for some individuals (either by over or under estimating intellectual abilities), for purposes of this study, only nonverbal intelligence estimates were obtained. The Block Design consisted of having participants re-create two-dimensional red-and-white geometric designs. This subtest evaluated non-verbal concept formation, fluid intelligence, coordination, and visual and perceptual organization. The Matrix Reasoning subtest required the participant to complete visual matrices and assessed fluid and visual intelligence, spatial ability, and perceptual organization. Combining the scores from these two measures produced a Perceptual Reasoning Index (PRI) score.

2. *Mini Mental State Examination: ASL (MMSE:ASL).* This measure was used as a screening tool to assess mental status in individuals whose primary language is ASL (Chovaz, 2019). Paralleling the Mini Mental State Examination (Folstein, Folstein, & McHugh, 1975), the MMSE:ASL is an 11-item tool that examines orientation, registration, attention, calculation, recall, and language, with a maximum score of 30. Cognitive impairment is indicated when individuals score a 26 or lower. The MMSE:ASL (Chovaz, 2019) is more appropriate to use with Deaf individuals using ASL, as it does not rely on knowledge of the English language. The MMSE:ASL is a video tool and was presented to participants on a computer to maintain standardization. The ASL interpreter was present to interpret and record participant's signed responses to the questions.
3. *Test of Memory Malingering (TOMM).* The TOMM is a 50-item forced-choice visual recognition task designed to determine if the individual is providing credible responses during testing. The measure included two learning trials where the participant is shown 50-target pictures of common objects one at a time for three seconds each, at one second intervals. The individual was then asked to identify the correct picture previously presented from a choice of two pictures. Through the use of the interpreter, corrective feedback was provided to the participant by indicating if the individual's responses were right or wrong. Following a 15 minute delay, the Trial was administered where the participant was asked to identify the correct target picture but without the stimuli pictures being re-administered.

Results

The following describes the results regarding our Deaf sample ($N = 30$, 11 male, 19 female ranging from 21 – 64 years of age). To determine how participants compared to normative WASI-II data, each Block Design and Matrix Reasoning raw score was calculated and matched with the appropriate *T*-score according to the participant's age group. The participants performed with a mean score of 49.4 ($SD = 8.1$) on the Block Design subtest. On the Matrix Reasoning subtest, participants performed with a mean score of 51.4 T ($SD = 5.9$). These scores were then combined to determine the PRI of the participants. It was found that the sample's score on the PRI, with a 95% confidence interval, was $M = 100.4$, $SD = 9.5$. The sample percentile on the PRI was $M = 50.4$. This placed the sample's performance ability for non-verbal intelligence in the average range.

All participants in the study met the cut-off score of less than or equal to 26 on the MMSE:ASL and the average score was $M = 29$. Only two participants scored a 26, while 17 achieved a perfect score of 30.

Table 1. Means, standard deviations, and ranges for test data.

	M	SD	Range
WASI-II PRI	100.4	9.5	79–126
TOMM Trial 1	48.1	1.8	44–50
TOMM Trial 2	49.9	.25	49–50
TOMM retention	49.9	.18	49–50
MMSE:ASL	29	1.4	26–30

Note: Sample size (N) = 30; WASI-II PRI = Wechsler Abbreviated Scale of Intelligence, Second Edition Perceptual Reasoning Index; TOMM = Test of Memory Malingering; MMSE:ASL = Mini Mental State Examination: American Sign Language; M = Mean; SD = Standard Deviation.

Demographic variables were studied to determine if there was a difference in TOMM performances based on aspects of the participant's background. More specifically, four demographic variables were collected on our sample of 30 Deaf individuals. These variables included gender, age, attendance at a School for the Deaf and highest level of education completed.

Firstly, an independent-samples t-test was conducted to compare differences in gender on the TOMM trials which was not significant.

Secondly, age of participants was examined. There was a significant positive association between participant ages and TOMM Trial 2 ($r = .37$, $p = .04$). There were no significant correlations for participant age with either Trial 1 or the Retention Trial.

Thirdly, the sample was analyzed regarding their early education placement regarding Deaf schools. There were no significant differences obtained on performances on the TOMM trials and whether a participant attended a School for the Deaf. And lastly, there were also no significant differences on TOMM trials among participants with or without postsecondary education.

The standard decision rules as outlined in the manual for the TOMM were used to interpret TOMM scores and to indicate valid or invalid performance (cut-off of ≥45 on Trial 2 or the Retention Trial for valid performance; Tombaugh, 1996). The participants obtained high scores on all three trials of the TOMM, with all demonstrating a valid response profile according to the standard protocol.

Examining the data more closely, one participant obtained a score of 44 on the first TOMM Trial, whereas all other participants scored above 45. Trial 1 performances were as follows (presented as percentage of the sample obtaining the listed score): 44 = 3.3%; 45 = 3.3%; 46 = 16.7%; 47 = 16.7%; 48 = 13.3%; 49 = 13.3%; and, 50 = 33.3%.

No participants scored below the standard cut-off on Trial 2 or Retention (i.e., ≥45 for valid performance), and the lowest score was 49. Two participants obtained a score of 49 (6.7% of the sample) and the remaining 28 participants obtained a score of 50 on Trial 2. Only one participate obtained a score of 49 on the Retention trial, with the other participants obtaining a perfect score. Please refer to Table 1 for means, standard deviations, and ranges of scores.

Discussion

Deaf individuals are known to have a greater neurological risk, particularly if the deafness is of non-genetic causes, as well as a risk for developing mental health difficulties (Du Feu & Chovaz, 2014). Encountering individuals who are Deaf in a neuropsychological practice is likely at some point in one's career, whether one has a clinical or forensic practice. It is important that these individuals have access to appropriate health care services, including neuropsychological assessments.

Obtaining a clear understanding of the validity of the neuropsychological assessment results is crucial, as the neuropsychological assessment conclusions can impact diagnosis, access to supports and additional services, and in some cases, impact the outcome of worker's compensation, disability, insurance claims, and potentially people's quality of life among other things.

With the above noted clinical significance in mind, the current study aimed to determine whether the TOMM is a valid measure to use with culturally Deaf individuals who use ASL. We examined whether Deaf participants with broadly normal intellectual abilities, who passed a brief cognitive screening measure, and who were not reportedly involved in active litigation or disability claims, were able to achieve the same standard cut-off score that has been normed for use in hearing samples.

The TOMM requires that explicit feedback be provided to examinees during trials so that response accuracy may increase (Tombaugh, 1996). The feedback was provided by an ASL interpreter. We found that in this sample response accuracy increased on subsequent trials, from an average score of 48.1 in Trial 1 to an average of 49.9 in both Trial 2 as well as the Retention Trial. These results suggest that culturally Deaf individuals who use ASL are able to perform just as adequately on the TOMM as hearing individuals when standard cut-off scores are used. In other words, the TOMM can be considered a valid measure to use with this group of individuals.

In this healthy Deaf sample, the range of scores for Trial 1 performance was 44 to 50. This was not unexpected given the wide range of Trial 1 performances in other healthy control groups studied (e.g., Etherton et al., 2005; Musso et al., 2011; Ryan et al., 2010; Vanderslice-Barr et al., 2011; Webber et al., 2018; Yanez et al., 2006). This is also consistent with Denning's (2012) summary of the data, which suggested that a cut-off score of approximately 40 on Trial 1 was sufficient to predict performance on the full administration of the TOMM. However, it is premature to set a Trial 1 cut-off score that accurately predicts valid or invalid performance on the full TOMM for healthy Deaf individuals. Additional studies would need to be done that address the limitations of this study.

With the exception of two participants, all other 28 healthy Deaf individuals scored perfectly on Trial 2 of the TOMM. The reason why two participants failed to correctly identify all target stimuli on Trial 2 is unclear. Without data from additional independent PVTs, the clinical interpretation of these borderline scores cannot be determined. This should not necessarily be construed as a "knowledge gap" or an inherent uncertainty in psychometric methods.

In fact, a recently published meta-analysis found converging empirical evidence for the clinical utility of alternative cutoffs (Martin et al., 2019) and this "indeterminate range" has recently been proposed as a legitimate third category in performance validity assessment (Erdodi, 2019). Emerging practice standards have evolved to implicitly acknowledge that borderline range scores are meaningfully different from both valid and invalid scores. Instead of theorizing their epistemological status, researchers started quietly excluding such scores from their criterion grouping, tacitly recognizing that they don't belong to either category (Abeare et al., 2019; Axelrod, Meyers, &

Davis, 2014; Schroeder, Martin, Heindrichs, & Baade, 2019; Sugarman & Axelrod, 2015; Whiteside et al., 2015).

Best practice continues to be to refer individuals to a neuropsychologist with the experience and qualifications to work with this population, thereby avoiding the use of interpreters and the potential pitfalls that are associated with interpreter use. However, this is not always clinically possible. In this study, the presence of an ASL interpreter did not cause an increase in TOMM failures at standard cutoffs. The interpreter's experience and knowledge of mental health practices when working with culturally Deaf individuals, and the fact that she was well trained apriori on the tests administered in this project, might have contributed to this finding. In reality, not all sign language interpreters are experienced in mental health assessments (Du Feu & Chovaz, 2014). The literature outlines the importance of having an ASL interpreter who is aware of culturally Deaf practices to adjust the information in a way that makes it accessible in the context of the culture (Hill-Briggs et al., 2007). Having a lack of knowledge of Deaf culture as well as in mental health assessment protocols while interpreting could lead to misunderstanding instructions, increasing the risk for inadequate translation into ASL.

The second reason why the ASL interpreter may not have impacted test scores is that the performance on the assessments did not have any consequences for the participants. According to the social facilitation theory that underlies the third-party observer effect, performance increases when the task is easy or familiar, while performance decreases when a task is difficult or unknown (Platania & Moran, 2001). As the participants were not in a situation where the results had any serious implications, there was no pressure to perform in a certain way. Experiencing a lack of pressure may have suppressed the drive or arousal in participants to perform in a certain way although the tasks were novel. This could have potentially made the tasks appear easier to the participants than they may appear to a real patient during a neuropsychological assessment. In a real neuropsychological assessment, the scores of the patient are applied in numerous ways including: determining cognitive capacities of brain-injured patients, monitoring the neuropsychological status of patients who have undergone surgical intervention, or in medico-legal situations such as trauma in motor vehicle collisions (Tranel, 2008). It would be suspected that the pressure for performance in these situations might have a greater impact on test scores than participating in a research study.

Performance on the TOMM also did not seem to be influenced by a lack of semantic knowledge. We wondered given some images presented in the TOMM did not directly translate into ASL if Deaf individuals may have had trouble recalling these images. In other words, we questioned if the lack of semantic knowledge may compromise visual memory. However, according to the scores on the TOMM, this was not the case. Since the TOMM uses everyday objects, it is likely that the participants had previous exposure allowing the development of appropriate labels, even if no sign exists for that object. In fact, it was noticed during testing that some participants would fingerspell the labels of the objects on the TOMM in English, although not all had a direct sign to match. Fingerspelling is the manual alphabet used in ASL performed by a variety of different hand gestures.

There are limitations to this study that need to be considered. Given the significance of interpreting the TOMM results within a clinical or forensic neuropsychological evaluation, it would be important to re-examine this question with a larger sample size, with an analog malingerer comparison group that are Deaf, and with Deaf individuals with known neurological and psychological impairments.

In addition, there was a lack of criterion measures used in this study. Recognizing the fact that the utility of other non language-based PVT, either stand-alone (e.g., Nonverbal Medical Symptom Validity Test or Rey-15 Item Memory Test) or embedded measures (e.g., Trail Making Test B/A; Grooved Pegboard, Finger Tapping Test, or Wisconsin Card Sorting Test), have not been examined in community dwelling healthy Deaf individuals, it would have been interesting to compare the current TOMM results with performances on other PVT. Such information might have strengthened the findings of this study.

While gender, education level, and age have not been shown to have an impact on TOMM results in the hearing population, studies on Spanish speaking individuals from some, although not all, Central and South American countries have shown that education and age have impacted TOMM results (Ardila et al., 2002; Vilar-López et al., 2007). As such, these variables should be more closely examined in the Deaf population. We did find positive associations with age and TOMM Trial 2. Our preliminary examination of education suggested no differences were obtained whether a participant attended a School for the Deaf or not, and also whether the participant attained any further postsecondary education. It is recognized that our results may be influenced by our small sample size and we feel these demographic variables would be particularly relevant to examine further.

Lastly, the participants in this study were all known to the ASL interpreter. This highlights the fact that the Deaf community including interpreters is small and well known to each other. This made it unclear whether there really was an effect of having an interpreter present as all participants had previously met or worked with the ASL interpreter. We could have used another ASL interpreter and assigned participants into two groups (known to ASL interpreter or unknown) during the assessments. This could have helped us to determine whether differences existed between groups who knew the interpreter versus those who did not.

According to what has been found in this study, the TOMM does not need to be revised in its administration or image content to be made more appropriate for Deaf individuals who use ASL. Best practices suggest that any measure of cognitive functioning be appropriately selected for this population and that an interpreter trained in mental health work be present during testing when a neuropsychologist who is fluent in ASL cannot be used. This study adds to the gap in the literature regarding the use of the TOMM with Deaf individuals who use ASL. Clinicians can have greater confidence that the Deaf individual's TOMM results reflect whether the individual is producing credible responses or not rather than indicating a difference in performance due to an existing language barrier and/or cultural differences.

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