An Adaptation of the Birmingham Cognitive Screen (BCoS) to the South African context (A Preliminary study).

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LIST OF ABBREVIATIONS

ABD	Acquired Brain Damage
BCoS	Birmingham Cognitive Screen
UCT	University of Cape Town
GSNSB	Groote Schuur Neurocognitive Screening Battery
MMSE	Mini Mental Status Examination
SPSS	Statistical Package for Social Science
SRPP	Student Research Participation Program

Abstract

The Birmingham Cognitive Screen (BCoS) is a neurocognitive battery for assessing cognitive impairment in people who have suffered brain damage. The screen was developed and normed in Birmingham which leads to question about the usefulness of the screen outside of this context. This study aimed to identify BCoS' tasks that South African participants find difficult. 26 cognitively intact South African students from the University of Cape Town and 6 cognitively intact individuals between the ages of 50-65 from Universities in the Western Cape were recruited to participate in the study. An examiner individually screened and scored these participants using the BCoS. Each task's mean score of the sampled students was compared to the BCoS norms and BCoS cut off scores. One sampled t-tests were conducted to detect if there were significant differences between tasks' mean score of the students and the BCoS norms and cut off scores. A second analysis was run to ensure that mean differences between were not due to age differences between the Birmingham group and the students. Each task's mean score of the 6 older participants was compared to the BCoS' norms and cut off scores. Again, one sampled t-tests were conducted to detect if there were significant differences between these scores. The results suggest that the BCoS' sentence reading task incorrectly detects for cognitive impairment in South African students. Also the South African participants scored significantly lower or higher than the BCoS' norms for particular BCoS' tasks. It was concluded that new BCoS' norms may need to be developed for the South African population and the sentence reading task may need to be adjusted to suite the South African population. However a further study should include larger sample size to confirm these results.

Key terms: Birmingham Cognitive Screen, norms, cut off scores, cognitively intact, cognitive impairment, South African and language.

Introduction

In developed countries, neuropsychological interventions following neurological change have become standard practice. Results from neuropsychological screening help clinicians map out areas of brain damage, establish impaired cognitive processes due to the brain damage, and also outline spared processes that can be utilised during rehabilitation and recovery. In South Africa neuropsychology has just been formally recognised as a stand-alone clinical area.

Like many countries, South Africa has a significant disease burden that requires neuropsychological interventions. It is estimated that the incidence of various forms of acquired brain damage (ABD) is higher in South Africa in comparison to the world wide average (Nell & Brown, 1991). These higher incidences of brain damage, and their associated negative impact on the sufferer's life, underscore the need for cognitive screening instruments that assess cognitive functioning following ABD. Screens that aid in accurate detection of cognitive impairment may assist clinicians in choosing more effective cognitive rehabilitation measures. In South Africa, widely used cognitive screens include less informative instruments such as the Mini-Mental Status Examination (MMSE) and the Groote Schuur Neurocognitive Screening Battery (GSNSB).

The MMSE tests cognitive functioning relating to orientation, language, memory, calculation, attention and visuospatial construction. However studies suggest that the MMSE is not a robust instrument. For instance, it has been shown to be poor at detecting deficits in executive functioning (Juby, Tench & Baker, 2002). The MMSE is also poor at detecting attention deficits, and it fails to differentiate memory retrieval problems from memory-encoding difficulties. It is also poor at detecting deficits in visuospatial abilities and is weak at assessing language functioning (Balchin, 2008).

The GSNSB is a better measure in the sense that it has been culturally adapted for use in South Africa. A pilot study, using Afrikaans, English and IsiXhosa speakers who were cognitively intact and consultation with experts in the South African culture, was used to adapt this test for use on the South African examinee (Balchin, 2008). This makes the GSNSB one of the few cognitive screens that are specifically adapted for use in South Africa.

Most of the neurocognitive tests currently in use across South Africa were standardised in western countries. Their psychometric qualities when used on South African clinical populations are unknown and very few of them have been adapted for local use. There is a need to adapt these neurocognitive tests for local use. The best candidates for such

a process would be new neurocognitive screens of which construction has been informed by recent research in neurocognitive science.

The Birmingham Cogntive Screen (BCoS) and its domains

The BCoS (Humphreys Bickerton, Samson & Riddoch, 2012) is a neurocognitive battery for assessing cognitive impairment in people who have suffered brain damage. The battery evaluates five cognitive domains which comprise of attention and executive function, language, memory, numeracy and apraxia. Attention tests target controlled and spatial attention. A BCoS attention assessing apple cancelation task was able to correctly identify different forms of neglect across stroke patients (Bickerton, Samson, Williamson & Humphreys, 2011). An apple cancelation task is an exercise that require examines to cross out complete apples on page filled with pictures of complete and incomplete apples. Language is assessed in terms of comprehension as well as written and spoken language. Memory tests evaluate episodic, long term and short term memory. The numeracy tests assess an individual's capacity to calculate, read and write numbers. Apraxia is assessed against limb and constructional apraxia, and assesses an individual's ability to control and carry out movements (Bickerton et al., 2014).

The BCoS is an aphasia and neglect friendly instrument which makes it suitable for use on a wider range of neurological patients. The neglect friendly characteristic of the screen means that stroke victims, who cannot process all the visual stimuli present in the visual display but can only detect visuals from the right or the left side of the display, can be tested due to the layout of the items. This makes the test highly inclusive, and the only standardised neuropsychological screen to incorporate these controls. Studies showed the screen's ability to correctly identify varying cognitive profiles across stroke patient (Bickerton et al., 2011, Bickerton et al., 2014; Bisiker & Bikerton, 2013)

The BCoS also only takes less than an hour to administer (Humphreys et al,. 2012). The screen is also user friendly in that it has a unique reporting system in which the cognitive profile of a patient's performance across the tests is illustrated in a chart format that is easy to understand (Humphreys et al., 2012). The BCoS has demonstrated good psychometric properties in terms of validity and reliability (Bickerton et al., 2012, 2014).

While BCoS addresses some of the shortfalls in some of the standard neuropsychological screens by incorporating tests that are, for instance, neglect controlled, it is not guaranteed that it would perform equally well in cultures other than the one it was normed. Cultural schemas and social contexts are an integral part of an individual's cognitive

activity and interpretive processes (Ratner, 1991). The clinical value in terms of diagnostic power and predictive validity of the BCoS and other western standardised tests can be compromised if the tests are used without considering the social or cultural context in which they are administered.

Cross Cultural Issues in Using Western Standardised Tests.

When administering cognitive screens, the examiner assumes that the examinee is comparable to the population in which the test was standardised. However this supposition is violated when the examinee is of a different culture or language to the standardization population (Flanagan & Oritz, 2001). A screen yields more useful results if it considers abnormal and normal behaviour for a given population (Balchin, 2008; Mushquash &Bova, 2007). Unfortunately, psychological assessment tools are usually created by and toward the globalisation of the norms appropriate to the white middle class male (Balchin, 2008; Nadeson, 1997; Richardson, 2002). This standardisation can also be applied to the development of the BCoS which was normed in England. Western standardised tests, such as the BCoS, maybe unreliable in South Africa with its majority African population whose culture and norms might differ in important ways from the English culture.

The effects of culture are explicit in some of the items on the BCoS. For instance, tests that require visual reading and naming visual stimuli are particularly sensitive to demographic variables such as language and age (Mansur, Radanovic, Taquemori, Greco & Araújo, 2005). BCoS items on the picture naming task may not be easily recognisable to the South African examinee.. Thus norms developed on English speaking individuals are not always appropriate for use in populations where English is not the first language (Manly, 2008; Swartz, Drennan & Crawford, 1998). Consequently if cultural variability is not taken into consideration by examiners using the screen, then incorrect detection of cognitive impairment may occur (Kennepohl, Shore, Nabors & Hank, 2004). For instance a cognitive screen's meaningless gesture production task may actually hold meaning in a specific culture and cause incorrect detection of impairment in the inferior portion of the left angular gyrus (Goldenberg & Hangmann, 1996). This in turn affects the effectiveness of neuro-rehabilitation treatments that aim at treating cognitive impairment. This unwanted effect of culture on lowering the reliability of screens' results brings forth the need to adapt screens such as the BCoS to the South African culture.

Aims and Hypotheses

The cross cultural diversity encompassing South Africa creates a dire need to locally

adapt western standardised neurocognitive screens (Anderson, 2001; Mathew & Bouwer, 2009). The benefits of the BCoS, as outlined above, make the screen a good candidate for local adaptation. The screen's utility in other cultures has been demonstrated. For example, the Cantonese version (HK BCoS) of the screen developed by Chan and colleagues (2013) has produced promising results. As far as we know, no attempts have yet been made to adapt the screen for use in South Africa. Part of the reason being is that it is a new screen that has just entered the market. However this adaptation is necessary, since some of the tasks in BCoS may not be recognisable or appropriate to the South African context. This study was therefore designed to investigate the performance of BCoS items on a selective homogenous sample of young adults with the aim of identifying and weeding out inappropriate items thereby making the instrument valid for use on South African patients. To achieve this the study set out to detect whether the BCoS contains items/tasks that are difficult for neurologically intact South African students, and that may also suggest brain damage where none exists

This study formed an initial step towards a broader normative study that aims at developing normative data for BCoS in South Africa. However BCoS norms were standardised on participants between the ages of 50-65, whereas our main sample of undergraduate students is much younger. Although the screen consists of basic cognitive tasks on which performance should not significantly vary with age, we also sampled a smaller group of participants whose ages lie within the BCoS normative sample's age range. The following hypotheses were tested:

Hypothesis 1: Scores for the student sample and older South African sample will be significantly lower from BCoS cut off scores insinuating that the BCoS incorrectly detect for cognitive impairment. .

Hypothesis 2: Scores for the student sample will be significantly different from BCoS norms scores.

Hypothesis 3: BCoS norm scores will be significantly different from scores for our 50-65years old sample. .

Hypothesis 4: No significant difference will be observed on performances between the student sample and older South African sample for tasks on which the groups have been shown to perform conversely from the norm.

(Please note that cut off score and norm scores are different scores)

Method

Design

This is a cross sectional study investigating BCoS performance in two South African samples.; 1) a student sample, and 2) a sample of adult aged 50-60years of age (the older sample). The study was designed to ensure that the performance of South African students on the BCoS was not due to age differences as the screen was normed on older people aged between 50 -65 years old. The dependent variable was the performance of the participants on the tests and the independent variable was the nationality of the sampled group.

Participants

10 cognitively intact undergraduate students from the Psychology honour's class at UCT were initially recruited for the pilot phase of the study. These students were recruited through verbal invitations from the researcher. This allowed the researcher to practice administering and scoring the screen. These 10 participants were not rewarded nor were they given an informed consent form to sign because data collected from these students was not used in the study. Data was collected via the administration of the screen to a randomly selected group of cognitively intact undergraduate students as well as staff from the University of Cape Town, University of Stellenbosch and the University of Western Cape who were between the ages of 50-65years old.

34 student participants were recruited however, due to time constraints and the non-arrival of participants, the researcher was only afforded 26 participants. 26 undergraduate students were recruited into the study (Male = 1; Female = 25). All the students were between the ages 19 and 23 years of age (M = 20.54; SD = 1.43). The students were recruited through the University's Student Research Participation Program (SRPP). This program requires students to volunteer as participants in research studies in order to qualify for a pre-requisite number of points. Participants were recruited to participate and notified about the opportunity to participate via Vula which is UCT's student centre site. The SRPP advert included the criteria that was needed to be met in order for the student to be able to participate in the study. See Appendix E.

This study used a convenient sample of undergraduate students. Non probability convenient sampling was used due to the participants being easily accessible which was suitable due to the time constraints placed on the researcher.

To strengthen the study, the researcher tried to recruit 34 older participants who were between the ages of 50-65years old (M = 53.16 SD =3.13). However due to time constraints, the researcher only recruited 6 participants. Although no age effects were expected, this was

done to ensure that the participants' chronological age was not a factor impacting performance on the BCoS. These 6 participants was made up of academic and non-academic workers at the University of Stellenbosch, the University of cape Town, and the University of Western Cape. On average the older participants (*M* = 18.50 *SD* =5.21) spent more years in the education system than the students (M= 14.08 SD=.69).This is important to note because level of education may affect performances on cognitive screens (Manly, Byrd, Touradji & Stern, 2004).

Participants in the 50-65 years old sample were recruited through direct verbal invitation and phone calls. Prior to the screening, the researcher showed these participants an information document that outlined the inclusion and exclusion criteria (see Appendix F). If potential participants had met the criteria they were allowed and requested to participate. Due to the time constraints placed on the researcher, nonprobability convenient had also been used to recruit these participants.

The researcher tried recruiting 34 participants in both sample sets because the screen was normed on 34 participants between the ages of 50-65 years old.

Inclusion and Exclusion Criteria

All Participants had to be cognitively intact. This is because the aim of the study was to detect for poor items of the scale. The sample group must have been able to speak and understand English. This was to account for the effect of language on performance on neuropsychological tests. Lastly, participants must have been South African and have lived in the country for all of their life so far. This had ensured that the participants are representative of the South African context and its culture.

The participants were excluded if they had a history of neurological disease/ disorder. These include Attention deficit disorder, Autism, Anxiety disorder, Bipolar disorder, Depression, Dyslexia, Epilepsy, Obsessive Compulsive Disorder, Schizophrenia and/or any Social Phobia. An individual was excluded if he or she had any cognitive functioning history of psychiatric illness, had any head injury and/or had a stroke. The exclusion criteria ensured that participants were cognitively intact.

Measures

The Birmingham Cognitive Screen (BCoS). The BCoS was used to screen students. The BCoS takes an hour to administer and provides a cognitive profile of the examinee on five cognitive domains, namely; attention and executive function, language, memory, number skills as well as praxis and action.

Attention and executive functioning are assessed using 5 tasks. These include an auditory attention task, rule finding and concept switching task, an apple cancelation exercise (crossing out picture of whole apples), visual extinction exercises and a tactile extinction task (Humphrey et al., 2012).

Language ability is measured by a picture naming task, a sentence construction exercise, a sentence reading task, the reading of non-words, writing words and non-words as well as an instruction comprehension task (Humphreys et al., 2012).

Memory is evaluated using three tasks, namely an orientation task, task recognition exercise and a story recall and recognition task (Humphreys et al., 2012). With advice from my supervisor, the researcher edited some details of the story for the story recall and recognition task to make it more representative of the South African context. The word 'Manchester' had been changed to 'Durban' and 'twenty five pounds' was changed to 'five hundred rands'.

Number skills are appraised through a number price/time reading task, number/ price writing task and a calculation task (Humphreys et al., 2012). The prices on the task were initially represented in the English currency of pounds but the researcher altered the prices to represent the South African rand. The tasks assess the ability to code and respond to number and to evaluate basic number processing operations.

To assess for functional praxis the screen applies a complex figure copy task, multi-step object use task, gesture production exercise, gesture recognition exercise and an imitation exercise (Humphreys et al., 2012). For a more detailed description of the screen please see Appendix A and Humphreys et al. (2012).

Procedure

The students were assessed on campus in a quiet room to control for extraneous variables, such as noise, that may distract participants. Rooms 3b, 3c and 3d of the PD Hahn building at the University of Cape Town was used as it fitted the above mentioned characterised. Four staff members from the University of Cape Town were screened in their offices without interruption. One staff member from the University of Stellenbosch and one staff member from the University of the Western Cape had been assessed individually in a quiet room in their home.

Written informed consent was obtained from all of the participants except from the first 10 participants that the researcher used to develop his skills using the screen. Participants gave informed consent by reading and signing the form. Thereafter the researcher assessed participants using the cognitive screen as well as recorded their results. Each session took

approximately one hour. Participants had been thanked for their participation and were allowed to ask questions regarding the study.

The researcher scored the participants during screening for all of the tasks on the BCoS except for the complex figure task and the apple cancelation task. These two tasks were scored after the screening of participants.

Data Analysis

The data was analysed using the Statistical Package for Social Sciences (SPSS) software (version 22, release number 22.0.0.0).

One sample t-tests were used to compare scores of students and older participants against BCoS cut off scores. One sample t-tests were also used to detect significant difference between the mean scores of both sets of sampled participants and the BCoS norms. One sampled t tests were used because the researcher only had access to the mean scores of the participants used to norm the screen and did not have access to their standard deviations or raw scores. One sample t-test is an acceptable way of comparing means given the lack of raw data (Fields, 2009)

The assumption that data should be normally distributed was expectedly violated as cognitively intact participants were anticipated to score highly on the screen. Bootstrap analyses were applied while performing all *t*-tests as bootstrapping controls for non-normality of data. Bootstrapping is the process of which the sampled participants are treated as a population and then samples are drawn and replaced from the original sample to produce a sample size of 1000 (Fields, 2009). The significance level was set at an alpha level of $p \leq .05$. A Cohen's d effect size (*r*) was calculated to illustrate practical significance of the results. An effect size of $r \geq .07$ denoted a high practical significance

Ethical Consideration

Ethics approval for the study was obtained from the Psychology Department's Research Ethics Committee at the University of Cape Town (Appendix D).

The study had no deception. However Participants were still debriefed after their screening (Appendix D).Students were awarded 2 SRPP points and the older participants were offered a cup of coffee. Informed consent was acquired from all the participants. Participants individual identity was promised to be anonymous but they took on a group identity of either being part of the student sample or older sample. Raw data was kept in a lockable safe and captured on password protected files.

Results

Boxplots were used to detect for extreme outliers in the 26 participants aged between 19-23 years old (see Appendix H). Only extreme outliers were removed from the data set as the sample size was small. One outlier for the Birmingham rule finding task, six outliers from the sentence construction task, three outliers from the non-word reading task, three outliers from the sentence reading accuracy task, one outlier from the first story recognition task, three outliers from the multistep object use, and one outlier from the imitation task were deleted. No data collected from the six participants aged 50-65 years old were deleted because the sample size was too small and removal of data would have skewed results. However there was one outlier in the auditory attention accuracy task, one outlier in the auditory attention practice exercise, one outlier in the Birmingham rule finding rules task, one outlier in the non-word reading task, one outlier in the word and non-word writing task and two outliers for the second story recall and recognition task. One sample t tests were used to compare the samples' scores to the BCoS cut off scores and norms. For comparisons across all tasks (See Appendix I). .

BCoS Task that Incorrectly Detect for Cognitive Impairment in the South African Samples

The researcher compared the BCoS cut off scores and participants' mean scores for each task on the BCoS that they scored below the cut off scores. The cut of scores are based on the based on the fifth percentile of the BCoS norms (Humphreys et al., 2012**).** The following are tasks for which participants scored below the cut off score:

Tasks indicating deficits in language abilities.

Picture naming task. For the picture naming task the undergraduate sample scored a mean of 10.77 (SD =1.99) which is below the cut off score 11.00. This result is insignificant t (25) =-.59, p =.280 However the older participants scored a mean score 11.83 (*SD* = 1.72) which is above the cut off score of 11.00. This difference is insignificant *t* (5) = .005, *p* = .453, *r* = .91

Sentence reading accuracy task. For the sentence reading task, all of the participants in the student sample scored 41.00 (*SD* = .00) which is below the cut off score of 42.000. This indicates impairment in participants' written language abilities. However all the participants in the older sample scored 42.00 which is in line with the cut off score

Task detecting for deficits in episodic memory.

First story free recall and recognition task. The older sample scored a mean score of

12.50 which is below the cut off score of 13.00. This result is non-significant, *t* (5) = -.57, *p* = .297, *r* = .23. However the undergraduate sample scored a mean of 13.82 (SD =1.17) which is higher than the cut off score of 13.00. This result is statistically significant, t (24) = 3.50, p = .008, r = 1.43 .

Task detecting for deficits in numeric abilities.

Number writing task. On average the students incorrectly read clock time and scored below the BCoS cut off score (M =8.00). However the difference between the scores was non-significant, *t* (25) = -1.51, *p* = -142, *r* =.29. The older sample (M =7.00, SD = 1.55) also scored below the BCoS cut off score (M = 8.00). However the difference between the scores was non-significant, *t* (5) = -1.58, *p* = .175, *r* = .58.

Please refer to table 1 for an illustration of the above results.

Table 1

Results for tasks that samples participants scored below the cut off scores

Task	*n*	*M*	Cut off score
Picture naming			<11.00
Participants(19-23yrs old)	26	10.77	
Participants (50-65yrs old)	6	11.83	
Sentence reading accuracy			<42.00
Participants(19-23yrs old)	26	42.00	
Participants (50-65yrs old)	6	41.00*	
Story free recall and recognition 1			<13.00
Participants(19-23yrs old)	25	13.82*	
Participants (50-65yrs old)	6	12.50	
Number reading			<8.00
Participants(19-23yrs old)	25		
Participants (50-65yrs old)	6	7.00	

Note denote significance at $p \leq .05$*

Next, the researcher compared the students' scores for each task to the BCoS norms. This comparison allows one to detect if scores for the student sample are significantly different from BCoS standard scores. The researcher also compared the older samples' scores on each task to the BCoS norms. From this comparison one can see if BCoS norm scores are significantly different from scores for our 50-65years old sample.

Results for tasks that participants scored below the BCoS norms.

Tasks which tests ability in spoken language.

The participants scored in line with the BCoS norms for the instruction comprehension task and the sentence construction tasks which are tasks used to assess examinees' spoken language abilities (see Appendix H). However participants scored below the norm for the picture naming task

Picture naming task. The students identified less pictures correctly in the picture

naming task (*M* = 10.769, *SD* = 1.986) than the standard BCoS norms (*M* = 13.1). This difference was statistically significant and had a high effect size *t*(25) = -5.984, $p \leq .001$, *r* = 2.39. The older sample (*M* = 11.83, *SD* = 1.72) also performed worse than the norm (*M* = 13.1) for the picture naming task. However this difference was not statistically significant, *t* (5) = -1.80, *p* =.153, but it still had a large effect size of *r* = 1.61. Please refer to table 2 for results.

Table 2

Task that test ability in spoken language that participants scored below the BCoS norm

Task	*n*	Score Range	*M*	*M* (BCoS norm)	*SD*	*df*	*t*	*p*	(*r*)
Picture naming		0-14		13.1					
Participants (19-23yrs.)	26		10.77		1.99	25	-5.98	.001*	2.39
Participants (50-65 yrs.)	6		11.83		1.72	5	-1.80	.153*	1.61

**denote that bootstrapping was performed*

Task which tests ability of written language

Word and non-word writing task. The students wrote more words incorrectly for the word and non-word writing task (*M* = 4.31, *SD* = .68) compared to the BCoS norm (*M* = 4.4). However this difference was insignificant with a small effect size, *t* (25) = -.69, *p* = .480, *r* =.23.The older sample (M = 4.17, SD = .41) also wrote more words incorrectly than the BCoS norm (*M* =4.4). The difference was also found to be insignificant but with a large effect size, *t* (5) = - 1.40, *p* = .102, *r* = 1.25. Please refer to table 3 for results.

Table 3

Task that test ability in spoken language that participants scored below the BCoS norm

Task	*N*	Score Range	*M*	*M* (BCoS norm)	*SD*	*df*	*t*	*p*	(*r*)
Word Non-Word writing task		0-5		4.4					
Participants ((19-23yrs.)	26		4.31		.68	25	-.69	.480	.28
Participants (50-65 yrs.)	6		4.17		.41	5	-.14	.102	1.25

Tasks that assess episodic memory

First story recall and recognition task. On average students recalled and recognised less detail on the story recall and recognition task (*M* = 13.820, *SD* = 1.17) compared to BCoS norms (*M*= 14.3). This differences is statistically significant with a big effect size, *t* (24) = -2.049, $p \leq .001$ *r* =1.506)**.** The older sample (*M* = 12.50, *SD* = 2.14) also performed worse than the norm (*M* = 14.3) in this task. However this difference is not statistically significant, *t* (5) = -2.06, *p* =.085 but it still has a large effect size of *r* = 1.84.

Second story recall and recognition task. The students also recalled and recognised less detail on their second attempt in the story recall and recognition task ((*M* = 13.62, *SD* =.94) compared to the BCoS norms (*M* = 14. 6). This difference is significant with a big effect size, *t* (25) = 11.458, $p \leq .002$, *r* = 4.58. On average, the older participants, also recalled and recognised less detail on their second attempt in the story recall and recognition task (*M* =14.00, *SD*= .63) than the norm (*M* = 14.6). This difference is significant with a big effect size, *t* (5) = -2.32, *p* =.016**,** *r* = 2.08.

Please refer to table 4 for above results.

Table 4

Task that assess episodic memory that participants scored below the BCoS norm

Task	*n*	Score Range	*M*	*M* (BCoS norm)	*SD*	*df*	*t*	*p*	(*r)*
Story recall and recognition 1		0-15		14.3					
Participants (19-23yrs.)	25		13.82		1.17	24	-2.05	.052	0.84
Participants (50-65 yrs.)	6		12.50		2.14	5	-2.06	.085*	1.84
Story recall and recognition 2		0-15		14.6					
Participants (19-23yrs.)	26		13.62		.941	25	-5.33	.002*	2.13
Participants (50-65 yrs.)	6		14.00		.63	5	-2.32	.016*	2.08

denote that bootstrapping was performed

Tasks that assess number skill

Participants scored below the BCoS norms for all the tasks that assess numeric processing.

number reading task. On average, the students read out more numbers incorrectly in

the number reading task (M = 7.654, SD = 1.164) compared to the BCoS norm (M = 8.8) This difference is significant and had a big effect size $t(25) = -5.020$, $p = .002$, r=2.020. The older South African participants (M = 7.000, SD = 1.55) also scored lower than the norm (M = 8.8). This difference is also significant with a high effect size, t (5) = -2.85, p = .017, r = 2.55.

number writing task. The students also failed to write down as many correct numbers for the number writing task (M = 4.15, SD = .37) compared to the BCoS norm (M = 4.9). This difference is also significant and had a high effect size $t(25) = -10.35$, $p \leq .001$, r =2.801. The older South African participants (M= 7.00, SD = .00) also scored below the BCoS norm (M = 4.9) for this task but they had no standard deviations within their group scores. This meant that a one sampled t tests could not be performed and was not needed as all of the older participants performed the exactly same in this task.

number calculation task. On average, the students made more incorrect calculations for the number calculation task (M = 3.153, SD = .93) compared to the BCoS norms (M = 3.6). This difference is statistically and large effect size significant t (25) = -2.46, p =.030, r = .098. The older South African participants (M= 3.17, SD= .98) also performed worse than the norm (M= 3.6). However this difference is not statistically different, t (5) = -1.08, p = .296. There was a high effect size of r =.97.

Please refer to table 5 for above results.

Table 5

Task that assess number skills that participants scored below the BCoS norm

Task	*n*	Score Range	*M*	*M* (BCoS norm)	*SD*	*df*	*t*	*p*	(*r)*
Number reading		0-9		8.8					
Participants (19-23yrs.)	26		7.65		1.16	25	-5.02	.002*	2.01
Participants (50-65yrs.)	6		7.000		1.55	5	-2.85	.017*	2.55
Number writing		0-5		4.9					
Participants (19-23yrs.)	26		4.15		.37	25	-10.34	.001*	2.80
Participants (50-65 yrs.)	6		4.000		.00	5			
Number calculation		0-4		3.6					
Participants (19-23yrs.)	26		3.15		.93	25	-2.46	.030*	.098
Participants (50-65 yrs.)	6		3.17		.98	5	-1.08	.296*	.97

*denote that bootstrapping was performed

Tasks that assess apraxia-action and movement abilities

Figure copy task. The student sample (*M* = 43.65, *SD*= 1.85) did not draw the complex figure as precisely as the standard BCoS norm (*M* = 45.1). This difference is significant and had a large effect size *t* (25) = -3.98, $p \leq .001$, r =1.59. The older sample (*M*= 42.83, *SD*= 1.17) also performed worse than the BCoS norm (*M* = 45 .1). This difference is significant and had a large effect size *t* (5) = -4.75, $p \leq .001$, *r* = 4.25.

Gesture production task. The younger (*M* = 10.46, *SD* = 1.36) and older sample (*M*= 10.83, *SD* = .75) produced more gestures incorrectly compared to the BCoS norm (M= 11. 5). However only the difference between the student sample and the norm were significant, *t* (25) =3.88, *p* =.049. Additionally a large effect size of *r* = 1.55 was found. The difference between the older South African participants and the norm is not significant, *t* (5) = -2.17, *p* = .465. Nevertheless a large effect size of *r* =1.94 was found.

Gesture recognition task. The gesture recognition task seemed to be a challenge for both the younger (*M* =5.17 *SD*= .57) and older South African participants (*M* = 5.50, *SD* = .55) as both samples recognised less gestures than the BCoS norm (M =5.8). The difference in performance between the students and the BCoS norm is not significant, *t* (25) = -1.65 *p*= .117. However a medium effect size of r =.66 was found. The difference in performances between the older South African participants and the norm is also insignificant with a large effect size *t* (5) = -1.34, *p* = .182, *r* =1.20.

Refer to table 6 for above results.

Table 6

Task that assess apraxia that participants scored below the BCoS norm

Task	*n*	Score Range	*M*	*M* (BCoS norm)	*SD*	*df*	*t*	*p*	(*r)*
Figure copy		0-47		45.1					
Participants (19-23yrs.)	26		43.65		1.85	25	-3.98	.001*	1.59
Participants (50-65 yrs.)	6		42.83		1.17	5	-4.75	.001*	4.25
Gesture production		0-12		11.5					
Participants (19-23yrs.)	26		10.46		1.36	25	-2.07	.049	1.55
Participants (50-65 yrs.)	6		10.83		.75	5	-.79	.465	1.94
Gesture recognition		0-6		5.8					
Participants (19-23yrs.)	26		5.17		.57	25	-1.65	.117*	.66
Participants (50-65 yrs.)	6		5.50		.55	5	-1.34	.182*	1.20

**denote that bootstrapping was performed*

There were some tasks that participants scored above the BCoS norms. The researcher compared participants' scores to the BCoS norms for these tasks.

Results for tasks that participants scored above the BCoS norms.

Task that assess spatial attention. The left visual unilateral task, right visual unilateral task, left visual bilateral task, right visual bilateral task, left tactile unilateral task, right tactile unilateral task and right tactile bilateral tasks are all spatial attention assessing tasks that participants scored in line with the BCoS norms (see appendix). The apple cancelation task and left tactile bilateral task are attention assessing tasks that participants scored above the BCoS norms.

Apple cancelation task. On average students crossed out more complete apples on the apple cancelation task (M = 49.16, SD = .71) compared to the BCoS norms (M = 48.00).This difference was statistically significant with a very large effect size, t (25) = 10. 56, $p \leq .001$, r = 4.22. The older sample also crossed out more apples on the apple cancelation task (M = 49.00, SD = 1.55). However this difference is statistically insignificant with a large effect size t (5) = 1.58, p =.175, r = 1.41.

Left tactile bilateral task. All of the participants from the student sample (M = 8.00, SD = .00) and the older sample (M = 8.00, SD = .00) scored better than the BCoS norms (M =7.9) because they correctly lifted up their left hand every time the researcher had touched

their hand. A *t* test was not, and could not be, performed because there is no deviation from the mean. Please see table 7 for above results.

Table 7

Task that assess spatial attention that participants scored above the BCoS norm.

Task	*n*	Score Range	*M*	*M* (BCoS norm)	*SD*	*df*	*t*	*p*	(*r)*
Apple cancellation		0-50		48.00					
Participants (19-23yrs.)	26		49.16		.71	25	10.56	.001*	4.22
Participants (50-65 yrs.)	6		49.00		1.55	5	1.58	.175	1.41
Left tactile bilateral		0-8		7.9					
Participants (19-23yrs.)	26		8.00		.00	25			
Participants (50-65 yrs.)	6		8.00		.00	5			

**denote that bootstrapping was performed*

Tasks that assess controlled attention

Participants scored above the BCoS norms for all the tasks that assess controlled attention.

Auditory attention task. All of the students correctly responded to three specific words that a man said on a recording for the auditory attention task (M = 54. 00, SD = .00) and performed better than the BCoS norm (M = 53.2). A *t* test was not, and could not be, performed because there is no deviation from the mean. The older participants also responded more accurately to words on the auditory attention task (M = 53.83, SD = .41) compared to the BCoS norms (*M* = 53.2). This difference is statistically significant and showed a large effect size t (5) = 6.80, $p \leq .001$, r = 6.08.

Auditory attention practice. On average both sets of the sampled participants needed less practice rounds for the auditory attention task than the BCoS norms. The students (*M* = 1, *SD* = .00) needed less practice than the BCoS norms (*M* = 1.1). A *t* test was not, and could not be, performed because there is no deviation from the mean. The older sample also needed less practice (*M* = 1.17, *SD* = .41) compared to the BCoS norms (*M* = 1.1). However this result is insignificant with a small effect size, t (5) = .40, p = .370, r =.36.

Birmingham rule finding task. On average the students detected more rules on the Birmingham rule finding task (*M* = 14.62, *SD* = 2.06) than the BCoS norms (*M* = 11.9). This difference is statistically significant with a large effect size, t (25) =6.72, p = .001, r = 2.69.

The older participants also detected more rules on the task (*M* = 15.00, *SD* = 1.67) compared to the BCoS norms (*M*= 11. 9). This difference is significant but with a small effect size, *t* (5) = 4.54, *p* = .006, *r* =.006.

Birmingham rule finding rules. There are three patterns governing the Birmingham rule finding task. All of the students detected all three patterns (M =3.00, SD =.00) and performed better than the BCoS norm (M =2.4). A *t* test was not, and could not be, performed because there is no deviation from the mean. On average the older participants also detected more pattern for this task (*M* = 2.83, *SD* = .41) compared to the BCoS norms (*M* = 2.4). However this difference is statistically insignificant but with a large effect size, *t* (5) = 2.60, *p* = .074, *r* = 2. 09

Please see table 8 for above results

Table 8

Task that assess controlled attention that participants scored above the BCoS norm.

Task	*n*	Score Range	*M*	*M* (BCoS norm)	*SD*	*df*	*t*	*p*	(*r)*
Auditory Attention accuracy		0-54		53.2					
Participants (19-23yrs.)	26		54.00		.00	25			
Participants (50-65 yrs.)	6		53.83		.41	5	6.80	.001	6.08
Auditory Attention practice		0-3		1.1					
Participants (19-23yrs.)	26		1.00		.00	25			
Participants (50-65yrs.)	6		1.17		.41	5	.40	.370	.34
Birmingham Rule finding accuracy		0-18		11.9					
Participants (19-23yrs.)	26		14.62		2.06	25	6.72	.001*	2.69
Participants (50-65 yrs.)	6		15.00		1.67	5	4.54	.006	4.06
Birmingham rule finding rules		0-3		2.4					
Participants (19-23yrs.)	25		3.00		.00	24			
Participants (50-65 yrs.)	6		2.83		.41	5	2.60	.074*	2.33

**denote that bootstrapping was performed*

Tasks that assess episodic memory

Participants scored below the BCoS norms for both story recall and recognition tasks

that assess episodic memory (see table 4). However participants scored above the BCoS norm for both story free recall only tasks and the tasks recognition exercise.

1st story free recall task.In their first attempt, students recalled more details, without the assistance of multiple choice questions (MCQs), for the story free recall task, (*M* =11.08, *SD* =1.92) compared to the BCoS norm (*M* = 2.81) . This difference is statistically significant with a large effect size, t (25) = 3.77, p ≤ .001, *r* = 1.51. The older participants also recalled more details of the story without the assistance of MCQs (*M* = 10.83, *SD* = 2.81) compared to the BCoS norm (*M* = 2.81). This result is statistically insignificant but had a large effect size , t (5) =2.35, p = .074, *r* = 2.09.

2nd story free recall task. The second story free recall task ran exactly like the first story recall task where no clues where given. However participants were required to recall as many details of the same story later on in the screening without the researcher rereading the story. The students recalled more details of the story (*M* = 12.89, *SD* = 1.53) than the BCoS norm (*M* = 11.5). . This difference is significant with a large effect size, *t* (25) = 4.61, *p* ≤ .001, *r* =1.184. One average the older sample also recalled more detail for the task (*M* = 13.17, *SD* = .75) than the BCoS norm (*M* = 11.5). This difference is statistically significant with a large effect size *t* (5) = 5.42, *p* = .003, *r* = 4.85.

Task recognition exercise. Everyone from the student sample (*M* = 10.00, *SD* =.00) and the older sample (*M*= 10.00, *SD* = .00) were able to correctly identify all the tasks that been used during the screening and performed better than the BCoS norm (*M* = 9.8). A *t* test was not, and could not be, performed because there is no deviation from the mean.

Please see table 9 for above results.

Table 9

Task that assess episodic memory that participants scored above the BCoS norm

Task	*n*	Score Range	*M*	*M* (BCoS norm)	*SD*	*df*	*t*	*p*	(*r)*
Story Free recall 1		0-15		9.0					
Participants (19-23yrs.)	26		11.07		1.92	25	3.77	.001*	1.51
Participants (50-65 yrs.)	6		10.83		2.81	5	2.35	.074*	2.09
Story Free recall 2		0-15		11.5					
Participants (19-23yrs.)	26		12.89		1.53	25	4.61	.001*	1.84
Participants (50-65 yrs.)	6		13.17		.75	5	5.42	.003*	4.85
Task recognition		0-10		9.8					

Participants (19-23yrs.)	26	10.00	.00	25	
Participants (50-65 yrs.)	6	10.00	.00	5	

**denote that bootstrapping was performed*

Tasks that assess praxis- action and movement abilities

Participants scored below the BCoS norms for the figure copy task, gesture production task and gesture recognition task that assess praxis (refer to table 6). However participants scored above the BCoS norms for the multistep object use task and the imitation task which also assess praxis.

Multistep object use task. Everyone from the student sample (*M* = 12.00, *SD* =.00) and the older sample (*M*= 12.00, *SD* = .00) were also able to precisely follow certain steps to make a torchlight work and performed better than the BCoS norm (*M* = 11.6). A *t* test was not, and could not be, performed because there is no deviation from the mean.

imitation Task. Again, everyone from the student sample (*M* = 12.00, *SD* =.00) and the older sample (*M*= 12.00, *SD* = .00) perfectly mirrored the meaningless actions of the examiner and performed better than the BCoS norm (*M* = 11.1). A *t* test was not, and could not be, performed because there is no deviation from the mean.

Please refer to table 10 for above results.

Table 10

Task that assess apraxia that participants scored above the BCoS norm

Task	*n*	Score Range	*M*	*M* (BCoS norm)	*SD*	*df*	*t*	*p*	(*r)*
Multistep object use		0-12		11.6					
Participants (19-23yrs.)	26		12.00		.00	25			
Participants (50-65 yrs.)	6		12.00		.00	5			
Imitation		0-12		11.1					
Participants (19-23yrs.)	25		12.00		.00	25			
Participants (50-65 yrs.)	6		12.00		.00	5			

Lastly, the researcher used an independent sample *t* tests (equal variance not assumed) to detect if significant difference are observed in performances between the student sample and older South African sample for tasks that both groups were shown to perform differently from the norm but conversely from one another.

Comparisons between the Student Sample and the Older South African Sample

***Task that assess written language ability*.** The student sample and older South African performed conversely from each other and differently to the BCoS norms for two tasks that assess abilities in written language.

***The non-word reading accuracy task*.** The students read more non words (words that are not a part of the English vocabulary) correctly from the non-word reading accuracy task (*M* = 5.96, *SD* = .21) compared to the BCoS norm (*M* = 5.8) This difference is statistically significant with a large effect size *t* (22) = 3.60, *p*= .002, *r* =1.54. Conversely the older South African participants (*M*= 5.5, *SD* = 1.23) read more non words incorrectly compared to the BCoS norm (*M* = 5.8). This difference is statistically insignificant but with a medium effect size (*M* = 5.8), *t* (5) = -.60, *p* = .575, *r* = .54. However the difference between the student participants and older participants was not significant with a small effect size *t* (5.08) = .910, *p* = .404, *r* = .53.

***Sentence reading task*.** Everyone in the older sample read the sentence correctly (*M* =42.00, *SD* =. 00) and performed better than the BCoS norms (*M* =41.9). There are no variances in the older participants' scores so there is no doubt about their mean. The students (*M* =41.00, *SD* = .00) all mispronounced the word 'viscount 'on the task and performed below the BCoS norms (M = 41.9). Also the older South African participants (*M* = 42.00, *SD* = .00) are seen to perform better than the younger South African participants (*M* = 41.00, *SD* =.00) in this task. Significance of the mean differences between the South African groups is not in doubt since both groups did not deviate from their mean.

Please see table 11 for above results.

Table 11

Results for tasks that both sets of participant performed conversely in

Task	*n*	Score Range	*M*	*M* (BCoS norm)	*SD*	*df*	*t*	*p*	(*r*)
Non-word reading accuracy		0-6		5.8					
Participants (19-23yrs.)	23		5.99		.21	22	3.60	.002*	1.54
Participants (50-65 yrs.)	6		5.5		1.23	5	-.60	.575*	.54
Sentence reading accuracy		0-42		41.9					
Participants (19-23yrs.)	22		42		.00	21			
Participants (50-65 yrs.)	6		41		.00	5			

**denote that bootstrapping was performed*

Discussion

The objective of this study was to identify if there are BCoS tasks that are difficult for neurologically intact South African participants and provide evidence for the need to adapt the instrument accordingly. Firstly, the researcher detected whether the BCoS contains tasks that suggest brain damage in cognitively intact South African participants. Cognitive impairment was incorrectly detected if students scored below the cut off score for BCoS tasks. Secondly, the researcher detected if there are significant differences between the sampled participants' scores on BCoS tasks and the BCoS norms. However comparison between the students' scores and the BCoS standardised scores was possibly problematic because the screen was normed on participants aged between 50-65 years old .To account for this potential problem, an additional six South Africans aged between 50-65years old were screened and compared to the BCoS cut off scores and the BCoS norms. However performance on the screen was not expected to vary between age groups (Humphrey et al., 2012).

BCoS Tasks that Incorrectly Detected for Cognitive Impairment

The student sample scored below the cut off score for the picture naming task and the sentence reading accuracy task which detects for deficits in language abilities. The older sample scored below the cut off score for the first story recall task which detects for deficits in episodic memory. However it was only for the sentence reading accuracy task that this difference proved significant.

For the sentence reading accuracy task, all the students pronounced the word 'viscount' as 'vis-count' instead of 'vi-count'. The word viscount is a word used in old English literature and not colloquially used in South African society today. Contrastingly, all

of the older participants pronounced the word correctly. Possibly, this difference is due to the different societal systems that these groups have been exposed to. The student sample lived most of their lives in the Democratic South Africa while the older participants lived most of their lives under the Apartheid governed South Africa. The Apartheid system was still influenced by the reminiscence of Colonial ideological systems which perpetuated the Eurocentric English language which encompassd old English literature. Consequently, language is imbedded in societal contexts and is not a neutral or universal predictor of cognitive impairment (Manly, 2008; Swartz et al,. 1997). Students' failure in this task also support the evidence that tests that require visual reading are particularly sensitive to some demographic variables (Mansur et al., 2005).

However for the rest of the BCoS' tasks, participants did not score below the cut off scores and incorrect detection of cognitive impairment was avoided. Hence the BCoS reliability and validity in detecting cognitive impairment is upheld (Bickerton et al., 2011; Bickerton et al., 2012, 2014). Yet for some of these tasks participants still scored significantly below or above the BCoS norms.

Tasks that Both Sets of Sampled Participants Scored Below The BCoS' norms

Difference due to language use

Participants scored below the BCoS norms for the number reading task and the picture naming tasks because these tasks seemed to test the ability to use and understand the English language instead of cognitive functioning. A Problematic item within the number reading task seems to be the reading of clock times. Most participants would use colloquial language when reading clock times, for instance, instead of saying "half past nine" they would say "nine thirty". This way of reading the time maybe context specific to South Africa.

Similarly, for the picture naming task, participants had problems recognizing the pictures of a leek, raspberries and a chisel. This finding supports the supposition that tests involving visual confrontation naming, like the picture naming task, are sensitive to demographic variables (Mansur et al., 2005).

Also participants commonly referred to the picture of a colander as a being a sieve. This and the number reading finding alludes to the problematic universal application of the English language by cognitive screens (Manly, 2008; Swartz et al,. 1997). Even though both sets of sampled participants scored below the norm for the picture naming task, only the students' scores were seen as significant. The non-significance of the older sample scores maybe due to the small sample size.

Difference due to Western norms.

Participants also scored below the BCoS norm for the gesture production task and number reading task. It is suggested that different contextual norms between Birmingham and South Africa caused participants to score lower than the norm for these tasks. For instance, for the number twelve thousand five hundred in the number writing task participants wrote '12 500' oppose to 12,500. This maybe because of the different numeric systems used by South Africa and Birmingham. Similarly, the hitchhiking gesture in the gesture production task seemed problematic for participants. Raw data suggested that the students (46%) and older participants (83%) struggled with the hitchhiking production. Hitchhiking is a Eurocentric activity and not common in South Africa. The findings on these tasks propose that norms developed on a Western population may not be normal outside of the contexts (Manly, 2008; Flanagan & Oritz, 2001; Mushquash &Bova, 2007).

Difference due unknown reasons.

. The South African participants also performed worse than the norm in the number calculation task. However the students performed significantly worse than the norm while the difference between the older participants' scores and the norm is non-significant. The older participants spent more years in the education system and this may have caused them to perform better than the students. Accordingly, the findings support the prospect that lower neuropsychological results are related to low levels of education and not cognitive impairment (Ostrosky-Solis, Ardila, Rosselli, Lopez-Arango & Uriel-Mendoza, 1998). However only 17% of the Birmingham sample had tertiary education which is lower than the average of the sampled participants.

The students and older participants scored below the norm for the 2nd story recall and recognition task however findings for the 2nd story recall tasks are significant. The older participants expectedly performed worse than the student sample because episodic memory declines with age (Craik & McDowd, 1987). However the students also performed below the norm suggesting that performance is not related to age but maybe related to the familiarity of details in the story. This suggestion is supported by the finding that participants scored above the norm for the 1st and 2nd story recall tasks which required participants to recall details of the story without the aid of multiple choice questions.

Difference due to researcher's subjectivity

Both the older and younger sampled participants scored below the norm score for the figure copy task. However they did score above the cut off score. The lower score may have been due to the fact that the South African participants and Birmingham participants were

marked by different examiner. This may have caused inter-ratter reliability issues.

However participants also scored above the Birmingham norm for some tasks.

Tasks for Which Both Sets of the Sampled Participants Scored Above the Norm

Participants scored significantly above the BCoS norms for the apple cancelation tasks, left tactile bilateral task, auditory attention task, Birmingham rule finding task, task recognition exercise, multi-step object use exercise, the meaningless imitation task as well as the 1st and 2nd story recall task. It is suggested that these tasks are relatively easy and contextually appropriate for South African participants. Hence the BCoS has good psychometric properties in terms of validity and reliability (Bickerton et al., 2012, 2014). However the finding that participants scored below and above the BCoS norms for some tasks suggest that new BCoS norms may need to be developed for South Africa.

Comparisons Between the Student and Older South African Samples.

As seen above, the student and older sample seem to perform better or worse than the BCoS norms for the same tasks proving that performance on tasks only slightly vary with age (Humphreys et al., 2012). However for the sentence reading task, the older participants performed better than the norm and the student sample performed worse than the norm. The difference between the student sample and older sample was significant for this task. This suggests that performance on the sentence reading task may significantly vary with age. Different norms may need to be created for this task across different age groups or details of the sentence may be changed to suite the South African population.

Limitations

The two big limitations of this study is the small sample size of the participants and all the participants being English speakers. The small sample, especially the older sample size, makes it difficult to generalise results to the South African population. The researcher tried to recruit as many participants as possible but was limited due to participant dropout rates and time constraints.

This study is a preliminary study and the researcher tried to detect for overt problematic items of the BCoS using English speaking South African participants. The researcher reasoned out that English speakers would not have problems understanding the screen but instead will have problems understanding overtly strange BCoS tasks. Nevertheless, English is only one of the 11 South African indigenous languages. Results of this study cannot be generalised to South African citizens who do not speak English.

Conclusion and Future research

In its entirety, the study provides evidence that the problematic tasks on the BCoS seems to be the sentence reading task that assesses language. Specifically, the word 'viscount' in the task may need to be changed to suite the South African. The more interesting finding is that South African participants perform significantly better and significantly worse than some of the BCoS norms for certain tasks.

Consequently it is suggested that more research be done, using a bigger sample size, to investigate the need to create new BCoS' norms for the South African population. However, South Africa has a multicultural population and future researchers should compare the performances on the screen for people from each of the 11 indigenous languages. This is important because screens that use a language foreign to the examinee may detect for inadequate understanding of the tests instead of cognitive impairment (Swartz et al., 1997).

References

Balchin, R. (2008). *The genesis and development of the Groote Schuur neurocognitive screening battery: a neurocognitive screening tool for the South African context.* (Unpublished doctoral thesis). University of Cape Town, South Africa.

Bickerton, W. L., Samson, D., Williamson, J., & Humphreys, G. W. (2011). Separating forms of neglect using the Apples Test: validation and functional prediction in chronic and acute stroke. *Neuropsychology*, *25*(5), 567. doi:10.1037/a0023501

Bickerton, W. L., Riddoch, M. J., Samson, D., Balani, A. B., Mistry, B., & Humphreys, G. W. (2012). Systematic assessment of apraxia and functional predictions from the Birmingham Cognitive Screen. *Journal of Neurology, Neurosurgery & Psychiatry*, *83*(5), 513-521. doi:10.1136/jnnp-2011-300968

Bickerton, W. L., Demeyere, N., Francis, D., Kumar, V., Remoundou, M., Balani, A., ... & Humphreys, G. W. (2014). The BCoS Cognitive Profile Screen: Utility and Predictive Value for Stroke. *Neuropsychology*, 29(4), 638-648. doi:10.1037/neu0000160

Bisiker, J., & Bickerton, W. L. (2013). Using a comprehensive and standardised cognitive screen to guide cognitive rehabilitation in stroke. *The British Journal of Occupational Therapy*, *76*(3), 151-156. doi:10.4276/030802213x13627524435261

Chan, J., Kong, A., Weekes, B., Humphreys, G., Riddoch, J., Bickerton, W., & Lau, J. (2013). A Validation of the Cantonese Version of the Birmingham Cognitive Screen (BCoS) for Stroke Survivors in Hong Kong. *Procedia-Social and Behavioral Sciences*, *94*, 240-241. doi:10.1016/j.sbspro.2013.09.119

Craik, F. I., & McDowd, J. M. (1987). Age differences in recall and recognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *13*(3), 474. doi:10.1037/0278-7393.13.3.474

Field, A. (2009). *Discovering statistics using SPSS (3rd ed.)*. London, England: Sage publications.

Flanagan, D. P., & Ortiz, S. O. (2001). How to Apply CHC Cross-Battery Assessment to Culturally and Linguistically Diverse Individuals. *Essentials of cross-battery assessment*, In A.S. Kaufman & N. L. Kaufman (Eds.) 213-270.

Goldenberg, G., & Hagmann, S. (1997). The meaning of meaningless gestures: A study of visuo-imitative apraxia. *Neuropsychologia*, *35*(3), 333-341. doi:10.1016/s0028 3932(96)00085-1

Humphreys, G. W., Bickerton, W. L., Samson, D., & Riddoch, M. J. (2012), *BCoS: Brain behaviour analysis*. East Sussex, England: Psychological Press.

Juby, A., Tench, S., & Baker, V. (2002). The value of clock drawing in identifying executive cognitive dysfunction in people with a normal Mini-Mental State Examination score. *Canadian Medical Association Journal, 167*(8), 859-864.

Kennepohl, S., Shore, D., Nabors, N., & Hanks, R. (2004). African American acculturation and neuropsychological test performance following traumatic brain injury. *Journal of the International Neuropsychological Society, 10*(04), 566-577. doi:10.1017/s1355617704104128

Manly, J. J., Byrd, D. A., Touradji, P., & Stern, Y. (2004). Acculturation, reading level, and neuropsychological test performance among African American elders. *Applied Neuropsychology, 11*(1), 37-46. doi:10.1207/s15324826an1101_5

Manly, J. J. (2008). Critical issues in cultural neuropsychology: Profit from diversity. *Neuropsychology Review, 18*(3), 179-183. doi:10.1007/s11065-008-9068-8

Mansur, L. L., Radanovic, M., Taquemori, L., Greco, L., & Araújo, G. C. (2005). A study of the abilities in oral language comprehension of the Boston Diagnostic Aphasia Examination-Portuguese version: a reference guide for the Brazilian population. *Brazilian Journal of Medical and Biological Research, 38*(2), 277-292. doi:10.1590/s0100-879x2005000200017

Mushquash, C. J., & Bova, D. L. (2007). Cross-Cultural Assessment and Measurement Issues. *Journal on Developmental Disabilities, 13*(1), 53-65.

Nadesan, M. H. (1997). Constructing paper dolls: The discourse of personality testing in organizational practice. *Communication Theory, 7*(3), 189-218. doi:10.1111/j.1468 2885.1997.tb00150.x

Nell, V., & Brown, D. S. (1991). Epidemiology of traumatic brain injury in Johannesburg II. Morbidity, mortality and etiology. *Social Science & Medicine, 33*(3), 289-296.

Ostrosky-Solis, F., Ardila, A., Rosselli, M., Lopez-Arango, G., & Uriel-Mendoza, V. (1998 Neuropsychological test performance in illiterate subjects. *Archives of Clinical Neuropsychology, 13*(7), 645-660. doi:10.1093/arclin/13.7.645

Ratner, C. (1991). *Vygotsky's sociohistorical psychology and its contemporary applications*. New York: Springer Science & Business Media. doi:10.1007/978-1-4899-2614-2

Richardson, K. (2002). What IQ tests test. *Theory & Psychology*, *12*(3), 283-314. doi:10.1177/0959354302012003012

Swartz, L., Drennan, G., & Crawford, A. (1997). Changing language policy in mental health services: A matter of interpretation. *Mental Health Policy Issues for South Africa*, 167 180.

Appendix A

Description of the BCoS

COGNITIVE DOMAIN BEING ASSESSED	TASKS USED TO ASSESS THE	DESCRIPTION OF THE TASK	WHAT EXACTLY IS THE TASK

	DOMAIN		MEASURING
1) Attention and Executive Functions	1.1) Auditory attention task	Participants are presented with 6 pre-recorded words. 3 are target words which participants should respond to. The other 3 are distractor words which the participants should ignore. The words are presented in random order	-Selective attention is evaluated (by testing if participants can respond to only target words) -sustained attention is measured (The exercise is performed in 3 blocks thus evaluating how long a participant can stay focused) -Working memory is evaluated by testing if the participant can recall all 6 items at the end of the task
	1.2)Rule finding and concept switching	The participants are presented with a grid that has a black marker across the grid. The marker moves in a lawful pattern across the grid and then the marker switches movement to a different lawful pattern.	-This measures the ability to find an abstract rule and to switch the rule across stimuli within and across dimensions
	1.30Apple cancellation	Participants are presented with	-egocentric neglect is measured by detecting

		an A4 sheet of paper that's laid out in a landscape position. The sheet is divided into 5 invisible columns with each column containing 10 complete apples along with bitten apples. Participants are asked to cancel the whole apples within each column	if examinees miss whole apples on the 1 side of the page. -Allocentric neglect is measured by detecting whether examinees make 'false positives' by cancelling bitten apples.
	1.4) Visual extinction exercise	Examinees are presented with four unilateral left stimuli, four unilateral right stimuli and eight bilateral items. The stimulus is finger wiggles by the examiner.	-Neglect is detected if examinee misses unilateral stimuli. -extinction is detected if examinees spatial detection drops when presented with two instead of one stimulus on one side.
	1.5)Tactile extinction	A tactile stimulus is presented to the examinee in the form of two taps	-detects for unilateral sensory deficits and extinction.

		on the hand by the examiner. Four unilateral right, four unilateral left and eight bilateral tactile stimuli are presented	
2) Language	2.1) Picture naming exercise	There are 14 grey shaded hand drawings presented to the participant. Half the items are living things and the other half are non-living. Half the items have long names (6-9 letters) , the other half have short names (3-5 letters)	-detects for articulation problems sensitive to stimulus length. -detects for deficits in semantic/ conceptual knowledge through the presentation of a wide range of semantic categories (pictures of living and non-living items)
	2.3)Sentence construction	Examinees are presented with a picture of a person performing an action and underneath the picture are two	-Detetcts if participants have problems in semantic and syntactic processes.

		words. The examinee is then requested to construct a sentence describing what the person is doing by including the two words shown below the picture.	
	2.3)Sentence reading	The participant is presented with two sentences and asked to read them. The sentences include both regular and exception words, as well as suffixed and prefixed words.	-measures examinees ability to read different word classes (verbs, nouns, pronouns, adjectives, adverb and prepositions) -Reading of lexception words assess lexical procedures in reading. 'Lexical' refers to vocabulary
	2.4)Reading non words	Participants are presented with 6 non word items that aree 5-6 letters long. The words are presented 3 at a time.	-Examines the ability to use phonological procedures in reading. Pronouncing the words by sounding them out.
	2.5) Writing	The examiner	-examines ability to

	words and non words	reads out four familiar words and one non word. The examinees would then write the word.	generate spelling phonologically and lexically
	2.6) Instruction comprehension	Examiner will use an index to rate how well a participant understands instructions on four target tasks. Target tasks are tasks where "instructions cannot be easily deduced by seeing the material alone". Ratings are influenced by the number of times the instruction has to be repeated.	Comprehension ability is evaluated. Thus the individual's ability to listen and understand.
3) Memory	3.1) Orientation	Examinees are asked questions that seek answers regarding	-Examines ability to access semantic autobiographic knowledge. -Asseses examines

		personal information and current date and time. Questions that assess examine awareness.	orientation in time and space. -Indicates to the examiner that a deficit of awareness (nosognosia) is apparent.
	3.2) Story recall and recogntion	A story, consistent of 15 segments, is presented to the participant. This story and its 15 segments have to be recalled by the participant.	-episodic memory for newly learned information is measured -Recogntion is measured by presenting the participant with a question (that acts as acue) for every "segment of the story the examinee omits or recalls erronously" -Task measures for encoding, retrieval and forgetting/consolidation deficits
	3.3)Task recognition	There are 10 items. Four of the items have already been presented before in the previous tasks. Examinees are required to identify which of the 10 items did	-ecological and unintentional memory -Evaluates if examinees have memory of on going events.

		they see in previous tasks.	
4) Number skills	4.1) Number price/time reading	Three complex numbers , three ‘times’ and three prices are presented to the participants and they are asked to read it out	-Ability to process numbers is assessed .
	4.2)Number/price writing task	5 complex numbers, 3 ‘times’ and 3 prices are read to examinee who then proceeds to write these numbers on a page	-Ability to process and write numbers are assessed.
	4.3)Calculation	1 addition, 1 subtraction, 1 division and 1 multiplication calculation is presented to the examinee. Examinees are expected to solve these issues.	- Ability to code and respond to numbers - Assesses whether basic number processing operations exist.

5) Praxis	5.1) Complete figure copy	A figure containing a middle structure and additional structures to the left and right are presented to the examinee. The examinee is asked to copy this image by redrawing it (NOT TRACE IT)	-Ability to organise the figure -detects for possible constructional apraxia -detects for possible visual neglect.
	5.2)Multi-step object use	The examinee is presented with multiple objects and then instructed to switch on a torch. The examinee has to distinguish between the target items (the torch and batteries) and the distractor items in order to select the tools to complete the action.	-“selection and sequence of action towards the goal’’ is assessed. -The ability to distinguish between target items and distractor items is assessed. -Detects for problems in spatial orientation and performing ‘correct manipulation’, i.e can the examinee put the batteries in the torch and switch it on
	5.3) Gesture	Examinees are	-Evaluates indirect root

	reproduction	verbally instructed to produce 3 communicative gestures and three object orientated action.	to action reproduction
	5.4)gesture recogntion	An examinee is expected to recognise six gestures that are performed by the examiner.	-This assesses lexical action recognition.
	5.5) Imitation	Four meaningless gestures are presented to the examinee. The examinee is asked to copy the gesture with their dominant hand .	-Ability to imitate meaningless gestures
			*across the 5 praxis test “we contrast an indirect root to action reproduction (imitation of meaningless gestures) with lexical action recognition and production to name ”

Appendix B

Informed Consent. (STUDENTS)

An adaptation of the Birmingham Cognitive Screen (BCoS) to the South African context

Overview of The study

The goal of the proposed study is to identify items of the Birmingham Cognitive Screen (BCoS) that may not be appropriate to use in South Africa by administrating the screen to cognitively intact University Students. A team inclusive of Dr Progress Njomboro (lecturer in

the University of Cape Town) and Sherwyn Naidoo (Psychology Honor's student at the University of Cape Town) will be responsible for the execution of the study.

Description of Procedure

The Birmingham Cognitive Screen is an instrument normally used to assess the cognitive profiles of person's with Acquired Brain Damage. This is done to assist clinicians in choosing appropriate neuro-rehabilitation procedures to help patients in their recovery.

For the following study, each participant will be screened individually using the BCoS. The screening will take place on the University of Cape Town's upper campus. The administration of the test is approximately 1 hour long. Participants will not receive their individual results on the BCoS, but will be able to download this thesis from the University of Cape Town's library website. Once participants have completed the assessment they will be thanked and will be allowed to comment or ask questions regarding the test.. You will not be identifiable from the thesis.

Participants are asked to have had at least 6 hours of sleep the day before they are tested. Also please make sure you have eaten and kept hydrated throughout the day. This is done to ensure that the participant will not suffer from mental fatigue during the test. However please note that this test is not a fairly rigorous test, in fact it is a fairly simple test.

An adaptation of the Birmingham Cognitive Screen (BCoS) to the South African context

Risk and inconvenience

There is minimal real risk associated with participating in the study. However if a participant's result from the screen are deemed to be abnormal for whatever reason, then the participant will be advised to go see Dr Progress Njomboro of the Psychology department at UCT for further screening. Please note that if such a case was to arise, the participant will be asked to see Dr Njomboro on a voluntary basis and will not be forced.

Benefit for participating in the study.

Participation in the study will lead to the acquisition of 2 SRPP point as recognized by the University of Cape Town

Confidentiality

Please note that all the information obtained from the participants will be kept confidential and anonymous. The information will only be seen by Mr Sherwyn Naidoo and Dr Progress Njomboro. Confidentiality of information obtained by the participant as well as participant's identity is assured through the safe storage of data

Voluntary participation

Participants are not forced to participate in the study. However once a participant has voluntarily accepted to be a part of the study, he or she is expected to show up on the day of his or her screening. Participants should inform Mr Sherwyn Naidoo at least a day before their screening if they are unable to take part in the study. The Participant should email Mr Naidoo, via the email address listed below, to indicate withdrawal from participation or to reschedule appointment.

Communication

If you have any questions regarding the study and/or regarding participation in the study please contact; **Sherwyn Naidoo (0729951675).**

Email address : sherwynuct@gmail.com

An adaptation of the Birmingham Cognitive Screen (BCoS) to the South African context

I …… ……, have read and understand the information given above, have provided honest information about myself and is willing to participate in the study called '' Analysing the applicability of items on the Birmingham Cognitive Screen (BCoS) to the South African context" .

Participant's signature……..

Witness signature.....

Date……

Appendix C

Informed Consent. (Older Partiipants)

An adaptation of the Birmingham Cognitive Screen (BCoS) to the South African context

Overview of The study

The goal of the proposed study is to identify items of the Birmingham Cognitive Screen (BCoS) that may not be appropriate to use in South Africa by administrating the screen to cognitively intact South African citizens. A team inclusive of Dr Progress Njomboro (lecturer in the University of Cape Town) and Sherwyn Naidoo (Psychology Honor's student at the University of Cape Town) will be responsible for the execution of the study.

Description of Procedure

The Birmingham Cognitive Screen is an instrument normally used to assess the cognitive profiles of person's with Acquired Brain Damage. This is done to assist clinicians in choosing appropriate neuro-rehabilitation procedures to help patients in their recovery.

For the following study, each participant will be screened individually using the BCoS. The screening will take place on the University of Cape Town's upper campus. The administration of the test is approximately 1 hour long. Participants will not receive their individual results on the BCoS, but will be able to download this thesis from the University of Cape Town's library website. Once participants have completed the assessment they will be thanked and will be allowed to comment or ask questions regarding the test. You will not be identifiable from the thesis.

Participants are asked to have had at least 6 hours of sleep the day before they are tested. Also please make sure you have eaten and kept hydrated throughout the day. This is done to ensure that the participant will not suffer from mental fatigue during the test. However please note that this test is not a fairly rigorous test, in fact it is a fairly simple test.

An adaptation of the Birmingham Cognitive Screen (BCoS) to the South African context

Risk and inconvenience

There is minimal real risk associated with participating in the study. However if a participant's result from the screen are deemed to be abnormal for whatever reason, then the participant will be advised to go see Dr Progress Njomboro of the Psychology department at UCT for further screening. Please note that if such a case was to arise, the participant will be asked to see Dr Njomboro on a voluntary basis and will not be forced.

Benefit for participating in the study.

Participation in the study will lead to the acquisition of a cup of coffee.

Confidentiality

Please note that all the information obtained from the participants will be kept confidential and anonymous. The information will only be seen by Mr Sherwyn Naidoo and Dr Progress Njomboro. Confidentiality of information obtained by the participant as well as participant's identity is assured through the safe storage of data

Voluntary participation

Participants are not forced to participate in the study. However once a participant has voluntarily accepted to be a part of the study, he or she is expected to show up on the day of his or her screening. Participants should inform Mr Sherwyn Naidoo at least a day before their screening if they are unable to take part in the study. The Participant should email Mr Naidoo, via the email address listed below, to indicate withdrawal from participation or to reschedule appointment.

Communication

If you have any questions regarding the study and/or regarding participation in the study please contact; **Sherwyn Naidoo (0729951675).**

Email address : sherwynuct@gmail.com

An adaptation of the Birmingham Cognitive Screen (BCoS) to the South African context

I …… ……, have read and understand the information given above, have provided honest information about myself and

is willing to participate in the study called ‘’ Analysing the applicability of items on the Birmingham Cognitive Screen (BCoS) to the South African context” .

Participant’s signature……..

Witness signature.....

Date……

Appendix D

Debriefing document

The Aim of the Research Project:

This research project aimed to detect for problem items on the Birmingham cognitive screen. The screen had been developed in Europe, specifically in Birmingham, and therefore the contents of the screen had taken into account the European culture and context. The screen had not been tested in South Africa and so it has not taken into account the cultural, linguistic and other contextual differences implicit in South Africa.

To test for and hopefully aid this weakness of the screen a test had to be conducted on cognitively intact students. The exclusion and inclusion criteria ensured that you, as one of the participants, is in fact cognitively intact. We then tested the screen on you to detect for items on the screen that you and other cognitively intact students find difficult or unfamiliar. These items will then be reviewed and analyzed.

If you have further questions or interests please contact

Sherwyn Naidoo : sherwynuct.ac.za

Appendix E

SRPP advertisement

Title: An adaptation of the Birmingham Cognitive Screen to the South African context

Organiser and researcher: Sherwyn Naidoo

Description: The study will screen cognitively intact participants (students) using the Birmingham Cognitive screen (BCoS). This is done to detect if there are issues with some of the items on the BCoS. The BCoS consists of fairly simple cognitive tasks**.** The screen takes 1 hour to administer therefore requiring an hour of the participant's time. This will lead to the participant gaining **2 SRPP points.**

Please note if you answer **yes** to one of the following items, then you will **not be able to participate** in the study

1) Do you have a history of neurological disease/ disorder? These include Attention deficit disorder, Autism, Anxiety disorder, Bipolar disorder, depression, dyslexia, epilepsy, Obsessive Compulsive Disorder, Schizophrenia and/or any social phobia.
2) Do you have any cognitive functioning history of psychiatric illness?
3) Have you ever had any head injury and had a stroke?

Please note; if you answer **no** to one of the following items, then you will **not be able to participate** in the study.

1) Have you completed and passed High school?
2) Are you a student at the University of Cape Town?
3) Are you within the age range of age range of 18- 23 years old?
4) Can you speak and understand English?
5) Were you born in South Africa?
6) If you were born in South Africa, have you, so far, lived all your life in South Africa?

Venue: room 3d (subject to change)

How to sign up for the study: Use the sign up roster available on the vula site.

Disclaimer

It is generally accepted that the decision to include or exclude individuals from participating in a study depends on the focus, objective, nature of research and context in which the

research is conducted. Some research may be focused on a certain individual (such as in a person's life history), or a group of individuals who share a specific characteristic (e.g., an identifiable group of asthma sufferers who happen to be all of one sex; a religious order that is restricted to one sex). Other examples include research that is focused on specific cultural traditions or languages, or on one age group (e.g., a study of posture corrections in adolescents). These are regarded as appropriate forms of inclusion and exclusion of individuals or groups in research studies - ***so long as the selection criteria for those to be included in the research are relevant to answering the research question***.

Appendix F

Information Document

Title: An adaptation of the Birmingham Cognitive Screen to the South African context

Organiser and researcher: Sherwyn Naidoo

Description: The study will screen cognitively intact participants (students) using the Birmingham Cognitive screen (BCoS). This is done to detect if there are issues with some of the items on the BCoS. The BCoS consists of fairly simple cognitive tasks**.** The screen takes 1 hour to administer therefore requiring an hour of the participant's time.

Please note if you answer **yes** to one of the following items, then you will **not be able to participate** in the study

- Do you have a history of neurological disease/ disorder? These include Attention deficit disorder, Autism, Anxiety disorder, Bipolar disorder, depression, dyslexia, epilepsy, Obsessive Compulsive Disorder, Schizophrenia and/or any social phobia.
- Do you have any cognitive functioning history of psychiatric illness?
- Have you ever had any head injury and had a stroke?

Please note; if you answer **no** to one of the following items, then you will **not be able to participate** in the study.

- Have you completed and passed High school?
- Are you within the age range of age range of 18- 23 years old?
- Can you speak and understand English?
- Were you born in South Africa?
- If you were born in South Africa, have you, so far, lived all your life in South Africa

Appendix G

UNIVERSITY OF CAPE TOWN

Department of Psychology

University of Cape Town Rondebosch 7701 South Africa
Telephone (021) 650 3414
Fax No. (021) 650 4104

17 June 2015

Mr S. Naidoo
Department of Psychology
University of Cape Town
Rondebosch 7701

Dear Mr Naidoo,

I am pleased to inform you that ethical clearance has been given by an Ethics Review Committee of the Faculty of Humanities for your project: *An adaptation of the Birmingham Cognitive Screen to the South African context.*

Please use the reference PSY2015-040 if required. I wish you all the best for your study.

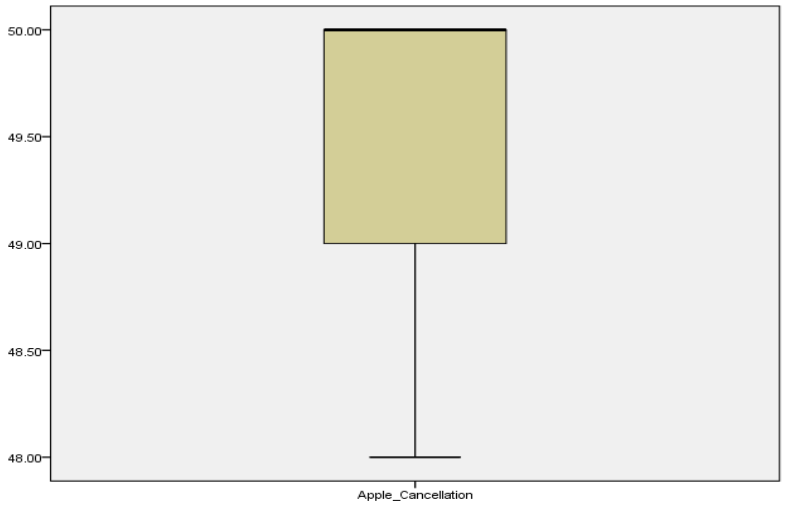
Yours sincerely,

Johann Louw PhD
Professor
Chair: Ethics Review Committee

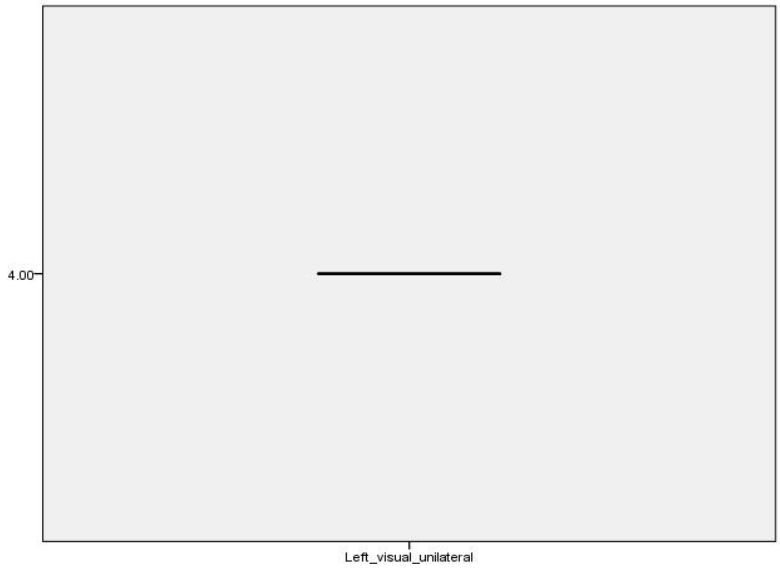
Appendix H

Box Plots showing outliers. (Student sample)

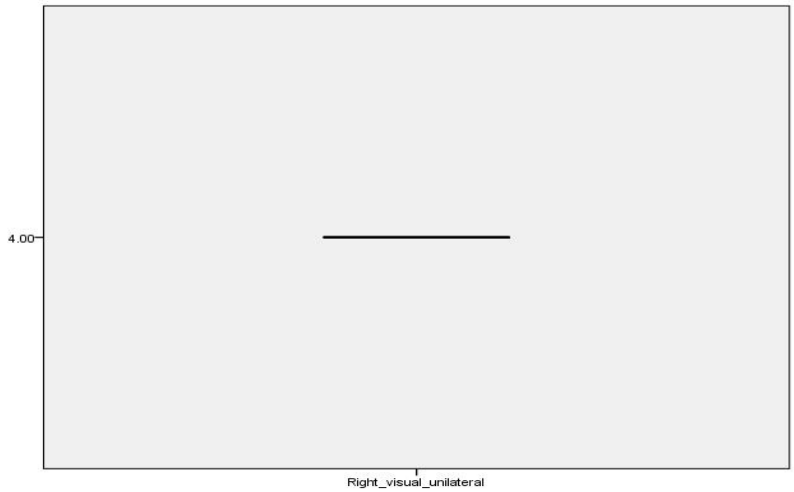
Apple cancelation task



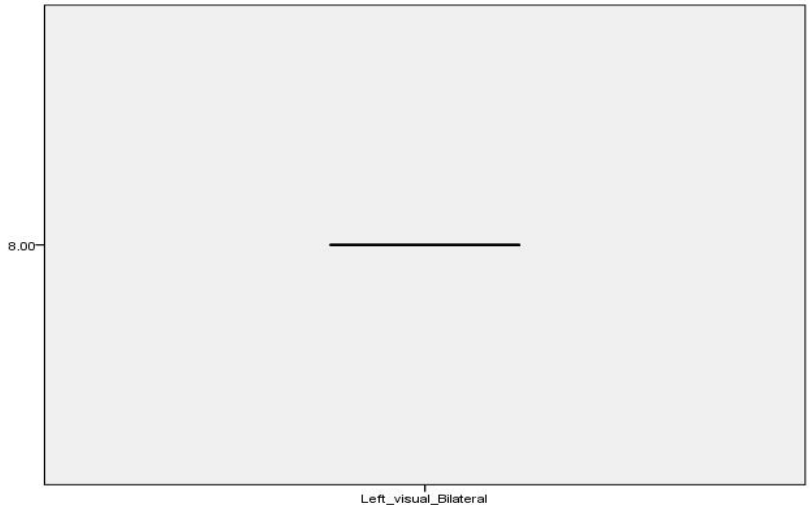
Left visual unilateral task



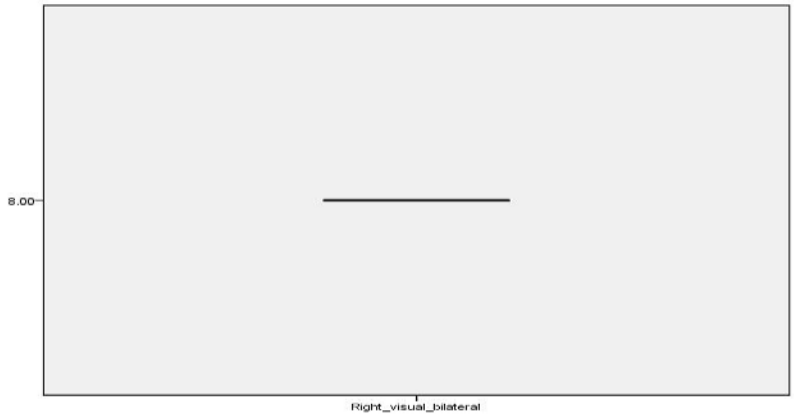
Right Visual Unilateral Task



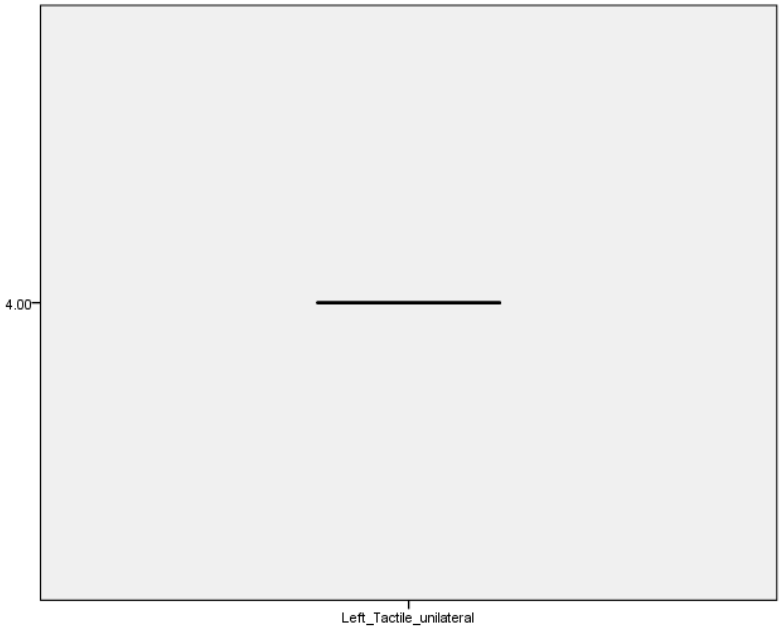
Left visual bilateral task



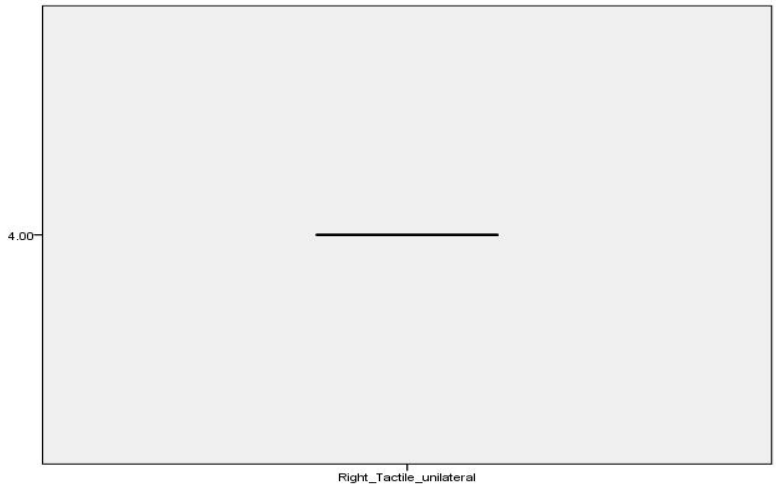
Right visual bilateral task



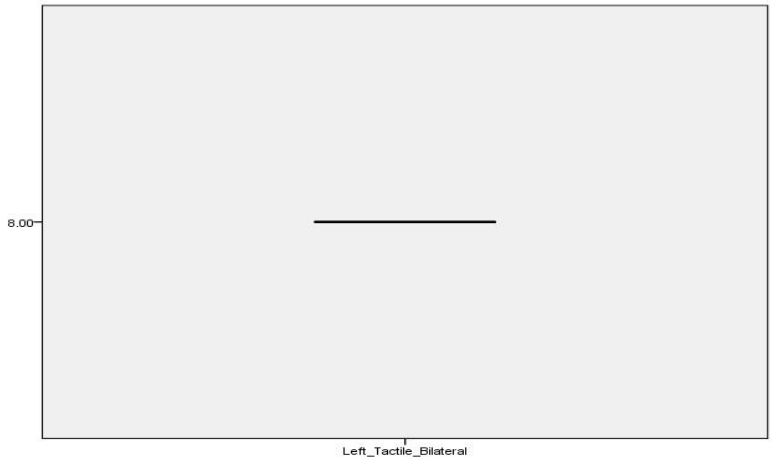
Left Tactile unilateral task



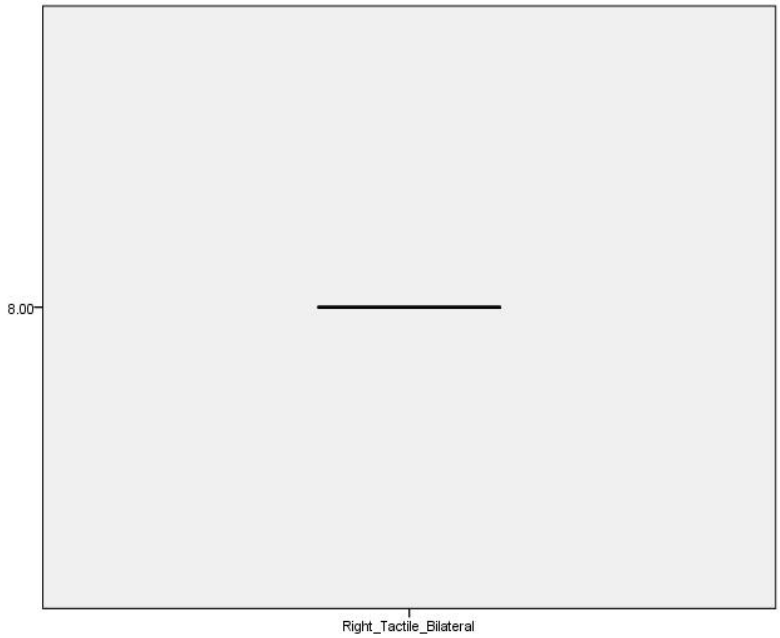
Right tactile unilateral task



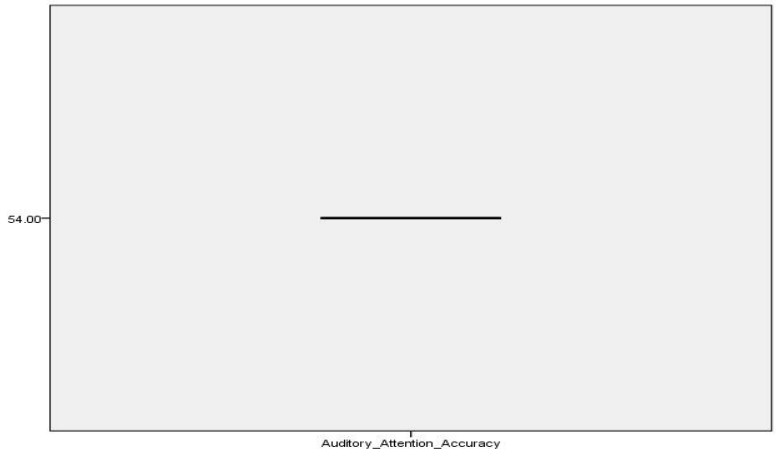
Left tactile unilateral task



Right Tactile Bilateral

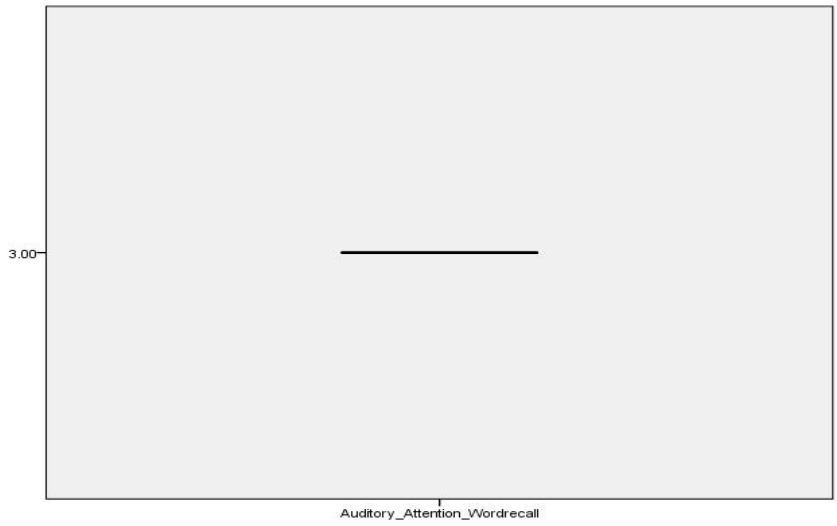


Auditory Attention task



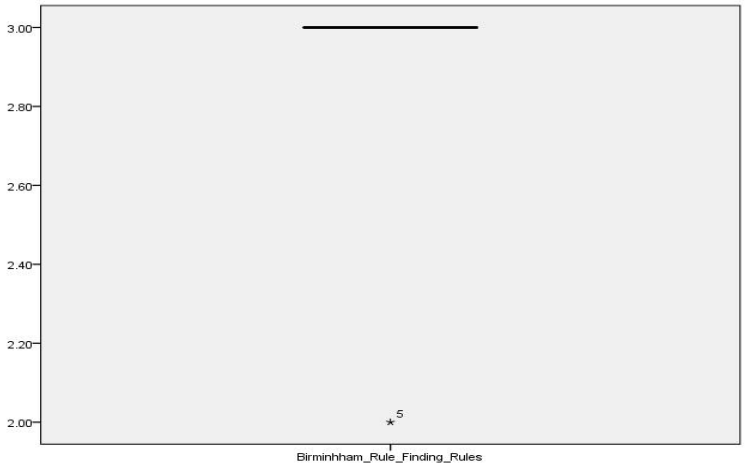
Auditory Attention Practice

Auditory Attention word recall

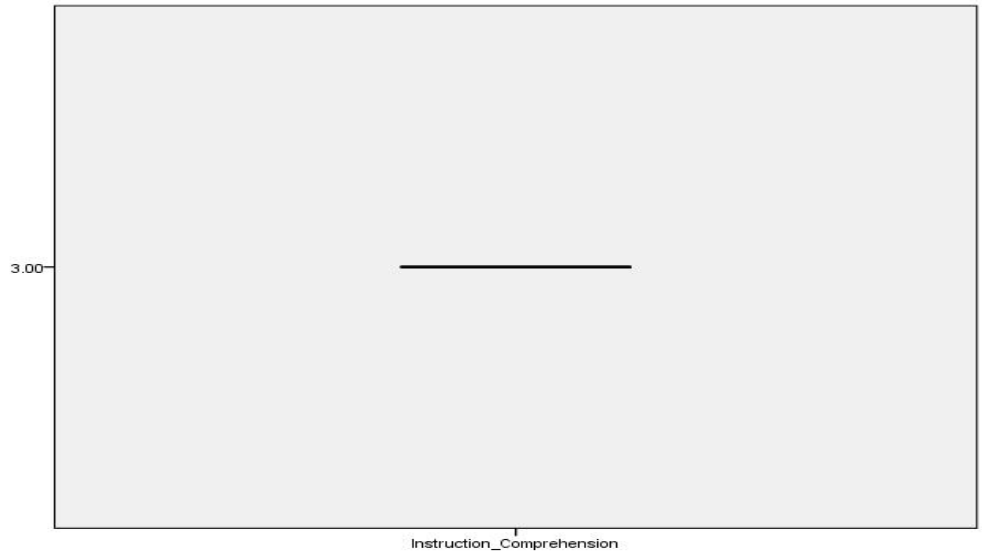


Birmingham Rule Finding accuracy

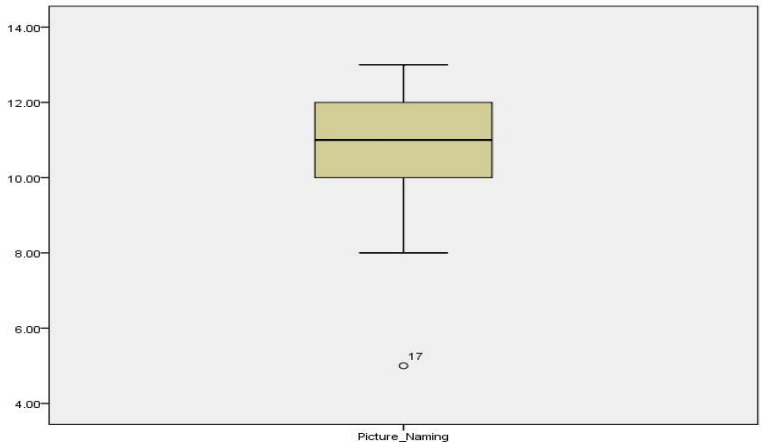
Birmingham Rule Finding Rules



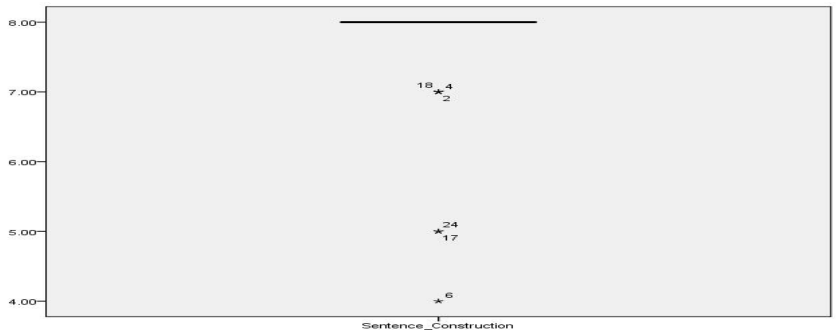
Instruction Comprehension



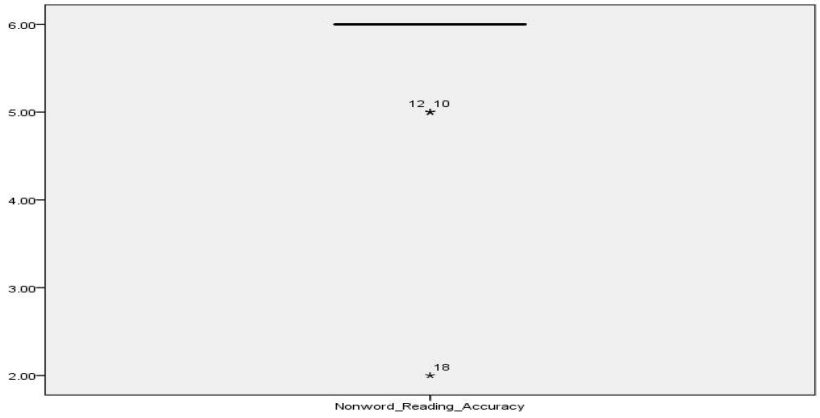
Picture Naming



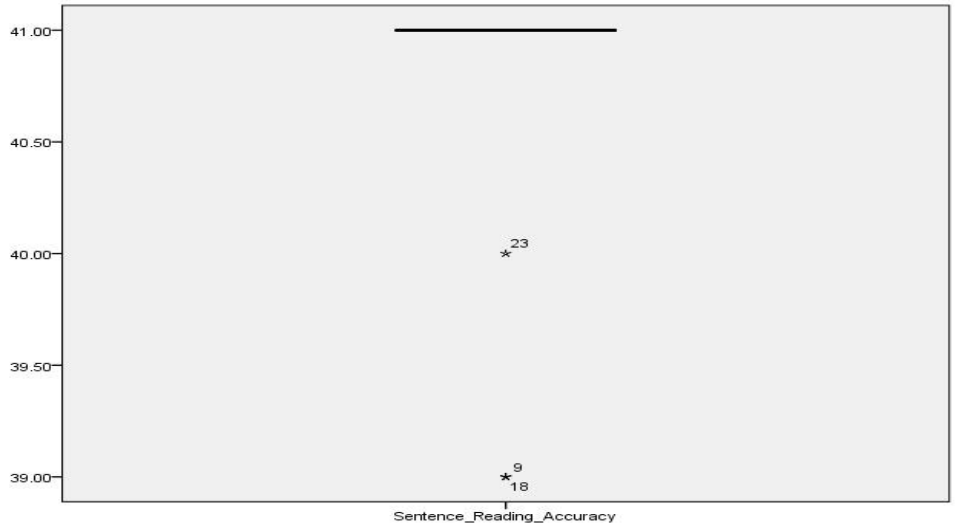
Sentence Construction



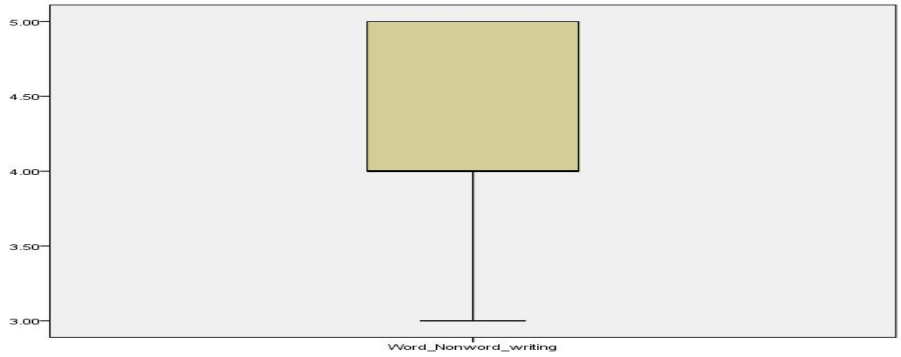
Non-word reading accuracy



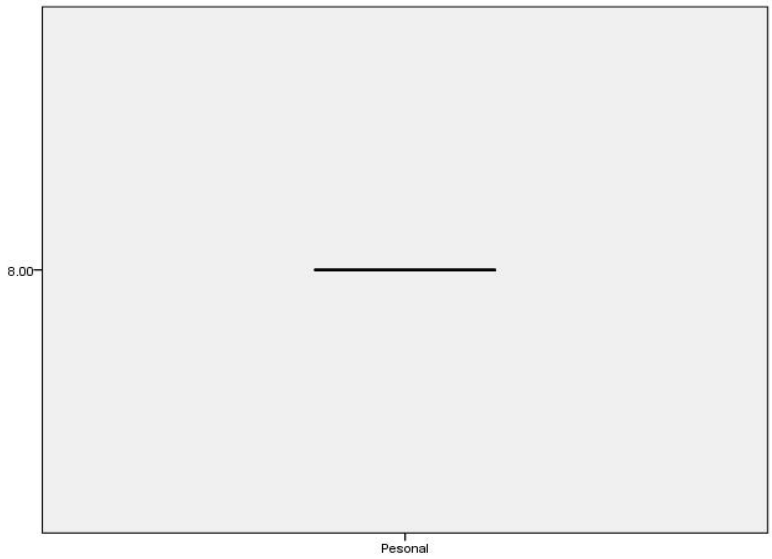
Sentence reading accuracy



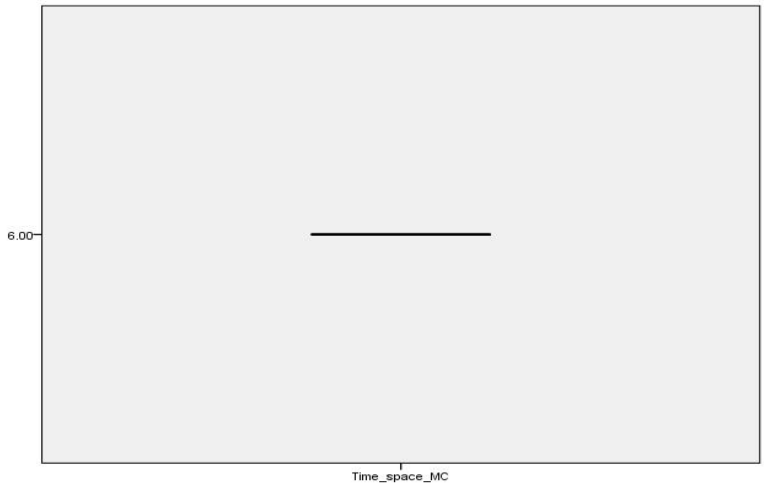
Word and Non-word writing



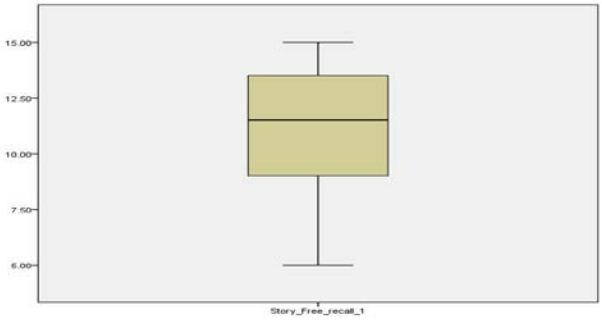
Personal information



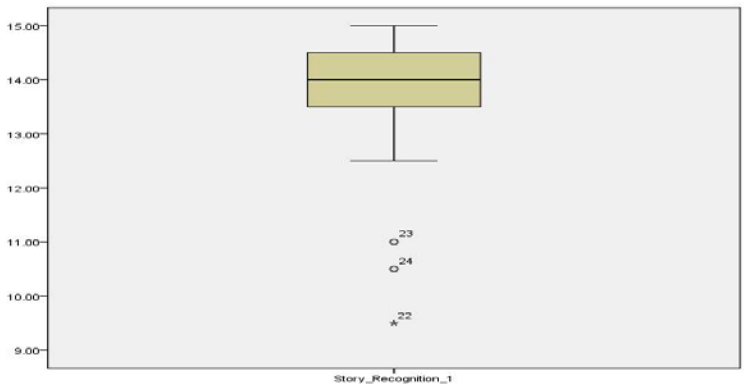
Time and Space



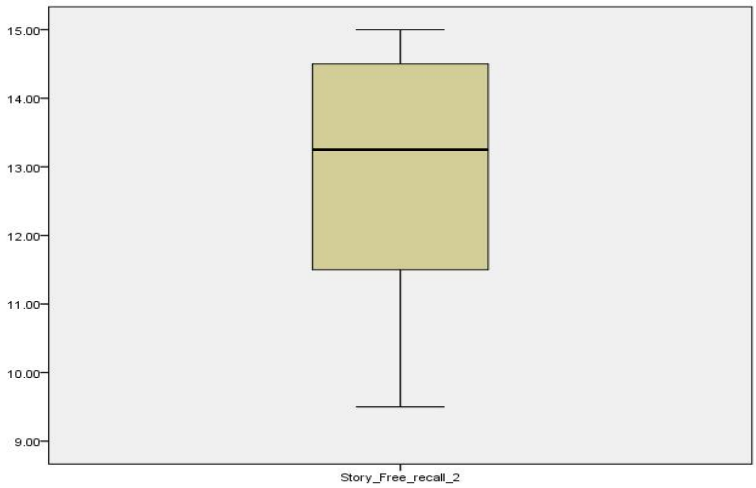
Story free recall 1



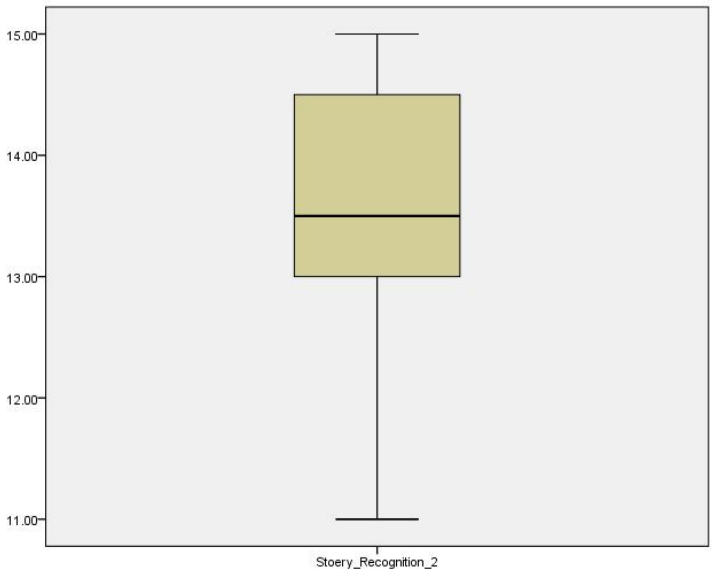
Story recognition 1



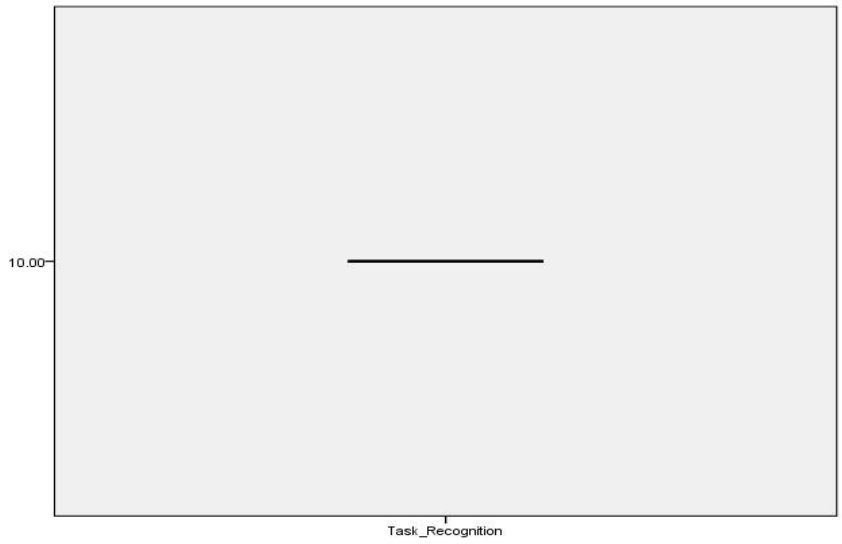
Story free recall 2



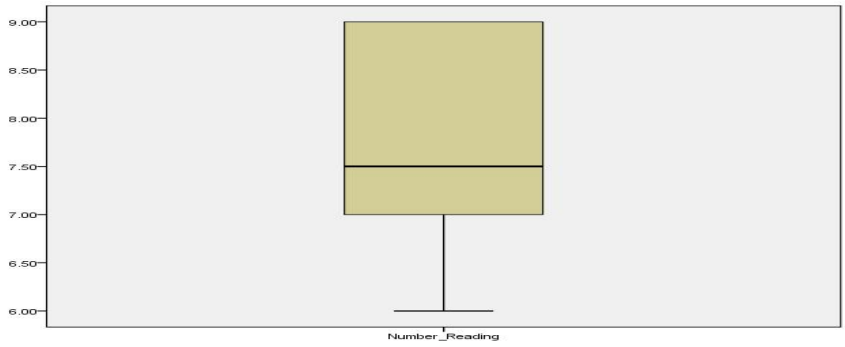
Story Recognition 2



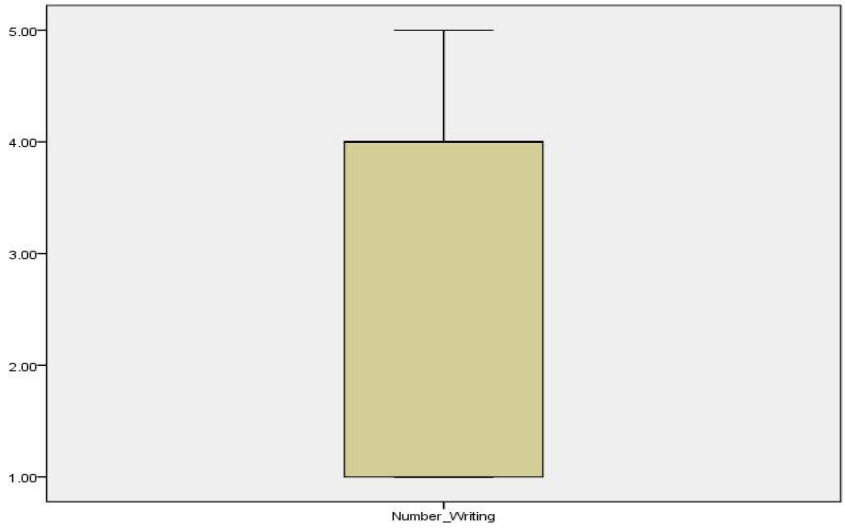
Task recognition



Number reading



Number writing



Number calculation

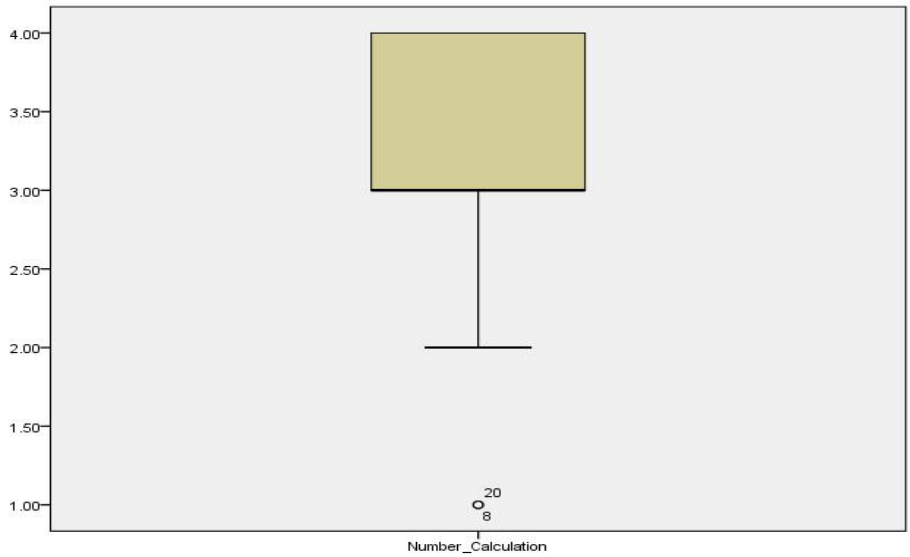
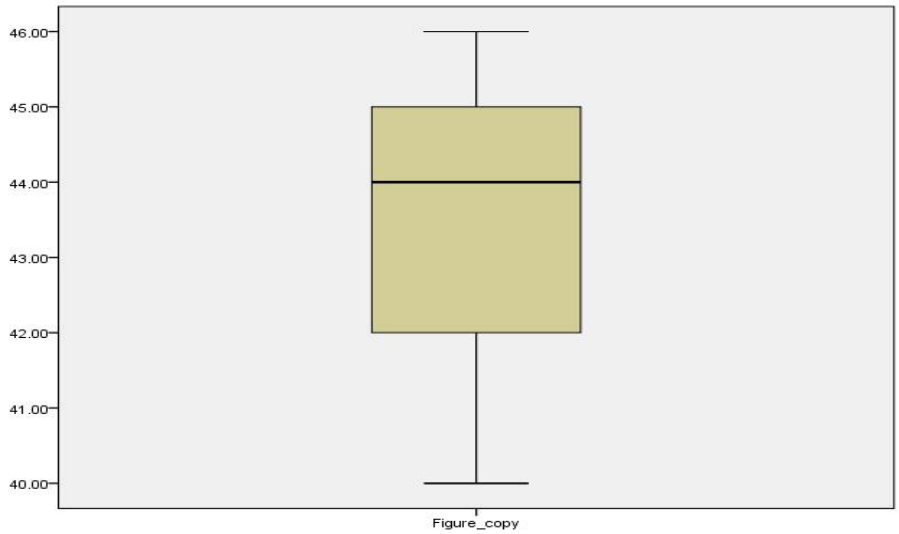
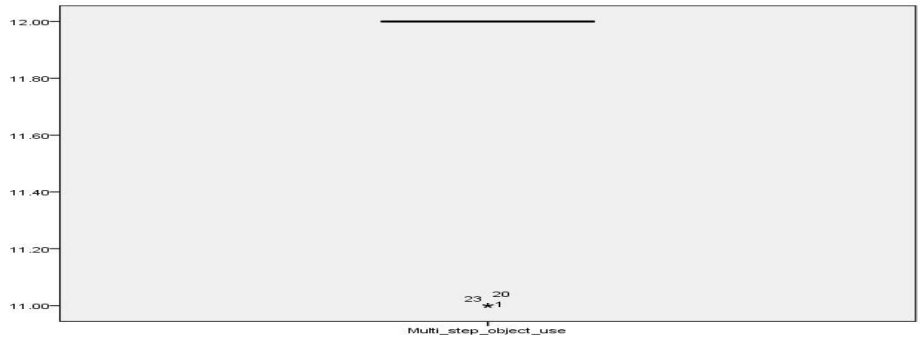


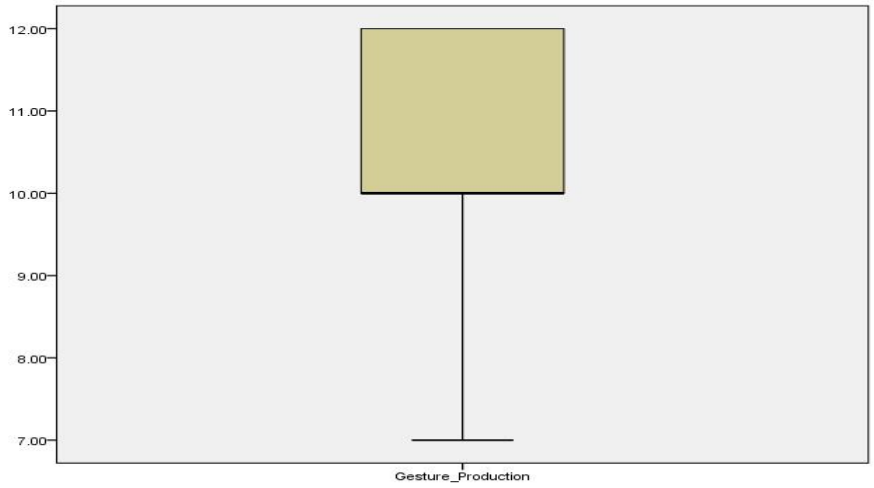
Figure copy



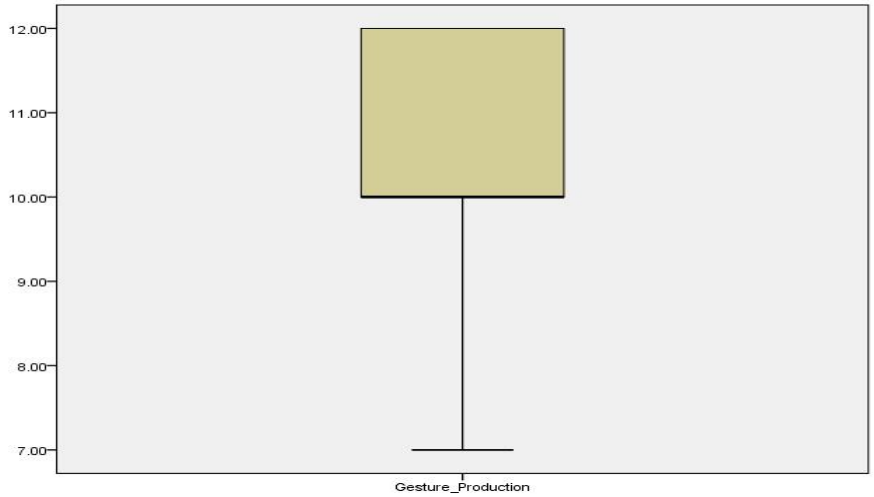
Multi step object use



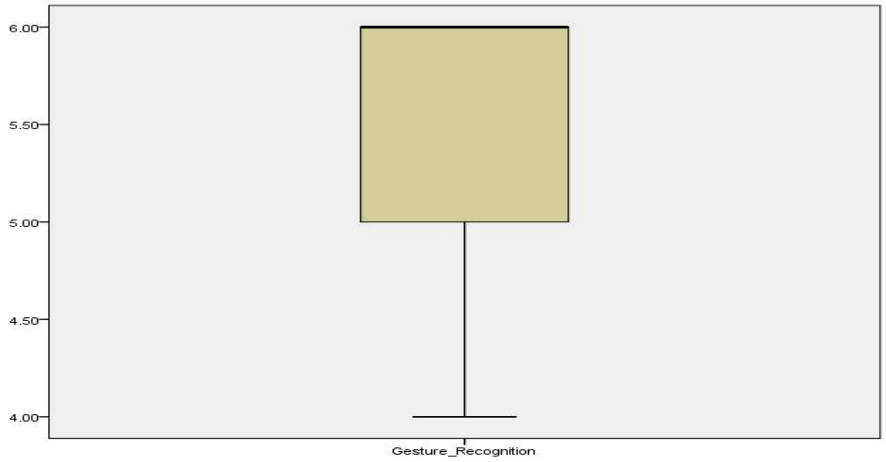
Multi step object use



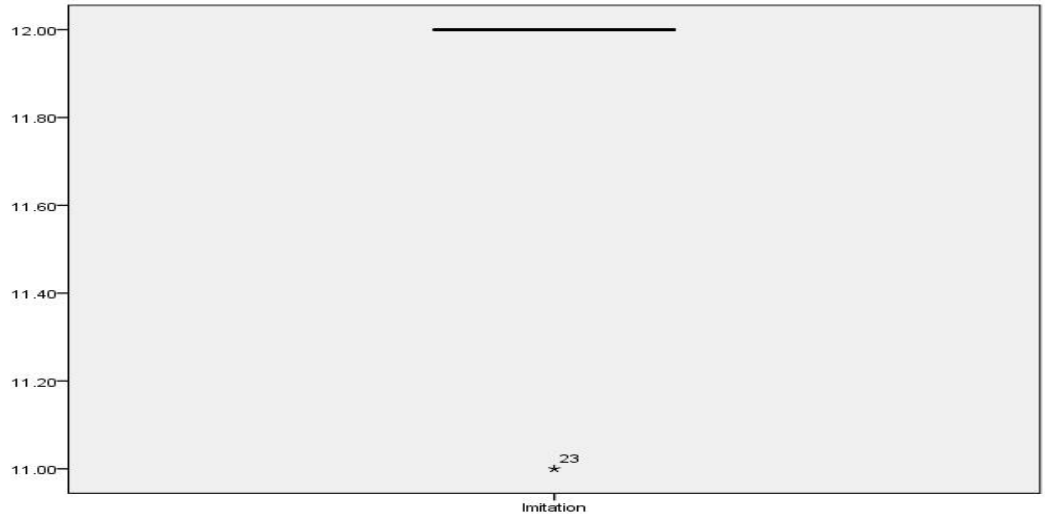
Gesture production



Gesture recognition



Imitation



Appendix I

Student scores compared to the BCoS cut off score and BCoS norms for all tasks.

Task	N	Mean	Std. Deviation	BCoS cut off scores	BCoS norm
Apple Cancellation	26	49.4615	.70602	42	48.0
Left_visual_unilateral	26	4.0000	.00000	<4	4.0
Right_visual_unilateral	26	4.0000	.00000	<4	4.0
Left_visual_Bilateral	26	8.0000	.00000	<8	8.0
Right_visual_bilateral	26	8.0000	.00000	<8	8.0
Left_Tactile_unilateral	26	4.0000	.00000	<4	4.0
Right_Tactile_unilateral	26	4.0000	.00000	<4	4.0
Left_Tactile_Bilateral	26	8.0000	.00000	<7	7.9
Right_Tactile_Bilateral	26	8.0000	.00000	<8	8.0
Auditory_Attention_Accuracy	26	54.0000	.00000	<51	53.2
Auditory_Attention_practice	26	1.0000	.00000	>1	1.1
Auditory_Attention_Wordrecall	26	3.0000	.00000	<3	3.0
Birmingham_Rule_Finding_Accuracy	26	14.6154	2.06062	<6	11.9
Birminhham_Rule_FindingRules	25	3.0000	.0000	<1	2.4
Instruction_Comprehension	26	3.0000	.00000	<3	3.0
Picture_Naming	26	10.7692	1.98611	<11	13.1
Sentence_Construction	20	8.0000	.00000	<8	8.0
Nonword_Reading_Accuracy	23	5.9565	.20851	<5	5.8
Sentence_Reading_Accuracy	22		.00000	<42	41.9
Word_Nonword_writing	26	4.3077	.67937	<3	4.4

Pesonal	26	8.0000	.00000	<8	8.0
Time_space_MC	26	6.0000	.00000	<6	6.0
Story_Free_recall_1	26	11.0769	2.81316	<6	9.0
Story_Recognition_1	25	13.8200	1.17154	<13	14.3
Story_Free_recall_2	26	12.8846	1.53172	<8	11.5
Story_Recognition_2	26	13.6154	.94136	<13	14.6
Task_Recognition	26	10.0000	.00000	<9	9.8
Number_Reading	26	7.6538	1.16421	<8	8.8
Number_Writing	26	2.8077	1.52366	<5	4.9
Number_Calculation	26	3.1538	.92487	<2	3.6
Figure_copy	26	43.6538	1.85348	<42	45.1
Multi_step_object_use	23	12.0000	.00000	<11	11.6
Gesture_Production	26	10.4615	1.36325	<10	11.5
Gesture_Recognition	26	5.6154	.57110	<5	5.8
Imitation	25	12.0000	.00000	<9	11.1

Older sample's scores compared to the BCoS cut off score and BCoS norms for all tasks.

	N	Mean	Std. Deviation	BCoS cut off score	BCoS norm
Apple_Cancellation	6	49.0000	1.54919	<42	48.0
Left_visual_unilateral	6	4.0000	.00000	<4	4.0
Right_visual_unilateral	6	4.0000	.00000	<4	4.0
Left_visual_Bilateral	6	8.0000	.00000	<8	8.0
Right_visual_bilateral	6	8.0000	.00000	<8	8.0

Left_Tactile_unilateral	6	4.0000	.00000	<4	4.0
Right_Tactile_unilateral	6	4.0000	.00000	<4	4.0
Left_Tactile_Bilateral	6	8.0000	.00000	<7	7.9
Right_Tactile_Bilateral	6	8.0000	.00000	<8	8.0
Auditory_Attention_Accuracy	6	53.8333	.40825	<51	53.0
Auditory_Attention_practice	6	1.1667	.40825	>1	1.1
Auditory_Attention_Wordrecall	6	3.0000	.00000	<3	3.0
Birmingham_Rule_Finding_Accuracy	6	15.0000	1.67332	<6	11.9
Birminhham_Rule_Finding_Rules	6	2.8333	.40825	<1	2.4
Instruction_Comprehension	6	3.0000	.00000	<3	3.0
Picture_Naming	6	11.8333	1.72240	<11	13.1
Sentence_Construction	6	8.0000	.00000	<8	8.0
Nonword_Reading_Accuracy	6	5.5000	1.22474	<5	5.8
Sentence_Reading_Accuracy	6	41.0000	.00000	<42	41.9
Word_Nonword_writing	6	4.1667	.40825	<3	4.4
Pesonal	6	8.0000	.00000	<8	8.0
Time_space_MC	6	6.0000	.00000	<6	6.0
Story_Free_recall_1	6	10.8333	1.91485	<6	9.0
Story_Recognition_1	6	12.5000	2.14476	<3	14.3
Story_Free_recall_2	6	13.1667	.75277	<8	11.5
Stoery_Recognition_2	6	14.0000	.63246	<13	14.6
Task_Recognition	6	10.0000	.00000	<9	9.8
Number_Reading	6	7.0000	1.54919	<8	8.8

Number_Writing	6	4.0000	.00000	<5	4.9
Number_Calculation	6	3.1667	.98319	<2	3.6
Figure_copy	6	42.8333	1.16905	<42	45.1
Multi_step_object_use	6	12.0000	.00000	<11	11.6
Gesture_Production	6	10.8333	.75277	<10	11.5
Gesture_Recognition	6	5.5000	.54772	<5	5.8
Imitation	6	12.0000	.00000	<9	11.1