Quality of education and neuropsychological test performance

Jeanie Cavé
Sterkfontein Psychiatric Hospital
South Africa
jeanie.cave@gmail.com

Kate Grieve
Department of Psychology
University of South Africa

Abstract

Neuropsychologists are becoming increasingly aware that there is a complex interplay of cognitive, personality, and socio-cultural factors that affect an individual's performance on neuropsychological tests. The current study investigated the relationship between quality of education and learners’ performance on neuropsychological tests of executive function. The sample included 40 high school learners: Group A comprised 20 learners with a high quality of education and Group B comprised 20 learners with a low quality of education. Four tests of executive function were administered, namely: the Verbal Fluency Test, the Design Fluency Test, the Stroop Test, and the Wisconsin Card Sorting Test (WCST). The results indicated that quality of education significantly affected the participants' performance, with Group A performing significantly better than Group B on all the tests of executive function. These findings have implications for the interpretation of neuropsychological test performance in cross-cultural research and practice.

Key words: assessment; cross-cultural neuropsychology; Design Fluency Test; executive function; neuropsychology norms; norm-referenced testing; quality of education; Stroop Test; Verbal Fluency Test; Wisconsin Card Sorting Test

Neuropsychology is the branch of psychology that explores the relationship between brain functioning and behaviour (Cohen & Swerdlik, 2002). It is the neuropsychologist’s role to assess individuals in order to draw inferences about the structural and functional characteristics of their brain. Since the 1990s, neuropsychology has gained institutional acceptance as a neuroscience and professional discipline. It has become a major responsibility of the neuropsychologist to conduct assessment (Perez-Arce, 1999). Neuropsychological assessment has grown from being
used only for diagnostic purposes in a clinical setting to being an integral part of treatment evaluation as well as a major source of contribution to research in the field of neuroscience (Anderson, 2001). Although a neuropsychological assessment does not consist of tests only, neuropsychological tests form an integral part of the assessment process as they are uniquely sensitive to different patterns of impairment that are associated with different disorders and damage to different areas of the brain (Anderson, 2001). It is important that neuropsychologists understand the complex interplay of biological, socio-cultural, cognitive, and other variables that may affect individuals’ performance on neuropsychological tests if they are to work effectively with individuals from diverse backgrounds. Quality of education is proposed as one such variable.

THEORETICAL BACKGROUND

Norm-referenced tests

Most of the tests used in neuropsychological assessment are norm-referenced tests. This means that the raw scores obtained during the test are interpreted by comparing the individual’s score to the scores of a group of test takers (Cohen & Swerdlik, 2002). Therefore, the individual’s performance is only understood relative to those scores obtained on the same test by a relevant population. The individual’s raw score, therefore, is essentially meaningless. Meaning is only found by comparing the individual’s score to those of a norm group. Norms are established by administering a particular test to a defined, representative sample of test takers in a process called standardisation. The range of performances is plotted on the normal curve, and norms are calculated based on this range (Cohen & Swerdlik, 2002). Thus, the evaluation of an individual’s performance is dependant on a comparison with a norm group’s performance. If the assessment is to yield valid and meaningful information, it is crucial that the particular person is compared to an appropriate norm group (Anderson, 2001). The interpretive validity of neuropsychological test results can be maximised through the development and use of demographically-specific norms (Anderson, 2001). Further, the criteria that define norm groups need to be researched in order to facilitate fair testing.

That is to say, it needs to be understood which factors, other than cognitive ability, most greatly affect an individual’s performance on neuropsychological tests, so that norms can be developed based on those factors. In South Africa, there is a severe lack of demographically appropriate norms for many populations assessed by neuropsychologists; thus, many neuropsychologists in South Africa rely on imported norms (Anderson, 2001). Anderson (2001) argued that this diminishes the validity of neuropsychological assessment in the South African context and represents a limitation to the growth of the field of neuropsychology.
Cross-cultural neuropsychological assessment

It is now widely considered among clinicians that neuropsychological assessment is not a one-size-fits-all practice (Lamberty, 2002). However, it must be noted that the field of neuropsychology has developed out of a modernist epistemology that emphasises positivism and linear causal thinking (Perez-Arce, 1999). These scientific values shaped the early premises of neuropsychology as a discipline to posit a direct, unencumbered link between the neurobiological brain, cognitive processes, and behaviour. Thus, assessment measures that were thought to be ‘culture free’ were promoted as being the most valid and reliable methods for neuropsychological assessment of an individual’s cognitive capacities and predicting his or her adaptive behaviours. Later researchers, however, began to assert the role of culture in influencing cognitive abilities (Bedel, Van Eeden, & Van Staden, 1999; Brickman, Cabo, & Manly, 2006; Greenfield, 1997; Nell, 2000; Perez-Arce, 1999) and theorists are now becoming increasingly aware that there is a complex interplay of cognitive, personality, and socio-cultural factors that affect an individual’s performance on neuropsychological tests (Bedel et al., 1999; Brickman et al., 2006; Greenfield, 1997; Nell, 2000).

A focus on within-group variation, level of education, and quality of education

A focus on culture fair assessment in the field of neuropsychology has resulted in much research being done to investigate factors, other than cognitive ability, that might influence an individual’s performance on neuropsychological tests. There has also been a shift away from focusing on the contribution of culture per se to an awareness of the importance of within-group variation (Byrd, Sanchez, & Manly, 2005). Culture can no longer be considered an homogenous construct, and researchers and clinicians have started to evaluate other socio-demographic variables that may affect an individual’s performance on neuropsychological tests.

Some researchers have investigated the effect of level of education in years on neuropsychological test performance and found it to be highly influential (Dick, Teng, Kemplar, Davis, & Taussig, 2002; Manly, Byrd, Tourdaji, & Stern 2004; Ostrosky-Solis, Ramírez, & Ardila, 2004; Ostrosky-Solis, Ramírez, Lozano, Picasso, & Velez, 2004). However, other researchers have found that level of education cannot be linked directly to an individual’s performance on neuropsychological test and that level of education has an uneven contribution to neuropsychological test performance (Levav, Bartko, Freund, & Mirsky, 1998; Ostrosky-Solis, Ardila, & Rosselli, 1999). Nell (2000) asserted that an individual with 12 years of education from an under-resourced rural school cannot be compared to an individual with the same number of years of education from a well-resourced urban school – even in the same country. That is to say, educational institutions differ greatly in terms of the...
quality of education they provide. This is especially true in the South African context, due to the legacy of apartheid as well as vast demographic differences in terms of opportunities, resources, and facilities (Skuy, Schutte, Fridjhon, & O’Carroll, 2001).

During the apartheid era, the education of black and white South Africans differed greatly. The education of black South Africans was organised by the Department of Education and Training (DET), which had different syllabi and examinations to those of private schools and white, Government schools (Model C schools, as they were referred to). The private and Model C schools were modelled on the British public school system and were of a high standard, whereas the DET schools were of a lower standard owing to lack of resources, which resulted in poorer facilities, high student-to-staff ratios, under qualified staff, and lack of materials, such as desks, books, and writing materials (Shuttleworth-Edwards et al., 2004). Although the apartheid government has been abolished, its legacy lives on in the difference in the quality of education offered by former DET schools and the more privileged private and Model C schools (Kahn, 2004; Motala, 2006; Skuy et al., 2001).

This difference is still reflected today especially in the Grade 12 results produced by the different types of schools, especially in the subjects of mathematics and physical science (Kahn, 2004). Therefore, it may be more useful to examine the variable quality of education, rather than level of education in years, when investigating factors that may influence neuropsychological test performance in order to improve test specificity specifically in the South African context (Byrd et al., 2005; Johnson, Flicker, & Lichtenberg, 2006; Manly, Jacobs, Tourdaji, Small, & Stern, 2002; Manly et al., 2004).

Some researchers have used reading level as a variable to operationalised quality of education and found that it has a stronger relation to neuropsychological test performance than level of education in years (Byrd et al., 2005; Johnson et al., 2006; Manly et al., 2002; Manly et al., 2004). In a South African study that investigated the relationship between quality of education and neuropsychological test performance, Shuttleworth-Edwards et al. (2004) investigated the cross-cultural influences on individuals’ performance on Wechsler IQ tests. They studied Wechsler Adult Intelligence Scale II (WAIS-II) test performance in a South African sample stratified in terms of language, level of education, and quality of education, operationalising quality of education based on the type of school participants had attended. Participants who had attended former DET schools, represented the lower quality of education group, while participants who had attended private or Model C schools, represented the higher quality of education group. The results showed that although differences were observed between groups in terms of the variables language and level of education, the greatest differences between groups were seen in the variable quality of education. That is to say, the results indicated that a higher quality of education correlated with higher scores on the Wechsler Adult Intelligence Scale III (WAIS-III) despite language and cultural differences. Even in
performance tasks, which are traditionally thought to be ‘culture and education free’, the performance of participants with a poor quality of education was significantly lower than the performance of participants with a higher quality of education. Based on these findings, Shuttleworth-Edwards et al. (2004) concurred with Rosselli and Ardila (2003) in that the procedural factor of test-taking skills, or test-wiseness, has a significant effect on IQ performance over and above pure language ability and crystallised knowledge.

However, Shuttleworth-Edwards et al. (2004) acknowledged that a focus on how quality of education affects individuals’ performance on neuropsychological tests does not imply a denial of other factors that are also influential in this regard. Factors, such as language, quality of communication in the home, parental level of education and occupation, as well as material opportunities, are also important factors affecting neuropsychological test performance that warrant investigation (Shuttleworth-Edwards et al., 2004). Still, Shuttleworth-Edwards et al. (2004) argued that the quality of education that a person receives is most likely to be positively associated with these aforementioned factors, and is a way of categorising these other important factors. Further, the authors argued, while these variables are likely to be highly interrelated, they are unlikely to be completely overlapping in their effects and thus it is preferable to investigate the variable quality of education directly.

The current study aimed to investigate the variable quality of education in terms of neuropsychological test performance, specifically on tests of executive function. Different neuropsychological tests have been developed to assess all cognitive abilities, such as memory, language, visuospatial processing, and executive function. A neuropsychological assessment of an individual will require a battery consisting of different tests of different modalities. Thus, although it is important to examine the effects of factors that might affect individuals’ performance on all types of neuropsychological tests, that was beyond the scope of the current study. Instead of administering a full battery, the current study administered tests of executive function only.

**Executive function**

Executive function represents a higher-order cognitive ability that acts in a supervisory capacity over other cognitive abilities. It is important for everyday problem solving, the ability to plan and strategise goal-oriented behaviour, and other important adaptive behaviours (Banich, 2004). These abilities are necessary in order for a person to respond adaptively in novel situations where he or she must generate and execute a plan of action as well as monitor its effects. Executive functions are also needed in familiar situations where habitual responses must be suppressed in favour of a less familiar, but more adaptive, response (Burgess, 2003). Thus, good executive function implies high impulse control, abstract thinking ability, volition, flexibility, self-monitoring ability and introspection.
It is also thought that executive function plays a crucial role in adaptive social behaviour as it enables an individual to understand how others perceive him or her, to be tactful, and to resist impulsive behaviours in favour of more socially acceptable responses (Banich, 2004). Executive function is crucial for a person to be able to adapt to the demands of society. Tests of executive function were chosen for the present study because important interpretations regarding a person’s ability to function competently in society are often made from the results of such tests. Thus, it is crucial to understand how factors other than cognitive performance may affect individuals’ performance on these tests.

**Education and executive function**

The relationship between the variables level of education and executive function has been explored in some studies. In a study conducted by Klenberg, Korkman, and Lahti-Nuuttila (2001), parental level of education was found to play an important influential role in the level of executive function in young children, with higher levels of parental education being associated with better performance by the participants.

Kempler, Teng, Dick, Taussig, and Davis (1998) examined the effect of education on executive function as measured by the Verbal Fluency Test and found that level of education was a more potent variable than age in predicting performance on this test. These authors found that ethnicity did not appear to affect the overall fluency performance. Loonstra, Tarlow, and Sellars (2001) conducted an investigation into the normative statistics available on the Controlled Oral Word Association Test (COWAT) and found evidence from a number of studies that indicated that COWAT is affected by age, gender, and, most of all, level of education. Waber, Gerber, Turcios, Wagner, and Forbes (2006) found that the fifth-grade children in their study who attended schools in disadvantaged areas had lower levels of executive function than their counterparts who attended schools in privileged areas, and that this negatively affected their performance on standardised tests that are used to evaluate academic abilities. These researchers found that children from low income, poor quality of education schools exhibited problems involving executive functions, and these executive function problems appeared to be related to their performance on standards-based tests.

Van der Elst, Van Boxtel, Van Breukelen, and Jolles (2006) conducted a study with cognitively screened, healthy, Dutch-speaking adults and found that age and education affected performance on the Stroop Word-Colour Test. They found that performance on this measure declined with advanced age and a poor quality of education. Further, these researchers found that education played a mediating role between age and performance by noting that age-related decline was more pronounced in participants with lower levels of education. Plumet, Gil, and Goanac’h (2005) observed similar results in their study using the WCST and the Verbal Fluency Test as measures of executive function with 133 healthy adult women. These researchers, too, found that
executive function declined with age and lower levels of executive function, and that age-related decline was more pronounced in participants with a lower quality of education. The findings of these two studies by Van der Elst et al. (2006) and Plumet et al. (2005) could be explained by the theory of cognitive reserve, which holds that certain aspects of life experiences, such as education attainment, may supply a reserve, in the form of a set of skills or repertoires, that allows some people to cope better with neuropathology or damage than others (Satz, 1993; Scarmeas & Stern, 2003).

This study aimed to investigate the relationship between quality of education, rather than level of education, and performance on neuropsychological tests of executive function. It is important to investigate all of the multiple variables that interact in a complex interplay to influence neuropsychological test performance as an understanding thereof increases the appropriateness and usefulness of the practice of neuropsychological assessment for diagnostic, prognostic, treatment, and recommendation purposes (Lamberty, 2002). It may be necessary to investigate whether there is a relationship between quality of education and neuropsychological test performance in order to establish whether it is appropriate to interpret the performance of individuals from diverse educational backgrounds using the same norms. Understanding the contextual factors that affect individuals’ performance on neuropsychological tests is important for the advancement of the field of neuropsychology in a country that is as culturally diverse as South Africa.

METHODOLOGY

Research design and procedure

The relationship between quality of education and neuropsychological test performance were investigated in this study with a between-groups research design. Four neuropsychological tests of executive function were administered to two groups of 20 learners each, Group A from advantaged, privileged, high quality of education schools, and Group B from disadvantaged, underprivileged, low quality of education schools. The learners exposed to a high quality of education attended two private schools, while the participants exposed to a lower quality of education attended two government schools, with all schools located in the Johannesburg area. The results were compared for statistically significant differences between the mean scores of the two groups on each of the tests.

Each learner was assessed individually by the first author in a private room. Each assessment period took approximately 45 to 60 minutes. The assessment sessions took place before school, after school, and during breaks so as not to disrupt teaching time. The four tests were administered in alternating order so that order effects would not influence the observations. The first three tests selected for the study were the Verbal Fluency Test, the Stroop Test, and the WCST. These tests were chosen because they are the tests that are most commonly used in clinical practice to assess...
executive function. The fourth test used in the study was the Design Fluency Test. Although the Design Fluency Test is less commonly used in clinical practice, it was chosen because it is regarded as a non-verbal measure of executive function, and therefore would traditionally be hypothesised to be ‘culture free’ (Rosselli & Ardila, 2003; Skuy et al., 2001).

The procedures used to score the raw data obtained in the study were those provided by Strauss, Sherman, and Spreen (2006), Trenerry, Crosson, DeBoe, and Leber (1989), and Heaton (1981) for the fluency tests, the Stroop Test and the WCST respectively. The responses were scored by the first author, and 10% of the scoring was checked for accuracy in terms of scoring by an experienced neuropsychologist. The mean raw scores for each group were analysed using statistical procedures.

**Sampling methods**

Cluster sampling was used to obtain the required sample according to the variables level of education in years and gender. The first author approached high schools that met the research criteria of high or low quality of education for assistance. High schools that agreed to participate were given detailed information regarding the rationale of the study as well as the necessary procedures in order to conduct the study, that is to say, how many participants were needed, from which grade, how much time participation would involve, and schedules for assessment. The first author addressed the Grade 11 and Grade 12 learners at each school, providing them with detailed information about the study, stressing that strict confidentiality would be observed. Pupils were invited to participate through motivation letters and consent forms sent home to the parents. Participation was on a completely voluntary basis and those learners who returned signed consent forms were included in the study.

**The schools**

As discussed previously, some studies have used reading level to operationalise quality of education (Byrd et al., 2005; Johnson et al., 2006; Manly et al., 2002; Manly et al., 2004). In South Africa, where there are 11 official languages, however, reading level may not be a useful measure of quality of education. Therefore, the present study operationalised quality of education based on the following criteria as described by Johnson et al. (2006), Nell (2000) as well as Shuttleworth-Edwards et al. (2004), as being factors determining quality of education: Private school or Model C school versus former DET school, staff-to-pupil ratio, teacher qualifications, quality, and accessibility of the library and science laboratory, and access to facilities, such as books, electricity, desks and writing equipment, computers, and the internet.

The two private schools in Johannesburg that agreed to participate in the study represented the high quality of education group. In both schools, class size did not exceed 25 learners. Many staff members at both schools had a master’s degree and doctorate. Both schools had: well-equipped libraries, that were regularly updated
with new material; computer centres, the first school having 50 computers and the second school having 28 computers, as well as access to the internet for learners to conduct research under supervision; and fully functional science laboratories with ample materials and apparatus. The learners had access to books and writing materials, and all desks and chairs were in good working condition. All classrooms at both schools had overhead projectors as well as white boards and chalkboards.

Two government schools in Johannesburg also agreed to participate in the study. Both schools were former DET schools and thus represented the low quality of education group. In both schools, class size ranged from 45 to 60 learners per class. None of the teachers at either school had an honours’ degree, and at one school, some teachers had only obtained diplomas. Neither of the schools had a library, computers, access to the internet, or fully equipped science laboratories. One school had two microscopes, while the other did not have any. At both schools, the science teachers complained that they did not have the necessary chemicals and equipment to teach Grade 12 chemistry. Only one of the schools had electricity. Neither school had overhead projectors and only some classrooms had chalkboards. At both schools, the desks and chairs were mostly broken, and the classrooms were dirty and vandalised.

The participants

Two groups of participants were included in the study: one private school group (Group A) and one government school group (Group B). The two groups were matched for age and gender. Each group consisted of 20 learners, and so there were 40 participants in total. Table 1 presents a detailed description of the demographic characteristics of each group, such as age, home language, parental level of education, and parental occupation, and relevant medical conditions. A discussion of these demographic variables is presented next.

Table 1: Demographic characteristics of participants

<table>
<thead>
<tr>
<th>Demographic characteristics</th>
<th>GROUP A</th>
<th>GROUP B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean)</td>
<td>17 years, 6 months, 10 days</td>
<td>17 years, 5 months, 14 days</td>
</tr>
<tr>
<td>Gender</td>
<td>Male: 10 (50%); Female: 10 (50%)</td>
<td>Male: 10 (50%); Female: 10 (50%)</td>
</tr>
<tr>
<td>Race</td>
<td>White: 15 (75%); Black: 4 (20%); Coloured: 1 (5%)</td>
<td>White: 0 (0%); Black: 20 (100%); Coloured: 0 (0%)</td>
</tr>
</tbody>
</table>
The mean age of the participants in each group was roughly the same with the mean age of Group A being 17 years, 6 months and 10 days, and that of Group B being 17 years, 5 months and 14 days. Thus, the difference in mean age between the two groups was less than a month. The two groups were matched for gender, and each group consisted of 10 males and 10 females. The predominant home language in

<table>
<thead>
<tr>
<th>Home language</th>
<th>English</th>
<th>Xhosa</th>
<th>Zulu</th>
<th>Sotho</th>
<th>Spanish</th>
<th>Tswana</th>
<th>Pedi</th>
<th>Venda</th>
<th>Ndebele</th>
<th>Kgaogelo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15 (75%)</td>
<td>1 (5%)</td>
<td>1 (5%)</td>
<td>2 (10%)</td>
<td>1 (5%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Repeated grades at school</td>
<td>Yes</td>
<td>2 (10%)</td>
<td>8 (40%)</td>
<td>No</td>
<td>18 (90%)</td>
<td>12 (60%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Years in current school (mean)</td>
<td>4.8</td>
<td>4.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parental highest level of education</td>
<td>Uncertain</td>
<td>0 (0%)</td>
<td>4 (20%)</td>
<td>Lower than Grade 12</td>
<td>0 (0%)</td>
<td>7 (35%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grade 12</td>
<td>3 (6%)</td>
<td>8 (25%)</td>
<td>Diploma</td>
<td>0 (0%)</td>
<td>1 (5%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bachelor's Degree</td>
<td>12 (60%)</td>
<td>0 (0%)</td>
<td>Degree</td>
<td>2 (10%)</td>
<td>0 (0%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Honours Degree</td>
<td>2 (10%)</td>
<td>0 (0%)</td>
<td>Master's Degree</td>
<td>3 (15%)</td>
<td>0 (0%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parental occupation</td>
<td>Unemployed</td>
<td>0 (0%)</td>
<td>5 (25%)</td>
<td>Domestic worker</td>
<td>0 (0%)</td>
<td>11 (55%)</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Manual labourer</td>
<td>0 (0%)</td>
<td>3 (15%)</td>
<td>Professional</td>
<td>17 (85%)</td>
<td>1 (5%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>3 (15%)</td>
<td>0 (0%)</td>
<td>Neurological/psychological/ other medical disorders</td>
<td>Yes</td>
<td>0 (0%)</td>
<td>20 (100%)</td>
<td>No</td>
<td>0 (0%)</td>
<td>20 (100%)</td>
</tr>
<tr>
<td>Treated by occupational therapist</td>
<td>Yes</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>20 (100%)</td>
<td>No</td>
<td>0 (0%)</td>
<td>20 (100%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Currently taking prescription medication</td>
<td>Yes</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>20 (100%)</td>
<td>No</td>
<td>0 (0%)</td>
<td>20 (100%)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Group A was English, with 75% \((n = 15)\) of the participants speaking English as a home language. In Group B, none of the participants spoke English as a home language. The predominant home languages in Group B were isiZulu and isiPedi, with 25% \((n = 5)\) of the participants in Group B speaking each of these as home languages.

The groups were disparate in terms of whether each participant had ever repeated a grade at school or not. In Group A, only 10% \((n = 2)\) of participants had ever repeated a grade at school, whereas in Group B, 40% \((n = 8)\) of the participants had repeated a grade at school.

The groups were comparable in terms of the number of years each participant had spent in their current school. In Group A, the mean number of years spent in the current school was 4.8 years, while in Group B, the mean number of years spent in the current school was 4.3 years. All participants who had attended another school prior to attending the current school had previously attended schools of a similar quality of education.

The parents of the participants in Group A had higher levels of education than the parents of the participants in Group B. In Group A, 60% \((n = 12)\) of the parents had a bachelor’s degree, 10% \((n = 2)\) had an honours degree, and 15% \((n = 3)\) had a master’s degree. None of the parents in Group A had a level of education lower than Grade 12. In Group B, however, 35% \((n = 7)\) of the parents had not obtained a Grade 12 certificate, 25% \((n = 8)\) had obtained a Grade 12 certificate and only one parent had a tertiary qualification, namely, a diploma. None of the parents in Group B had obtained university degrees. There was also a higher level of unemployment among the parents in Group B than in Group A with 25% \((n = 5)\) of the parents in Group B being unemployed while no parent in Group A was unemployed. In terms of medical history, none of the participants in Group A or Group B reported any history of neurological, psychological or other serious illness. No participant in the study had ever sustained a serious head injury, experienced seizures, nor was any participant on chronic medication.

**Measurement instruments**

Four tests of executive function were used, namely: the Verbal Fluency Test, the Design Fluency Test, the Stroop Test, and the WCST.

**Ethics**

Most of the participants in the study were legal minors, so issues of informed parental consent were taken into consideration. Consent forms were sent home to the parents, and signed consent forms for each participant were collected prior to each assessment session. Confidentiality was discussed on three occasions: when the first author addressed the learners as a group for recruitment of participants; in
the motivational letters sent home; as well as at the beginning of each assessment session. As all the learners were either in Grade 11 or Grade 12, sensitivity to syllabus demands and minimal disruption to the learners was emphasised. Thus, the research procedure was designed in such a way as to assess learners before, between, or after classes so that they would not miss any important teaching time. Participants were informed that they were at liberty to withdraw from the research at any time. One participant from Group A chose to withdraw after two tests were administered as he was pressured to fulfil other sporting and cultural activity obligations and did not have time to complete participation.

**RESULTS**

The aim of this study was to investigate the relationship between quality of education and learners’ performance on neuropsychological tests of executive function. This was done by assessing two groups, one with a high quality of education (Group A) and one with a low quality of education (Group B), on four neuropsychological tests of executive function. The mean scores of each group were compared and analysed for statistically significant differences between means.

Firstly, tests of normality were applied in order to assess whether the data obtained follow the normal distribution curve or not. Tests of normality that were applied were the Kolmogorov-Smirnov Test and the Shapiro-Wilk Test. For the data that followed the normal distribution curve, parametric statistical tests were used, but for data that did not follow the normal distribution curve, non-parametric statistical tests were used. These were the Independent Samples t-test and the Mann-Whitney U test, respectively. The mean performances of the males and females within each group were also compared and analysed for significant differences between means in order to control for gender effects.

The results of the tests for statistically significant difference between means show that the means of Group A and Group B are significantly different for all the scoring criteria of all four tests at a 1% level of significance, except for the scores on the Stroop Form C-W Time criterion, where the differences between means are significant at a 10% level, and therefore are not considered statistically significant.

Please see Table 2 overleaf.
Table 2: Results of the statistical analysis for significant differences between means of Group A and Group B

<table>
<thead>
<tr>
<th>Test</th>
<th>Subtest</th>
<th>Group</th>
<th>N</th>
<th>Mean/ Mean Rank</th>
<th>P-value</th>
<th>t</th>
<th>Mann-Whitney U value</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbal Fluency</td>
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Thus, the results indicate that there are highly significant differences between the mean performances of the learners receiving a good quality education, Group A, as compared with the performances of the learners at the disadvantaged school, Group B, with Group A performing significantly better.

**DISCUSSION**

The results obtained from the statistical analysis of the data show that for every score on all four tests administered, that is to say the Verbal Fluency, Design Fluency, Stroop Test, and WCST, there are significant differences between the mean scores of Group A, the private school participants, and Group B, the government school group, with Group A performing significantly better than Group B on each score. The differences observed between the means for all the scores are highly significant on all the tests, on a 0.01 level of significance.

Overall, the results suggest that there is a relationship between quality of education and neuropsychological test performance, particularly tests of executive functioning. It must be emphasised, however, that neuropsychological tests, like all psychological tests, cannot directly measure constructs in the same way that a scale can measure weight or a ruler can measure length (Cohen & Swerdlik, 2002). That is to say, neuropsychological tests can neither directly measure nor give a completely accurate indication of a cognitive function. Therefore, the results do not necessarily suggest that Group A has better executive functioning per se than Group B, only that Group A performed better on the tests of executive function than Group B did. Further, these results do not suggest that quality of education per se is responsible for these differences. Further research is needed to delineate definite explanations for the results obtained in the study. Therefore, it is emphasised that the explanations proposed next are tentative hypotheses based on the available literature.

The results obtained in the study may be due to other socio-cultural variables that could affect performance on neuropsychological tests. As seen in Table 1, Group A and Group B differed significantly in terms of other variables besides quality of education, such as home language, general school performance, parental level of education, and parental occupation. Still, as Shuttleworth-Edwards et al. (2004) noted, quality of education is generally an indication of such variables. According to Shuttleworth-Edwards et al. (2004), an emphasis on the effect of quality of education on neuropsychological test performance does not mean a denial of the effects of these variables. Instead, quality of education can be seen as a meta-factor that often

<table>
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implies these other factors. That is to say, when an individual attends a school that offers a high quality of education, it is most likely that he or she comes from a home where the importance of education is emphasised, the parents themselves are educated, the parents emphasise communication and learning in the home, and the parents are able to provide socio-cultural opportunities for the children. It may be these factors that affected the results obtained in the current study.

The differences observed between the performances of Group A and Group B may be due to the impact quality of education has on test-wiseness as well as its effects on the manifestation of skills that are measured in neuropsychological tests. Millman, Bishop, and Ebel (1965) defined test-wiseness as ‘a participant’s capacity to utilise the characteristics and formats of the test and/or the test-taking situation to receive a high score’ (p. 707). Further, neuropsychological tests measure a person’s functioning and this is often the product of skills learned at school, rather than of innate, or fluid intelligence, as in the case of IQ test performance where there is growing doubt about IQ tests being as uninfluenced by training as has sometimes been claimed (Shuttleworth-Edwards et al., 2004). Many researchers have acknowledged that the abilities assessed in most neuropsychological tests are learned and highly trained, and the way in which they manifest is determined by exposure to Western education (Ardila, 1995; Gasquoine, 1999). Thus, the quality of education a person receives is likely to influence his or her level of skills as measured by neuropsychological tests. Chan, Shum, Touloupolous, and Chen (2008) also argued that culture affects the manifestation of executive function, and thus will affect an individual’s performance on tests of executive function.

Another possible explanation for the differences observed between the two groups may be the effect that environmental factors, such as quality of education, may have on the organisation of the brain itself (Eviatar, 2000). This can be explained by the concept of plasticity, which is defined as the changes that can occur in the physiology of the brain as a result of experience (Banich, 2004). The brain has the ability to change due to environmental input. Quality of education represents such an environmental input that may cause changes to occur in the structure and organisation of the neural pathways in the brain.

The differences observed may also be due to other factors that are often correlated with the quality of education a person receives, such as quality of communication in the home, parental education, and wealth of social opportunities available. Indeed, the two groups differed on these variables (see Table 1 below).

Intrapersonal factors, such as motivation, personality, and general cognitive ability, may also contribute to variations in individuals’ test performances and may have played a role in the differences observed between the two groups in the present study. Personality, emotional state, and motivation may affect a participant’s performance in that they can influence the way in which a participant responds (Lezak, 1995; Vanderploeg, 2000). Since the mentioned environmental, personality,
and biological factors were not controlled for in the current study, it cannot be concluded that quality of education caused the differences observed between the mean performances of Group A and Group B. The possible effects of these factors on the participants’ performance represent a limitation of the study.

It is possible that there may be some relationship between quality of education and learners’ performance on neuropsychological tests of executive function, but it is not clear whether quality of education per se is responsible for the differences observed or whether quality of education is associated with other demographic and personality factors that affect performance. Whatever the reason behind the differences observed is, the results of the study show that the participants from a disadvantaged educational background performed significantly more poorly than the participants from an advantaged educational background.

The implication of these findings is that neuropsychologists cannot appropriately use the same norms to assess the performance of individuals from disadvantaged educational backgrounds as they use when assessing individuals from advantaged educational backgrounds. As Anderson (2001) found in his study, using imported norms that were not developed on a representative norm group can lead to false positives in diagnosis of neuropathology. This means that an individual from Group B in the current study might be misdiagnosed with neuropathy when compared with imported norms, despite being neurologically intact. Such occurrences are likely to reduce the quality of service delivery in the profession of neuropsychology in South Africa. Individuals will not benefit from the inappropriate diagnosis, prognosis, treatment, and recommendation decisions made by neuropsychologists using unrepresentative norms.

**Recommendations**

Based on the results of the study, some recommendations can be made. First, the results clearly indicate that a high quality of education is associated with a better performance on neuropsychological tests of executive function. This suggests that the way in which norms are developed for such tests, and the way in which test scores are interpreted, need to be revised, taking into account quality of education. In addition to revising norms, the nature of the relationship between quality of education and learners’ neuropsychological test performance needs to be further investigated in future research. Recommendations for future studies would be for the current study to be repeated across South Africa with the following modifications: using larger samples, administering an entire neuropsychological test battery, and conducting further investigation into and multivariate statistical analysis of the contributions of socio-environmental, intrapersonal, and demographic variables.
QUALITY OF EDUCATION AND NEUROPSYCHOLOGICAL TEST PERFORMANCE

CONCLUSION

The results of the study have indicated that there is a relationship between quality of education and learners’ performance on neuropsychological tests of executive function. Therefore, it can be concluded that quality of education is a variable that needs to be considered when developing, norming, scoring, and interpreting neuropsychological tests and test results. It is suggested that it is more useful to consider quality of education, rather than culture per se, when considering the appropriateness of neuropsychological tests of executive function and when interpreting test results. It is recommended that more research into the relationship between quality of education and neuropsychological tests be conducted and it is also recommended that neuropsychologists take quality of education into consideration when developing test norms and when interpreting test results.

BIOGRAPHICAL NOTES

Jeanie Cavé completed her master’s degree in clinical psychology at Unisa in 2008. She is currently completing her internship as a Clinical Psychologist at Sterkfontein Psychiatric Hospital.

Kate Grieve is a clinical psychologist (with neuropsychology as area of focus) and has extensive applied and research experience in this field. She was the coordinator of the Masters in Research Consultation Programme at Unisa. She retired at the end of 2007.
REFERENCES


