Screening for Working Memory Difficulties Using the Do-It Profiler and Neuropsychological Pen-and-Paper Tests in High School Learners.

Claire Tatham

TTHCLA001

&

Khayreyah Antvorskov

ANTKHA001

ACSENT Laboratory

Department of Psychology

University of Cape Town

Supervisor: Dr. Leigh Schrieff

Word count:

Abstract: 252

Main Body: 6,575

PLAGIARISM

DECLARATION

1. I know that plagiarism is wrong. Plagiarism is to use another's work and to pretend that it is one's own.

2. I have used the *American psychological Association (APA)* convention for citation and referencing. Each significant contribution to, and quotation in, this essay / report / project / from the work, or works, of other people has been attributed, and has cited and referenced.

3. This essay / report / project / is my own work.

4. I have not allowed, and will not allow, anyone to copy my work with the intention of passing it off as his or her own work.

5. I acknowledge that copying someone else's assignment or essay, or part of it, is wrong, and declare that this is my own work.

SIGNATURE: C.M.T

SIGNATURE: K. A.

Table of Content

Acknowledgements.……4
Abstract.……..5
Literature review.……6-10
Research aim and hypothesis……...……..10
Methods……...…….10-14
Results……..14-19
Discussion…….19-23
Conclusion…….23
References……...……..24-26
Appendices…….…..28-36

Acknowledgements

We would like to express our deepest gratitude to the following people and organizations:

To the National Research Fund (NRF) for financing this research.

To the social worker overseeing the youth centre and the girls residing at the youth centre who kindly took the time to participate in this research.

To our supervisor, Doctor Leigh Schrieff, for her dedication, guidance and feedback. Thank you for the valuable contributions you made to this project and the willingness in which you offered us support and encouragement throughout this research process.

To our co-researcher, Asheeqa Petersen for her mentorship and guidance. Thank you for sharing your knowledge with us and for the direction and assistance you provided.

To Professor Colin Tredoux for the quick and very helpful support, he provided for the statistical analysis of this research.

To our families and loved ones for the financial and emotional support, as well as the contacts they provided for our data collection.

Abstract

The SA educational system has formed part of a global movement towards more inclusive forms of education. However, inclusive learning in the context of SA faces some major challenges. In particular, pen-and-paper neuropsychological tests traditionally used for the screening of NDDs are time-consuming, costly, and difficult to administer and score. Computerized tests such as the Do-It Profiler have been offered as a more accessible alternative for the screening of NDDs. In this study, we investigated whether the Do-It Profiler could effectively predict WM neuropsychological outcomes from traditional pen and paper tests. This research focuses on WM as it is an important consideration regarding NDDs. We also investigated the prevalence of WM deficits in a sample of female adolescents in Cape Town (N = 18). Although the Do-It was not shown to have high predictive validity for WM deficits in this sample, these results could have been attributed to the small sample size and data collection methods in our study. Some evidence of a relationship between the Do-It Profiler and the Letter-Number Sequencing subtest of the WISC-IV was found, with the individual slope coefficient for Do-It WM scores found to be significant in predicting Letter-Number Sequencing (t = 2.17, $p < 0.05$). Additionally, we found that there was a high prevalence (66.67 %) of WM deficits in our sample which was measured using the Do-It. Overall, the Do-It Profiler has been shown to be a promising computerized assessment platform and, therefore, further research is needed on this assessment platform and LDDs in SA.

Neurodevelopmental disorders (NDD) are used to describe a range of conditions that manifest early in life and are typified by deficits in development (McCarthy et al., 2015). These may include learning difficulties and disabilities (LDDs), which are characterized by significantly low academic achievement in school (Johnson et al., 2010). Over the past two decades, there has been a global movement towards more inclusive education, with research showing an increase in students with NDDs attending mainstream schools (Yoro et al., 2020). This increase highlights the need for more efficient and cost-effective screening tools for NDDs to assist teachers with identifying and supporting students in need (Nel & Grosser, 2016). Students with NDDs are at a greater disadvantage in South Africa (SA) where learners may face considerable barriers to learning, including poor education quality, poverty, unemployment and malnutrition (Nel & Grosser, 2016). However, with no standard, nationally accepted tool established for the screening of NDDs in SA, this poses a major challenge (Nel & Grosser, 2016). Through introducing tools in schools that make screening for NDDs more efficient, children with NDDs could have more opportunities to achieve academically and develop skills that enhance their success as adults (Boat & Wu, 2015). Current screening procedures are not alleviating the problem (Nel & Grosser, 2016). This may be because screening for NDDs is typically an expensive and time-consuming process that requires particular expertise, and as such, is often inaccessible to those who lack the resources for it.

Neuropsychological Tests

The screening of NDDs is typically done through pen-and-paper neuropsychological tests (Llewellyn et al., 2019). However, pen-and-paper tests, although reliable and valid and able to capture several important clinically relevant attributes (e.g., reasons for test failure; amount of effort or motivation displayed), are long and arduous to administer and score and are expensive (Gualtieri, 2004). Moreover, pen-and-paper methods are often unable to take into account other factors that may affect NDDs such as socio-demographic factors and comorbid disorders, because the additional tests would be too time-consuming and costly (Kirby & Welch, 2016). Pen-and-paper tests also require trained specialists for administration and scoring, thus restricting the number of individuals who can administer the tests and who can be tested at a time (Fichman et al., 2014).

Further, several neuropsychological tests are only available in a limited number of languages, usually English and other western languages (Oppong, 2017). SA has 11 official

languages, and most tests are not available in the majority of these languages. Hence translators and/or bi/multilingual individuals are often needed in assessments completed in languages other than English, which is impractical given that such expertise is limited in many contexts (Llewellyn et al., 2019; Lucas, 2013). It is also ideal that there are norms available for the particular community where neuropsychological tests are administered (Lucas, 2013). However, in the case of SA where resources are scarce, such norms are often unavailable and such standardization not typically feasible (Lucas, 2013).

For all of these reasons, while pen-and-paper assessments are most often used, the use of alternative test options has been increasing, with the need for screening tools that are cost-effective, quick and accessible (Llewellyn et al., 2019). Computer-based testing appears to satisfy these requirements.

Computerized Tests

There has been an increase in the development and use of computer-based testing in neuropsychology, and the conversion of traditional pen-and-paper tests to computerized versions (Kane & Parsons, 2017). During the last decade, computer-based testing has become widely used for NDD diagnoses (Kane & Parsons, 2017). Computerized tests are advantageous as they do not require trained specialists in terms of their administration, are relatively cost-effective, easy and quick to administer and score, can collect normative data, and test large groups (Casaletto & Heaton, 2017; Llewellyn et al., 2019). However, there has been debate around the equivalence of computer-based testing to traditional tests (Kane & Parsons, 2017).

Equivocality in measurement between computer-based tests and traditional tests continues to be a concern especially regarding the validity and reliability of computer-based batteries (Llewellyn et al., 2019). Moreover, the administration of a test may affect how well the results generalize to everyday circumstances; certain populations could perform worse on computer-based tasks despite no impairment in daily situations on the same domain (e.g., based on familiarity around computer usage; Llewellyn et al., 2019). Further, one of course loses the ability to observe why an individual might do poorly on an assessment as computerised assessments do not allow for clinical observations (Leposavić et al., 2010). While such limitations are possible and should be considered, computer-based testing increasingly shows promise and utility in screening for NDDs, and many programs have been reported as valuable. The Do-It Profiler is one such tool.

The Do-It Profiler

The Do-It Profiler is a computerized screening and assessment system that is able to provide a person-centred assessment of LDDs based on demographic factors and the individual's setting (Kirby, 2016). The Do-It measures several domains, including literacy, arithmetic, attention, and working memory (WM) and does not require trained specialists to administer it (Do-It Profiler, 2018). It has been used and standardized in a number of countries, including SA, and can be made available in any of the 11 official SA languages, which is useful for the SA context (Do-It Profiler, 2018).

The Do-It was standardized as part of a study on literacy achievement in relation to substance abuse, study skills, school violence exposure and socio-economic status on approximately 35 000 students in SA (Pillay, 2017a). Pillay (2017a, 2017b, 2018) has used literacy tests from the Do-It to investigate literacy achievement in SA in several studies. However, studies investigating other Do-It domains in SA are needed.

Working Memory

One such domain is WM. WM may be an important issue to consider concerning LDDs. Although poor WM has been shown to negatively impact learning and development in both typical and atypical students (Cowan, 2014), impairments in WM are six times more likely to occur in children with LDDs than typically developing children (Pickering & Gathercole, 2001). WM is responsible for the short-term storage and manipulation of information necessary for simple and complex cognitive tasks and has been implicated in the learning and practice of arithmetic, literacy, and science (Baddeley, 1992; Gray et al., 2015; Rogers et al., 2011; St. Clair-Thompson & Gathercole, 2006).

In Baddeley's (1992) model of WM, WM is divided into three subcomponents: the central executive, which is an attentional-controlling system, the visuospatial sketchpad which processes visual WM, and the phonological loop which is involved in the rehearsal and processing of audioverbal WM (Baddeley, 1992; Napier, 2014). The Do-It Profiler WM test uses the backward Digit Span test, a well-known, reliable and valid test of WM (Baddeley, 1992), which relies on Baddeley's visual WM component. Most pen-and-paper tests of WM are audio-verbal. The Do-It eliminates common issues that affect the administration of the Digit Span such as presenting the digits faster than other digits and an inconsistent pitch whilst calling out the numbers (Raiford et al., 2010). WM is a good measure of a child's learning abilities because it is

not strongly affected by a child's history and, therefore, gives a strong indication of the child's capacity (Alloway & Alloway, 2010).

A longitudinal study on the effects of WM on high school dropout risk found that early WM skills predicted high school dropout risk later in life (Fitzpatrick et al., 2015). This study included 1,824 children whose WM was assessed at ages 2-3 using an Imitation Sorting Task. Results showed that a one-point increase in preschool WM scores decreased the likelihood of high school dropout by 26% (Fitzpatrick et al., 2015), while controlling for socio-economic status, sex, and IQ. Rogers et al. (2011) also reported poor WM to be a significant risk factor for academic failure, but particularly for those with attentional problems. In this study, audio-verbal and visual-spatial WM were investigated independently and simultaneously. Deficits in audioverbal WM were found to have a strong influence on the relationship between classroom inattention and academic underachievement in mathematics and reading (Rogers et al., 2011). Visuospatial and audioverbal WM have been found to be significant predictors of both mathematics and reading achievement (Napier, 2014). Visuospatial WM has been closely linked to mathematics and science achievement (St. Clair-Thompson & Gathercole, 2006).

Conclusion

Research has shown an increase in students with NDDs attending mainstream schools, which means there is a growing need for more efficient and cost-effective screening tools for NDDs (Nel & Grosser, 2016: Yoro et al., 2020). This is particularly the case in SA where learners may already face significant barriers to learning (Nel & Grosser, 2016). NDDs are typically screened through pen-and-paper neuropsychological tests, which, although reliable, are time-consuming and difficult to administer and score, and are costly (Gualtieri, 2004; Llewellyn et al., 2019). This means that they are often inaccessible to much of the SA population who lack the resources for it (Nel & Grosser, 2016). Computerized tests have been offered as an alternative for the screening of NDDs because they are relatively cost-effective, quick and easy to administer and score, can collect normative data, and test large groups (Casaletto & Heaton, 2017; Llewellyn et al., 2019). The Do-It Profiler has been identified as one such tool. The Do-It profiler is a computerized screening and assessment system available in multiple languages that is able to provide a person-centred assessment of LDDs based on demographic factors (Do-It Profiler, 2018; Kirby, 2016). LDDs are a category of NDDs that are characterized by significantly low academic achievement in school (Johnson et al., 2010). The Do-It measures

many learning capacities, including WM, therefore, providing a diverse assessment of LDDs. WM abilities have been shown to be an important consideration with regard to LDDs because it is a common impairment among learners with LDDs and because of the crucial role WM plays in multiple areas in school (Gray et al., 2015; Pickering & Gathercole, 2001; Rogers et al., 2011; St. Clair-Thompson & Gathercole, 2006). The Do-It profiler may be a solution to providing better screening and assessment of LDDs in SA which could assist the education system to provide better support for those affected by LDDs.

Research Aims and Hypotheses

This study formed part of a larger study run by a clinical Neuropsychology Masters student who investigated whether the Do-It Profiler could successfully predict neuropsychological outcomes in reading, arithmetic and attention on traditional pen-and-paper tests in a sample of high school adolescents. Our study, which focuses on WM, had two objectives. The first objective was to investigate prevalence rates of WM deficits in a sample of high school students in Cape Town, SA, using the Do-It Profiler. The second objective was to investigate whether the Do-It Profiler could effectively predict WM neuropsychological outcomes from traditional pen and paper tests. The following research hypothesis was tested for the second objective: The WM outcomes on the Do-It Profiler can significantly predict the WM outcomes assessed on traditional neuropsychological pen and paper tests.

Methods

Research design and setting

The research design was quantitative and cross-sectional, with a within-subjects design. There were two phases to the study, a screening phase, and a formal neuropsychological test phase, to address the two objectives of this study. Phase 1 was the LDDs screening phase wherein participants completed the Do-It Profiler on a laptop in a silent area. Phase 2, which began one week after Phase 1, was the formal neuropsychological test phase. During this phase, participants were contacted via Zoom and completed the two core Working Memory Index (WMI) subtests of the Wechsler Intelligence Scale for Children (WISC-IV) (Wechsler, 2003). These are the Letter-Number sequencing and (audio-verbal) Digit Span subtests (Weschler, 2003). The participants in this study were recruited from a non-profit residential female youth

centre in Cape Town, SA. This youth centre houses 24 girls under the age of 18 who have been placed there by court order because they are in need of care and protection. Most of the girls have come to the centre because of abandonment or parental neglect or they are trafficking victims. Some have been placed at the centre because they were removed from their homes due to issues with their behaviour such as drug use, gang involvement and/or violence.

Participants

Our study included 18 female participants between the ages of 13 and 16 (M = 15.22; SD = 0.94). This age restriction was based on that of the larger study and the upper age limit for the age range for which the WISC IV was developed. Initially, 24 participants were recruited, however, 1 participant chose not to take part, 3 participants were older than 16 and 1 participant was younger than 13. Additionally, one participant did not complete the WM component of the Do-It profiler in Phase 1. All participants were fluent in English.

Phase 1 of the study included those youth centre residents who had been given consent from the social worker overseeing the centre and who also assented to participate in this study. Those eligible for Phase 2 of the study had to have completed Phase 1 of the study, been given consent from the social worker and gave assent to participate. The study had no additional exclusion criteria.

Measures

Screening measures.

Demographics. The social worker overseeing the centre was the guardian for all participants. This social worker was asked questions about the demographics of participants which included information about their age, home language and how they came to be in the youth centre.

Computerized screening measure.

Do-It Profiler. The Do-It Profiler is a computerized screening and assessment system for LDDs composed of several modules assessing multiple domains (Kirby, 2016). This study utilized the Do-It Profiler module that assesses WM, which contains a computerized Digit Span test. The Do-It profiler demonstrates high levels of validity and good internal consistency (Do-It Profiler, 2018) and has been used in the SA context (see Pillay, 2017a; Pillay, 2017b; Pillay, 2018).

Pen-and-paper neuropsychological test.

Wechsler Intelligence Scale for Children (WISC-IV). WM was measured using the WMI of the WISC-IV, a neuropsychological measure that tests the general intellectual functioning of children aged 6 to 16 years old. The WISC-IV has high validity and reliability and the WMI that consists of two core subtests (Letter-Number Sequencing and (audio verbal) Digit Span) has been found to have an average internal consistency value of .92 and an average test-retest coefficient of .86 (Wechsler, 2003). The Digit Span subtest encompasses both forward and backward Digit Span recall, which measures basic attention and WM, respectively. Forward Digit Span recall involves a sequence of numbers which are read aloud to the participant who is then asked to recall the number sequence in the same order. Backwards Digit Span recall also involves a sequence of numbers read aloud, however; in this subtest the participant must recall the number sequence in reverse order. The Letter-Number Sequencing subtest consists of a series of letters and numbers which must be organized into alphabetical and numerical order. This subtest measures the ability of an individual to keep verbal information in mind while manipulating it. Studies using the WISC-IV have been conducted both within SA and abroad (see Gomez et al., 2016; May et al., 2016).

Procedure

After receiving ethical clearance from the Department of Psychology's Research Ethics Committee at the University of Cape Town (UCT) (Appendix D) and permission to conduct the study with high school adolescents from Cape Town schools from the Western Cape Education Department (WCED) (Appendix E), English medium schools were contacted (once Covid-19-related restrictions were lifted) and invited to participate in the study. However, due to Covid-19 social distancing measures and the fact that the school / academic calendar was significantly impacted this year, schools were unable to accommodate research projects even later in the 2020 academic year. Thus, convenience and word-of-mouth sampling were used, and the study was advertised to possible participants in our communities.

A non-profit residential female youth centre in Cape Town was also contacted in the process and a participant invitation flyer (Appendix A) was sent via email explaining the nature and purpose of the study. The centre was able to accommodate this study and thus participants were recruited from this centre. The social worker who acted as guardian for all the girls was sent parental consent forms electronically via google forms to complete for each of the girls who would participate (Appendix B). This non-profit residential female youth centre houses 24 girls

under the age of 18 who have been placed there by the children's court due to neglect or abandonment, issues with their behaviour, or they were trafficking victims.

For Phase 1 of the study, participants were asked to complete an informed assent form (Appendix C) before participation and then each participant was given unique login details which allowed them to access the Do-It Profiler. Each participant completed the screening on a laptop in a quiet room, individually. After 1 week, the social worker overseeing the centre was contacted to arrange an appropriate time for a Zoom call for the second phase of this study. Participants were then sent a link for a Zoom session during which one of the researchers administered the WM component of the WISC-IV. Verbal assent was obtained at the start of the testing session for Phase 2 of the study, using an assent form, which was read out to participants (Appendix C). Participants were asked in the process of obtaining assent forms in Phase 2 of the study for permission to record the session. This was done in order to ensure the accurate collection of data and enable the collection of detailed information. Thereafter, the social worker who acted as the guardian for all the participants and provided consent for each participant, was asked questions about the demographic information of the participants.

After the completion of Phases 1 and 2, the data from the Do-It and pen-and-paper tests was collated and stored on a password-protected computer and all hard copies of the formal neuropsychological test scores were stored in a secure place at one of the researcher's homes, given the current working conditions with the Covid-19 pandemic.

Data Analysis

The data was collated and analysed using RStudio version 3.6.2 software. The significance level or alpha was set at $p < .05$. Descriptive statistics were conducted for the demographics of the participants and the measures used in Phase 1 and 2, namely the Do-It Profiler and the WISC IV, WMI subtests. Hierarchical multivariate regression analyses were used to determine if the Do-It outcomes from Phase 1 could successfully predict WM neuropsychological outcomes from the WISC-IV WM subtests obtained in Phase 2.

Ethical Considerations

Informed consent and assent. Ethical approval was granted by the UCT department of psychology and the WCED granted permission for the study to be conducted at Cape Town schools. The social worker at the female residential youth centre was the appointed guardian for the participants in the study. This social worker was sent a participant invitation flyer (Appendix

A) and parental consent form (Appendix B) before residents of the youth centre participated in the study. Because this study focuses on a group of minors, the social worker needed to sign and return the consent form if the residents were to participate in the study.

The social worker completed the consent forms via google forms before participants participated in Phase 1 of the study. Participants were also asked to complete an informed assent form (Appendix C) before Phase 1 of the study. In Phase 2 one of the researchers verbally went over the assent form with the participants in the Zoom session and verbal assent was given. Participants were assured in the forms that participation in the study was voluntary and that participants were free to withdraw from the study at any time with no penalties. After Phase 2 was completed participants were asked if they had questions about the study and any questions or concerns were addressed.

Benefits and risks. All possible risks and benefits of the study were explained in the parental consent form and a participant invitation flyer given to participants prior to participation. The primary benefit of the study was that all participants were provided with an assessment of their WM abilities. They will also be provided with a summary of their strengths and weaknesses in the other skills, such as literacy and arithmetic, which the Do-It Profiler assesses, once the complete assessment for the larger study has taken place. For participating in the study, participants will be given an R100 Pick n Pay or Shoprite voucher which was mentioned in the consent and assent forms.

Referrals. If a participant's score on any of the neuropsychological tests fell within a Borderline or Extremely low range, or the Do-It profiler indicated a potential LDD, researchers would refer the participant for further testing, either to the district educational psychologist, or the Groote Schuur Neuropsychology clinic. This will be done on completion of the larger assessment for the larger study and when the clinic is up and running again.

Results

Descriptive Statistics

Descriptive statistics, including means (M) and standard deviations (SD), for the key study variables are presented in Table 1. None of the standard deviations are especially large or concerning. All participants fell into the required age range, with the average age of participants being 15.22 years. The sample was made up of one 13-year-old, three 14-year olds, five 15-year olds, and nine 16-year olds.

Using the Do-It Profiler to assess WM, the average score reported was 1, indicating significant challenges in WM (*M* = 1.94, *SD* = 1.39). Figure 1 presents the number of participants that scored in each category of the Do-It Profiler WM assessment report. 12 out of the 18 participants (66.67 %) scored 1 on the Do-It Profiler WM assessment. Only 1 participant (5.56%) received a score of 3, indicating reasonable WM skills, and 5 participants (27.78%) received a score of 4, indicating good WM skills. None of the participants received a score of 2, indicating many challenges reported in WM.

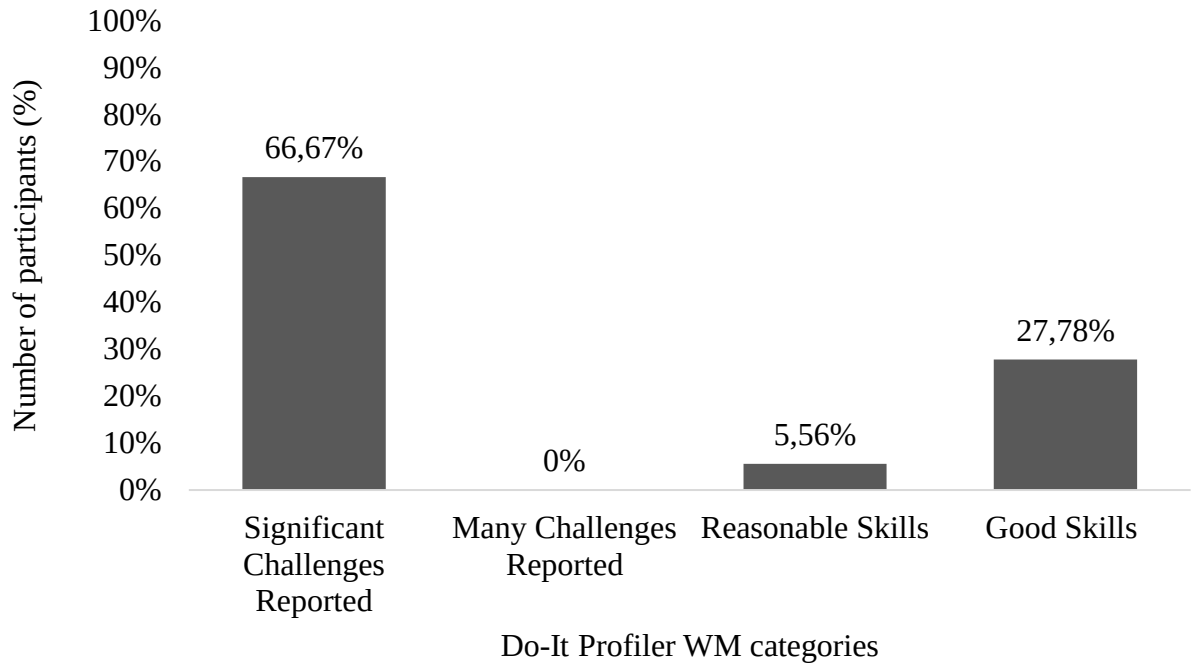

Figure 1: Percentage of participants that scored in each category of the Do-It Profiler WM assessment report (*N* = 18)

For WMI scores and the Letter-Number Sequencing subtest scaled scores, on average, participants scored in the extremely low range (*M* = 66.28, *SD* = 11.82) and (*M* = 3.94, *SD* = 2.80), respectively). For Digit Span Forwards (*M* = 5.28, *SD* = 2.72) and Digit Span Backwards (*M* = 5.44, *SD* = 2.85), on average, participants scored in the borderline range. The minimum scores fell in the extremely low range for all WMI subtests; Digit Span Forwards, Digit Span Backwards, Letter-Number Sequencing and WMI scores.

Table 1

Descriptive Statistics (N = 18)

Variables	M	SD	min	max
Age	15.22	0.94	13	16
WMI [a]	66.28	11.82	50	80
DSF [b]	5.28	2.72	2	11
DSB [b]	5.44	2.85	1	12
LNS [b]	3.94	2.80	1	9
Do-It [c]	1.94	1.39	1	4

Note. WMI = Working Memory Index, DSF = Digit Span Forwards, DSB = Digit Span Backwards, LNS = Letter-Number Sequencing, Do-It = Do-It Profiler Working Memory Score; [a] = Numeric variable (<70 = extremely low; 70-79 = borderline; 80-89 = low average; 9-109 = average; 110-119 = high average; 120-129 = superior, > 130 = very superior); [b] = Numeric variable (1-3 = extremely low; 4-5 = borderline; 6-7 = low average; 8-11 = average, 12 – 13 = high average); [c] = Categorical variable (1 = significant challenges reported; 2 = many challenges reported; 3 = reasonable skills; 4 = good skills).

Correlations

Table 2 summarizes the results of the correlational analyses. A significant moderate positive correlation was found between Letter-Number Sequencing and Do-Profiler WM scores ($r = 0.48$, $p < .05$). However, there were no statistically significant correlations between Do-It Profiler WM Scores and the other neuropsychological pen-and-paper assessment scores of Digit Span Forwards, Digit Span Backwards and WMI. Moreover, although both Digit Span Backwards and Letter-Number Sequencing scores shared a strong significant correlation with WMI scores (DSB: $r = 0.68$, $p < .01.05$; LNS: $r = 0.86$, $p < .001$), Digit Span Forwards scores did not share a significant correlation with WMI scores. In addition, Age seemed to share a moderate positive correlation with Do-It Profiler WM scores, but not with the other WM scores. Age also seems to share a negative, moderate correlation with Digit Span Forwards scores, suggesting that as age in the sample increased, so scores on DSF decreased.

Table 2

Correlations between all study variables. (N = 18)

Variables	Age	DSF	DBF	LNS	WMI	Do-It
1.Age	-					
2.DSF	-0.30	-				
3.DSB	0.14	-0.21	-			
4.LN	0.05	0.03	0.45			
5.WMI	-0.04	0.29	0.68**	0.86***	-	
6. Do-It	0.37	-0.14	0.27	0.48*	0.34	-

Note. WMI = Working Memory Index, DSF = Digit Span Forwards, DSB = Digit Span Backwards, LNS = Letter-Number Sequencing, Do-It = Do-It Profiler Working Memory Score; *p < .05. **p < .01. ***p < .001.

Hierarchical Multivariate Regression Analyses

Before analysis of the regression models, preliminary analyses were conducted and it was found that the assumptions of linearity, normality and homoscedasticity were not upheld for all regression models. This is likely due to the small sample size. In order to check whether there were issues with multicollinearity between the variables in our models, VIF values were assessed. All values fell only slightly above 1 (VIFmax = 1.20). This suggests no issues with multicollinearity. In order to identify any potential problematic influential cases, model diagnostics were also assessed, but no influential cases were identified.

Table 3 summarizes the results of the 3 hierarchical multivariate regression analyses with Digit Span Backwards, Letter-Number Sequencing, and WMI scores as the dependent variables. In step 1 a multiple regression was run with the control variables of attention (DSF scores) and age. For step 2, the Do-It Profiler WM score variable was added to the model. To check whether step 2 was significantly different from step 1 for all 3 models, an ANOVA was conducted. It was found that step 2 did not significantly differ from step 1 for all 3 models, F (3, 15) = 1.81, p = 0.2. We now look at each of the models separately and in more detail.

Digit Span Backwards.

Step 1. The control variables of attention (DSF) and age accounted for 5% of the observed variance in the Digit Span Backwards scores. However, age and attention failed to significantly predict Digit Span Backwards scores and the model was not found to be significant

overall, F (2,15) = 0.41, p = 0.67.

Step 2. The addition of Do-It Profiler WM scores at step 2 explained a further 6% of the observed variance in Digit Span Backwards scores. The overall regression model was also not found to be significant, F (3, 14) = 0.56, p = 0.65, and none of the variable significantly predicted Digit Span Backwards scores.

Letter-Number Sequencing.

Step 1. The control variables of attention (DSF) and age accounted for only 1% of the observed variance in the Letter-Number Sequencing scores. However, age and attention failed to significantly predict Letter-Number Sequencing scores and the model was not found to be significant overall, F (2,15) = 0.04, p = 0.96.

Step 2. The addition of Do-It Profiler WM scores at step 2 explained a further 25% of the observed variance in Letter-Number Sequencing scores. Additionally, the individual slope coefficient for Do-It Profiler WM scores was found to be significant, t = 2.17, $p < 0.05$. However, overall, this model was not found to be significant, F (3, 14) = 1.61, p = 0.23, and none of the other variables significantly predicted Do-It Profiler WM scores.

Working Memory Index.

Step 1. The control variables of attention (DSF) and age accounted for 9% of the observed variance in the WMI scores. However, age and attention failed to significantly predict WMI scores and the model was not found to be significant overall, F (2,15) = 0.70, p = 0.52.

Step 2. The addition of Do-It Profiler WM scores at step 2 explained a further 15% of the observed variance in WMI scores. Overall, this regression model was also not found to be significant, F (3,14) = 0.56, p = 0.65, and none of the variables significantly predicted WMI Scores.

Table 3

Multiple Regression Analyses Predicting Digit Span Backwards, Letter-Number Sequencing, and WMI Scores from Do-It Profiler WM Scores (N = 18).

	Working Memory					
	DSB		LNS		WMI	
Predictors	β	ΔR^2	β	ΔR^2	β	ΔR^2
Step 1		0.05		0.01		0.09
Age	0.24		0.19		0.67	
Attention	-0.2		0.05		1.32	
Step 2		0.06		0.25		0.15
Do-It	0.52		1.08*		3.56	
	$R^2 = 0.11$		$R^2 = 0.26$		$R^2 = 0.24$	
	$Adj.R^2 = -0.09$		$Adj.R^2 = 0.10$		$Adj.R^2 = 0.08$	

Note. WMI = Working Memory Index, DSF = Digit Span Forwards, DSB = Digit Span Backwards, LNS = Letter-Number Sequencing, Do-It = Do-It Profiler Working Memory Score. **p* < .05. ***p* < .01. ****p* < .001.

Discussion

The SA educational system has formed part of a global movement towards more inclusive forms of education (Nel & Grosser, 2016). However, inclusive learning in the context of SA faces some major challenges. First, learners in SA are already at greater risk of facing significant barriers to learning including poor education quality, poverty, unemployment and malnutrition, which may exacerbate the problems that individuals with NDDs face (Nel & Grosser, 2016). Second, with pen-and-paper neuropsychological tests traditionally used for the screening of NDD being time-consuming, costly, and difficult to administer and score, they are often inaccessible to much of the SA population, which puts many individuals with NDDs at risk of going undetected (Gualtieri, 2004; Llewellyn et al., 2019). These issues highlight the need for screening tools that are more efficient and cost-effective (Nel & Grosser, 2016: Yoro et al., 2020). Computerized tests such as the Do-It Profiler have been offered as a more accessible alternative for the screening of NDDs (Casaletto & Heaton, 2017). The Do-It Profiler screens for LDDs, a category of NDDs characterized by low academic achievement, and assesses several

learning domains, including WM (Kirby, 2016). Research has shown that WM plays a crucial role in multiple areas in school and that impairments in WM are six times more likely to occur in children with LDDs (Gray et al., 2015; Pickering & Gathercole, 2001; Rogers et al., 2011; St. Clair-Thompson & Gathercole, 2006). Learners with WM impairments who go undetected are at a greater risk for grade retention and academic failure (Fitzpatrick et al., 2015; Rogers et al., 2011). Therefore, WM is important to consider when screening for LDDs.

Thus, the first objective of this study was to investigate prevalence rates of WM deficits in a sample of high school students in Cape Town, SA, using the Do-It Profiler. The second objective was to investigate whether the Do-It Profiler could effectively predict WM neuropsychological outcomes from traditional pen and paper tests in a sample of high school adolescents.

Prevalence rates of WM deficits

Due to COVID-19 restrictions, we only sampled from a small residential female youth centre in Cape Town. All the girls in this youth centre have been placed there by the children's court due to neglect or abandonment, issues with their behaviour, or they were trafficking victims. Within this small sample, according to the results of the Do-It Profiler, 12/18 (66.67%) participants had significant challenges in the WM component which is defined by a score of 1. Thus, there was a high prevalence of WM deficits in our sample as measured by the Do-It profiler.

In terms of participants' performance on the WISC-IV WM subtests, participants WMI scores were in the extremely low range on average, which also indicates a high prevalence of WM deficits in the sample. In terms of the subtests making up this index, the average Digit Span Backwards score (M = 5.44) was higher than the average Letter-Number Sequencing score (M = 3.94). However, on average, both scores were in the extremely low to borderline range indicating problems with WM. WM has been implicated in the learning and practice of arithmetic, literacy, and science (Gray et al., 2015; Rogers et al., 2011, St. Clair-Thompson & Gathercole, 2006). Previous research has also indicated an important relationship between WM and academic achievement (Alloway & Alloway, 2010; Rogers et al., 2011). Therefore, poor WM performance in this sample indicated by both scores from the Do-It Profiler and the WM components of the WISC-IV show that participants in this study may benefit from WM interventions.

On average, participants also scored in the borderline range for the Digit Span Forwards subtest, which assesses attention. This outcome is concerning, as attention is a precursor to all other cognitive functions; therefore, attentional problems can affect other cognitions such as WM. WM has been shown to be a significant risk factor for academic failure for those with attentional problems (Rogers et al., 2011).

Comparison of Do-It Profiler and WISC-IV WM outcomes

For the second objective of this study, we hypothesized that the WM outcomes on the Do-It Profiler could significantly predict the WM outcomes assessed on traditional neuropsychological pen and paper tests. Although there was a significant moderate positive correlation between Letter-Number Sequencing and Do-Profiler WM scores, there were no significant correlations between the Do-It Profiler WM and Digit Span Forwards, Digit Span Backwards and WMI scores. There was a moderate positive correlation between the Do-It Profiler WM scores and age, suggesting that older participants had better Do-It Profiler WM scores. On the other hand, there was a moderate negative correlation between the Digit Span Forwards scores and age. indicating that as age increased, the scores on the Digit Span Forwards decreased. This result suggests that older participants in the sample had poorer attention.

Letter-Number Sequencing scores shared a significant moderate positive correlation with Do-It Profiler WM scores ($r = 0.48$, $p < .05$). This relationship was also evident within the hierarchical multiple regression with Letter-Number Sequencing as the dependent variable. Within this regression, the individual slope coefficient for the Do-It Profiler WM scores was found to be significant, suggesting that Do-It Profiler WM scores could potentially predict Letter-Number Sequencing scores. It may be that the slope coefficient for Do-It Profiler WM scores is significant for the Letter-Number Sequencing model and not the other WM subtests because of the Letter-Number Sequencing task's association with both reading/spelling and counting. As such, Letter-Number Sequencing scores may be more closely related to LDDs, which the Do-It Profiler WM scores pick up. However, the hierarchical multivariate regression analysis revealed that the Do-It Profiler WM scores did not significantly predict the Digit Span Backwards, Letter-Number Sequencing and WMI scores. Thus, overall, our hypothesis was not supported in this sample.

Although participants met the criteria for the Letter-Number Sequencing component of the WISC-IV, which requires participants to count to 5 and recite the alphabet to the letter C, 11

participants were unable to recite their full alphabet. This could have affected their performance as some of the Letter-Number Sequencing trials include letters up to Z. These participants' difficulty reciting their full alphabet with the presence of WM deficits as indicated by scores from both the Do-It Profiler and the Digit Span Backwards and the Letter-Number Sequencing from the WISC-IV, could indicate the presence of underlying LDDs. Therefore, the participants could benefit from further testing and learning interventions. The closer association between the Do-It Profiler outcome scores and LNS may indeed be a function of underlying LDDs in the sample.

Although the Do-It Profiler was not shown to have high predictive validity for WM deficits in this sample, this assessment platform was easy to administer and score, did not require a trained specialist for administration and was relatively cost-effective since it was able to be administered in a non-profit residential female youth centre. Additionally, participants in this study were not experienced computer users but were able to complete the Do-It Profiler with few difficulties demonstrating the platforms ease of use.

There is a dearth of literature on the Do-It Profiler in SA and no studies thus far have measured WM using this online assessment platform. Therefore, this study is the first of its kind in SA and contributes to the limited existing literature on computerized assessment platforms. This study has also contributed to existing literature on adolescent LDDs and WM impairment through investigating the prevalence of WM deficits in high school adolescents in Cape Town. Overall, the Do-It Profiler provided diverse and constructive reports on the participant's learning abilities with WM and, therefore, has been shown to be a promising computerized assessment platform. The Do-It Profiler can also be made available in any of the 11 official SA languages, which is useful for the SA context (Do-It Profiler, 2018).

Study limitations and future research

This study was limited due to the COVID-19 social distancing measures and restrictions and, therefore, had to be altered according to these restrictions, one of these being that we were unable to sample from schools and reach our original sample target (N = 104). Using G*Power (Version 3.1.9.4), an a priori power analysis was conducted and indicated a minimum sample size of 104 participants, assuming a target power of .80 and a medium effect size (Cohen's f^2 = .15) with α = .05 (Faul et al., 2007). Thus, the study is limited by a small sample size (N = 18). Our study was also limited by a homogenous sample of only female participants from the same

residential female youth centre in Cape Town. Future research could utilize the original study proposal which planned to use 104 participants from English medium high schools in Cape Town. Another limitation which came as a result of the Covid-19 social distancing measures is that Phase 2 of this study, the neuropsychological pen-and-paper test phase, was conducted via Zoom. Zoom was the most convenient platform to conduct the second phase of the study with the participants. This was a limitation in the study because the WISC-IV is traditionally administered in person and the video calls were sometimes affected by bad network connections. Therefore, the results of this study are not generalizable to the population. In spite of these limitations, the Do-It profiler is a promising computerized assessment platform that, with further research and possible adaptation, could assist the SA education system in identifying learners with possible LDDs thus allowing them to provide greater support to such learners.

Conclusion

In this study, we investigated whether the Do-It Profiler could effectively predict WM neuropsychological outcomes from traditional pen and paper tests. We also investigated the prevalence of WM deficits in a sample of adolescents in Cape Town. We found that the Do-It Profiler did not predict WM neuropsychological outcomes from the WM components of the WISC-IV. However, we did find some evidence of a relationship between the Do-It Profiler and the Letter-Number Sequencing subtest of the WISC-IV. These results could have been attributed to the small sample size and data collection methods in our study which came as a result of Covid-19 social distancing measures and were limitations in this study. With regards to prevalence, we found that there was a high prevalence of WM deficits in our sample which was measured using the Do-It Profiler. This high prevalence was also reflected in the WMI scores of the WISC-IV. Overall, this study is the first of its kind in SA and thus contributes to the limited existing literature on the Do-It Profiler and computerized assessment platforms in SA. The Do-It Profiler has been shown to be a promising computerized assessment platform and, therefore, further research is needed on this assessment platform and LDDs in SA.

References

Alloway, T. P., & Alloway, R.G. (2010). Investigating the predictive roles of working memory and IQ in academic attainment. *Journal of Experimental Child Psychology, 106*(1), 20-29. https://doi.org/10.1016/j.jecp.2009.11.003

Baddeley, A. (1992). Working memory. *Science, 255*(5044), 556-559. https://doi.org/10.1126/science.1736359

Boat, T. F., & Wu, J. T. (2015). *Mental disorders and disabilities among low-income children.* The National Academies Press. https://doi.org/10.17226/21780

Casaletto, K. B., & Heaton, R. K. (2017). Neuropsychological assessment: Past and future. *Journal of the International Neuropsychological Society, 23*(9-10), 778–790. https://doi.org/10.1017/s1355617717001060

Cowan, N. (2014). Working memory underpins cognitive development, learning and education. *Educational Psychology Review, 26*(2),197-223. https://doi.org/10.1007/s10648-013-9246-y

Do-IT Profiler. (2018). Do-IT Profiler: Criminal Justice System 2018. Retrieved from: http://www.doitprofiler.net

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175-191. https:/doi.org//10.3758/bf03193146

Fichman, H. C., Uehara, E., & dos Santos, C. F. (2014). New technologies in assessment and neuropsychological rehabilitation. *Trends in Psychology, 22*(3), 539-553. https://doi.org/10.9788/tp2014.3-01

Fitzpatrick, C., Archambault, I., Janosz, M., & Pagani, L. S. (2015). Early childhood working memory forecasts high school dropout risk. *Intelligence, 53*, 160-165. https://doi.org/10.1016/j.intell.2015.10.002

Gomez, R., Vance, A., & Watson, S. D. (2016). Structure of the Wechsler Intelligence Scale for Children – Fourth Edition in a group of children with ADHD. *Frontiers in psychology, 7*, 737. https://doi.org/10.3389/fpsyg.2016.00737

Gray, S., Rogers, M., Martinussen, R., & Tannock, R. (2015). Longitudinal relations among inattention, working memory, and academic achievement: Testing mediation and the moderating role of gender. *Peerj, 3*, 1-26. https://doi.org/10.7717/peerj.939

Gualtieri, T. (2004). Computerized neurocognitive testing and its potential for modern psychiatry. *Psychiatry (Edgmont), 1*(2), 29-36.

Johnson, E. S., Humphrey, M., Mellard, D. F., Woods, K., & Swanson, H. L. (2010). Cognitive processing deficits and students with specific learning disabilities: A selective meta-analysis of the literature. *Learning Disability Quarterly, 33*(1), 3–18. https://doi.org/10.1177/073194871003300101

Kane, R. L., & Parsons, T. D. (2017). *The role of technology in clinical neuropsychology*. Oxford University Press. https://doi.org/10.1093/oso/9780190234737.001.0001

Kirby, A. (2016). Using data driven decision systems to deliver person-centred approaches in developmental disorders: one example of complexity – the criminal justice system. *Hilary Place Papers, 3,* 1-11.http://hpp.education.leeds.ac.uk/wpcontent/uploads/sites/131/2016/02/HPP2016-3-Kirby.pdf

Kirby, A., & Welch, D. (2016). The equality act 2010, specific learning difficulties and the police. *The Police Journal: Theory, Practice and Principles, 89*(3), 227-240. https://doi.org/10.1177/0032258x16657132

Leposavić, I., Leposavić, L., & Saula-Marojević, B. (2010). Neuropsychological assessment: computerized batteries or standard tests. *Psychiatria Danubina, 22*(2), 149–152. https://www.researchgate.net/profile/Ivana_Leposavic/publication/44687343_Neuropsychological_assessment_Computerized_batteries_or_standard_tests/links/0a85e52d6d279d9b64000000/Neuropsychological-assessment-Computerized-batteries-or-standard-tests.pdf

Llewellyn, C., Ayers, S., McManus, C., Newman, S., Petrie, K. J., Revenson, T. A., & Weinman, J. (2019). *Cambridge handbook of psychology, health and medicine*. Cambridge University Press.

Lucas, M. (2013). Neuropsychological assessment in South Africa. In S. Laher & K. Cockcroft (Eds.), *Psychological assessment in South Africa* (pp. 186–200). Wits University Press. https://doi.org/10.18772/22013015782.18

May, P. A., de Vries, M. M., Marais, A. S., Kalberg, W. O., Adnams, C. M., Hasken, J. M., Tabachnick, B., Robinson, L. K., Manning, M. A., Jones, K. L., Hoyme, D., Seedat, S., Parray, C. D. H., & Hoyme, H. E. (2016). The continuum of fetal alcohol spectrum disorders in four rural communities in South Africa: Prevalence and characteristics. *Drug and Alcohol Dependence, 159,* 207-218. https://doi.org/10.1016/j.drugalcdep.2015.12.023

McCarthy, J., Chaplin, E., Underwood, L., Forrester, A., Hayward, H., Sabet, J., Young, S., Asherson, P., Mills, R., & Murphy, D. (2015). Screening and diagnostic assessment of neurodevelopmental disorders in a male prison. *Journal of Intellectual Disabilities and Offending Behaviour*, *6*(2), 102-111. https://doi.org/10.1108/jidob-08-2015-0018

Napier, D. (2014). *Predicting adolescents' academic achievement: The contribution of attention and working memory* (Unpublished Master's thesis). University of South Florida, Florida.

Nel, M., & Grosser, M. M. (2016). An appreciation of learning disabilities in the South African context. *Learning Disabilities – A Contemporary Journal, 14*(1), 79-92.

Oppong, S. (2017). Contextualizing psychological testing in Ghana. *Psychology and its Contexts, 8*(1), 3-17.

Pickering, S.J. & Gathercole S.E. (2001). *Working memory test battery for children manual*. The Psychological Corporation.

Pillay, J. (2017a). Is school lunch connected to literacy achievement in primary school children? a South African perspective. *International Journal of Psychology & Behavior Analysis, 3*(1), 32–48. https://doi.org/10.15344/2455-3867/2017/125

Pillay, J. (2017b). Bullying experiences and literacy achievement amongst primary school children. *Journal of Psychology in Africa*, *27*(6), 561-563. https://doi.org/10.1080/14330237.2017.1399549

Pillay, J. (2018). Hope for the future and literacy achievement in a sample of impoverished South African primary school children. *Africa Education Review*, *15*(2), 32-48, https://doi.org/10.1080/18146627.2016.1224601

Raiford, S.E., Coalson, D.L., Saklofske, D.H., & Weiss, L.G. (2010). Practical issues in WAIS-IV administration and scoring. In L.G. Weiss, D.H. Saklofske, D.L. Coalson & S.E. Raiford (Eds.), *Practical resources for the mental health professional* (pp. 25-59). Academic Press. https://doi.org/10.1016/b978-0-12-375035-8.10002-3

Rogers, M., Hwang, H., Toplak, M., Weiss, M., & Tannock, R. (2011). Inattention, working memory, and academic achievement in adolescents referred for attention deficit/hyperactivity disorder (ADHD). *Child Neuropsychology*, *17*(5), 444-458. https://doi.org/10.1080/09297049.2010.544648

St. Clair-Thompson, H. L., & Gathercole, S. E. (2006). Executive functions and achievements in school: Shifting, updating, inhibition, and working memory. *The Quarterly Journal of Experimental Psychology, 59,* 745–759. https://doi.org/10.1080/17470210500162854

Wechsler, D. (2003). *Wechsler Intelligence Scale for Children–Fourth Edition*. The Psychological Corporation. https://doi.org/10.1037/t15174-000

Yoro, A. J., Fourie, J. V., & van der Merwe, M. (2020). Learning support strategies for learners with neurodevelopmental disorders: Perspectives of recently qualified teachers. *African Journal of Disability, 9,* 10. https://doi.org/10.4102/ajod.v9i0.561

Appendices

Appendix A: Participant Invitation Flyer

UCT Department of Psychology

Participant Invitation Flyer

You and your child are being invited to participate in our research. We would like to learn more about computers and their ability to assess neuropsychological outcomes such as memory. In order to do this, we are asking high school learners to complete 2 sets of activities to compare computer-based activities to pen-and-paper activities.

If you agree to participate in this study, your child will be asked to participate in two phases/sessions. During the first session, you will be asked to complete a set of computer- based activities. These activities include reading, basic math problems and memory activities. This will take approximately 30 minutes to complete. During the second session, your child will be asked to complete a set of pen-and-paper activities that are similar to the previous session. This session will take approximately 1 hour and 30 minutes and will be conducted online by one of the researchers on this study using Skype/Zoom/Teams Meetings. This session will be recorded for accuracy and detailed information. As the parent/guardian, you will be asked to participate in an interview via Skype/Zoom/Teams Meetings to gather information regarding demographics such as education and employment.

In order to participate, your child will need to be between the ages of 13 and 16 years old. For your child to participate in phase 2 of the study, they will need to be fluent in English. The limit in terms of language for Phase 2 of the proposed study is a function of lack of translated neuropsychological tools into other South African languages used in this phase of the study. There are no other exclusion criteria.

Taking part in this study will not cause any harm to you or your child, however, participation during the session may make you feel tired. Should you wish to take a break, you may do so at any time. Should you wish to stop participating in this study, you may do so at any point in the study without repercussions. There are no known benefits to you by taking part in this study. However, as part of taking part in this study, you will receive a R50

Checkers/Pick ‘n Pay voucher at the end of each session as compensation. You will also receive a 250MB bundle to allow for internet access for each session you and your child participate in.

Any information provided by you in the sessions will be kept confidential. Your names will be removed, and will instead be given a code that is only recognizable by the researchers involved. Any information provided will only be used for research purposes such as a research report.

Should you wish to participate in this research, please contact the following email/s for more information: ptrash010@myuct.ac.za (Asheeqa), tthcla001@myuct.ac.za (Claire) or antkha001@myuct.ac.za (Khayreyah).

Appendix B: Parent Consent Form

UCT Department of Psychology

Parent Consent Form

Informed consent for your child to participate in research

Your child is being invited to participate in a research study. This form provides you with the information about the study and requests your permission for your child to take part. Your child’s participation will be voluntary. To better inform your decision, please read the information below and should you have any questions, feel free to contact the primary researcher. Your child will not be disadvantaged in any way by choosing to participate in the research or not.

1. **Title of research study**

   Using the Do-It Profiler to screen for neurodiversity and in predicting neuropsychological outcomes in a sample of high school learners.

2. **Principal researchers and contact details**

   Asheeqa Petersen

   Masters in Psychology student

   Department of Psychology

   University of Cape Town

ptrash010@myuct.ac.za

Dr. Leigh Schrieff
Supervisor
Department of Psychology
University of Cape Town
leigh.schrieff-elson@uct.ac.za

3. **Source of funding**

   NRF and MRC

4. **Purpose of the study**

   The purpose of the study is to compare outcomes of a computerised-screening measure to neuropsychological outcomes of pen-and-paper measures and whether both measures can successfully produce similar results. Neuropsychological outcomes are skills such as the ability to remember lists, ability to read and understand as well as ability to do math.

5. **Participation in this study**

   Your child will be asked to complete a set of activities during two phases/sessions. Phase 1 will require your child to complete a set of activities on a computer. Phase 2 will require your child to complete a set of activities with pen and paper via Skype/ Zoom/ Microsoft Teams with a researcher. These sessions will be recorded to ensure information is documented accurately. Both phases will assess your child's reading fluency and comprehension, spelling ability, arithmetic and memory. Additionally, as the parent or guardian of the child, you will be asked to participate in an interview in which demographic information, such as education and employment, can be collected from you.

6. **Duration of participation**

   Completion of Phase 1 will take approximately 30 minutes and completion of Phase 2 will take approximately 1 hour and 30 minutes. If at any time, your child wishes to stop their participation, they may do so without any repercussions. The parent interview will take approximately 30 – 45 minutes.

7. **Number of participants**

   All learners will be invited to participate.

8. **Possible risks and/or discomforts**

There are minimal risks involved in participating in this study. For example, your child may feel tired during completion of the activities. However, your child will be allowed to take a break should they wish to do so. If there are any discomforts your child may experience by participating in this study, you may contact the principal researcher. .

9. Possible benefits

Your child may not personally benefit from participating in this study. However, any information gathered from their participation may help in assessing the feasibility of computerised-screening techniques.

10. Compensation

Your child will be compensated with a R50 Checkers/Pick 'n Pay voucher for each phase that they participate in. We will also provide a weekly bundle of 250MB of data to allow for internet connectivity to participate in the study.

11. Voluntary participation and withdrawal

Participating in this study is entirely voluntary and both you and your child may stop participating at any point during the study. Should you or your child wish to withdraw, there will be no penalties or repercussions. However, should you or your child withdraw, yours and your child's permission will be asked to continue to use the information provided.

If you or your child has any questions regarding their rights in participating in this research, you may contact the Psychology Department office on 021 650 3417 or email Rosalind Adams (rosalind.adams@uct.ac.za). Alternatively, you can contact the primary researchers should you have any questions about the study (contact information provided on Page 1).

12. Confidentiality of information and privacy

Any information provided by you or your child will be kept confidential and will only be accessed by researchers of this study. All the information provided will be coded for anonymity and will be kept anonymous when included in reports. Your child's information will not be released without your permission unless required by law.

13. Further requirements

By participating in this study, the primary researcher and supervisor request permission to obtain your child's school report. This will be used in comparison to your child's

performance on the tasks and activities in this study. It will also be used to draw conclusions between the school report and your child's performance on those tasks and activities.

14. Signatures

Signature of person providing consent:

I (the parent/legal guardian) have been informed about purpose of the study, the risks and benefits involved, procedure of collecting data and how it will be used. I have received a copy of this form with the details of the primary researchers should I wish to ask any questions.

I voluntarily agree that myself and my child may participate in this study and hereby provide permission for the collection and use of the data based on my child's performance, including permission to obtain my child's school report, as well as the collection of data regarding my demographics. (By signing this form, you are not giving away any of your legal rights.)

Initial and surname of child

Grade

By marking this box (✓/ X), I agree to both my child and my own participation in this study.

Please indicate below if you would like to be notified of future research projects conducted by the primary researchers:

_____ (initial) Yes, I would like to be added to your research participation pool and be notified of research projects in which I might participate in the future.

Method of contact:

Phone number: _____

E-mail address: _____

Appendix C:

UCT Department of Psychology

Participant Assent Form

PERMISSION TO PARTICIPATE IN RESEARCH

You are being invited to participate in my research. We would like to learn more about computers and their ability to assess neuropsychological outcomes such as memory. In order to do this, we are asking high school learners to complete 2 sets of activities to compare computer-based activities to pen-and-paper activities.

If you agree to participate in this study, you will be asked to participate in two phases/sessions. During the first session, you will be asked to complete a set of computer-based activities. These activities include reading, basic math problems and memory activities. This will take approximately 30 minutes to complete. During the second session, you will be asked to complete a set of pen-and-paper activities that are similar to previous session. This session will take approximately 1 hour and 30 minutes. This session will be recorded for accuracy and detailed information.

Taking part in this study will not cause any harm to you, however, participation during the session may make you feel tired. Should you wish to take a break, you may do so at any time. Should you wish to stop participating in this study, you may do so at any point in the study without repercussions. There are no known benefits to you by taking part in this study. However, as part of taking part in this study, you will receive a R50 Checkers/Pick ‘n Pay voucher at the end of each session as compensation.

Any information provided by you in the sessions will be kept confidential. Your name will be removed, and you will instead be given a code that is only recognizable by the researchers involved. Any information provided will only be used for research purposes such as a research report.

By signing this, it means that you would like to participate in this study. Should you wish to not take part, you do not have sign this form. Before, signing this form, we will answer any questions you may have about the study. If you cannot think of any questions now, you may ask them the next time we meet.

If you have any questions regarding your sights in this study, you may contact the Psychology Department office on 021 650 3417 or email Rosalind Adams (rosalind.adams@uct.ac.za). Alternatively, you may also contact the primary researchers involved in this study:

Dr. Leigh Schrieff (supervisor) – leigh.schrieff-elson@uct.ac.za

Asheeqa Petersen (researcher) – ptrash010@myuct.ac.za

I would like to take part in this study:

Initial and surname

Grade

By marking this box (✓/ X), I agree to:

- My participation in this study;
- That I have been informed of my rights and;
- That my participation in the neuropsychological tests can be recorded.

Appendix D: Ethical Approval Letter

UNIVERSITY OF CAPE TOWN

Department of Psychology

University of Cape Town Rondebosch 7701 South Africa
Telephone (021) 650 3417
Fax No. (021) 650 4104

27 July 2020

Asheeqa Petersen
Department of Psychology
University of Cape Town
Rondebosch 7701

Dear Asheeqa

I am pleased to inform you that ethical clearance has been given to the amendment of your proposal by an Ethics Review Committee of the Faculty of Humanities for your study, *Using the Do-IT Profiler to screen for learning difficulties and disabilities and in predicting neuropsychological outcomes in a sample of high school learners.* The reference number is PSY2019 -052.

I wish you all the best for your study.

Yours sincerely

Catherine L. Ward, PhD
Professor
Chair: Ethics Review Committee

Appendix E: Western Cape Education Department Approval Letter

Directorate: Research

Audrey.wyngaard@westerncape.gov.za
tel: +27 021 467 9272
Fax: 0865902282
Private Bag x9114, Cape Town, 8000
wced.wcape.gov.za

REFERENCE: 20200820-7589
ENQUIRIES: Dr A T Wyngaard

Ms Khayreyah Antvorskov,
56 Elgin Road
Sybrandpark
Rondebosch
7700
Ms Claire Tatham
4 Glade Close
Rondebosch
7700

Dear Ms Khayreyah Antvorskov and Claire Tatham

RESEARCH PROPOSAL: SCREENING FOR WORKING MEMORY DIFFICULTIES USING THE DO-IT PROFILER AND NEUROPSYCHOLOGICAL PEN-AND-PAPER TESTS IN HIGH SCHOOL LEARNERS

Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. Educators' programmes are not to be interrupted.
5. The Study is to be conducted from **20 August 2020 till 30 September 2020.**
6. No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December).
7. Should you wish to extend the period of your survey, please contact Dr A.T Wyngaard at the contact numbers above quoting the reference number?
8. A photocopy of this letter is submitted to the principal where the intended research is to be conducted.
9. Your research will be limited to the list of schools as forwarded to the Western Cape Education Department.
10. A brief summary of the content, findings and recommendations is provided to the Director: Research Services.
11. The Department receives a copy of the completed report/dissertation/thesis addressed to:

    The Director: Research Services
    Western Cape Education Department
    Private Bag X9114
    CAPE TOWN
    8000

We wish you success in your research.

Kind regards.
Signed: Dr Audrey T Wyngaard
Directorate: Research
DATE: 21 August 2020