

Is the Color Trails Culture Free?

Ahmed F. Fasfous^{1,2}, Antonio E. Puente^{1,3,*}, María Nieves Pérez-Marfil¹, Francisco Cruz-Quintana¹,
Isabel Peralta-Ramirez^{1,2}, Miguel Pérez-García^{1,2}

¹*Facultad de Psicología, Universidad de Granada, Spain*

²*Centro de Investigación Mente, Cerebro y Comportamiento (CIMCYC), Universidad de Granada, Spain*

³*University of North Carolina Wilmington, Wilmington, NC, USA*

*Corresponding author at: University of North Carolina Wilmington, Wilmington, NC 28403, USA. Tel.: +1-910-962-3812; fax: +1-910-509-9372.

E-mail address: puente@uncw.edu (A.E. Puente).

Accepted 13 July 2013

Abstract

Increasingly clinical neuropsychology has been addressing the effects of culture on neuropsychological functioning. However, that focus has been on comparing performance on standardized tests across two or more groups, often Hispanic. In this study, Arabic children were tested in Morocco using a “culture-free test,” Children’s Color Trails. Children of different ages and living in rural and urban centers were tested. The results suggest that the Color Trails Test scores from Arab children differed from U.S. norms available. Furthermore, the location of testing and the age of the child were of significance. The role of culture-specific tests was considered.

Keywords: Arab Children; Culture; Neuropsychology; Non-verbal test

Introduction

Culture is a critical issue in neuropsychological assessment, and a number of studies have emphasized the significant effect of culture on neuropsychological assessment (Ardila, 1995, 2005; Greenfield, 1997; Jacobs et al., 1997; Luria, 1976; Ostrosky-Solís, Ramírez, Lozano, Picasso, & Vélez, 2004; Puente & Ardila, 2000; Agranovich et al., 2011). Trying to address this influence, several neuropsychological tests have been developed under the label of “culture fair.” However, most of these tests have only been tested in Anglo-Saxon or Hispanic samples of adults. For this reason, the main objective of this paper is to examine if the Children’s Color Trails Test (CCTT) could be considered as a culture fair test using an Arabic children sample.

Two types of tests can be used in cross-cultural studies—the culture-free test and the culture-specific test. In this study, we utilized the Children’s version of the CCT (D’Elia, Staz, Uchiyama, & White, 1996), which is presented as a culture-free version of the Trail Making Test (TMT A&B; Reitan, 1979). The TMT is one of the most often used neuropsychological tests in the USA (Rabin, Barr, & Burton, 2005) and is sensitive to cognitive impairment (Lezak, 1995; Mitrushina, Boone, & D’Elia, 1999; Reitan, 1979). Research has suggested that culture and language may have an effect on the TMT and the Children’s TMT (Reitan, 1971), perhaps due to the usage of the English alphabetic letters (Dugbartey, Townes, & Mahurin, 2000; Lee, Cheung, Chan, & Chan, 2000; Leon-Carrion, 1989; Mok, Tsang, Lee, & Llorente 2008; Rosin & Levett, 1989). However, in a study using an Arabic Version of the Expanded TMT to compare healthy and brain-damaged adults from Sudan with healthy and brain-damaged adults from the USA, researchers found that the healthy Sudanese group scored similar to the North American brain-damaged group (Stanczak, Stanczak, & Awadalla, 2001).

The CCTT was developed to reduce the effect of the language and culture on the TMT by using numbers and colors instead of numbers and alphabetic letters (D’Elia et al., 1996). The CCTT (Llorente, Williams, Satz, & D’Elia, 2003) is a special version for children that is similar to the Children’s TMT. The CCTT is functionally equivalent to the Children’s TMT in distinguishing the difference between normal children and children with cognitive impairment in different countries, such as Korea (Koo & Shin,

2008) and the USA (Llorente et al., 2003; Williams et al., 1995). The validity and reliability for the CCTT have been reported in different studies (Koo & Shin, 2008; Llorente et al., 2009; Williams et al., 1995).

Literature suggests that multiple variables such as age, gender, and IQ could have an impact on CCTT scores. Several studies show evidence that age is highly correlated with better performance on the CCTT (Koo & Shin, 2008; Llorente et al., 2003; Williams et al., 1995), whereas gender appears to have a smaller effect. Although Williams and colleagues (1995) found that girls were faster than boys in completing the CCTT2 and Llorente and colleagues (2003) found girls were faster in the CCTT1, more recent research has found no significant gender differences in CCTT scores (Mok et al., 2008). Another variable that seems to have an effect on CCTT performance is IQ, in that children with higher IQs tend to be able to complete the CCTT more quickly (Mok et al., 2008; Williams et al., 1995). Recently, in a study conducted among Chinese children from Hong Kong, Mok and colleagues (2008) found that the CCTT was influenced by children's language backgrounds, in that children with Chinese as their dominant language tended to perform better than both English-Chinese bilinguals and children with English as their dominant language.

Although the CCTT is widely used in neuropsychological assessment (Mok et al., 2008; Strauss, Sherman, & Spreen, 2006), only two cross-cultural studies to our knowledge have examined the effect of culture on the CCTT (Koo & Shin, 2008; Mok et al., 2008). Although normative data for the CCTT are provided for North American (Llorente et al., 2003) and Korean children (Koo & Shin, 2008), normative data and cross-cultural studies using the CCTT are not available in the Arab world.

The Arab world consists of 22 countries with more than 300 million inhabitants (League of Arab States, 2011). Clinical neuropsychology is not developed in these countries, and few studies have examined the effect of the Arab culture on the neuropsychological test in children (Sobeh & Spijkers, 2012) and adults (El-Sheikh, El-Nagdy, Townes, & Kennedy, 1987; Khalil, 2010; Stanczak et al., 2001). The aim of this study was to obtain preliminary CCTT data for Moroccan Arab children and also to examine the effect of culture on CCTT performance. We hypothesized that the results of normal Moroccan children ages 7, 9, and 11 will be different from those presented in the manual.

Method

Participants

Participants included a total of 154 school-aged children (76 boys and 78 girls) ages 7, 9, and 11 and from different grade levels were recruited from schools belonging to two different areas in the province of Chefchaouen. The children in the first group were recruited from a school located in the downtown area of Chefchaouen. This group consisted of 78 children (39 boys and 39 girls), including 26 second graders (13 boys and 13 girls), 26 fourth graders (13 boys and 13 girls), and 26 sixth graders (13 boys and 13 girls). The children in the second group were recruited from a school located in the outskirts of Chefchaouen. This group consisted of 76 children (37 boys and 39 girls), including 24 second graders (11 boys and 13 girls), 26 fourth graders (13 boys and 13 girls), and 26 sixth graders (13 boys and 13 girls). According to teachers and parents interviews, all participants were free from any medical problems.

Approval was obtained from the Ethical Committee of the University of Granada (Spain) to conduct the study, and permission from the Delegation of Education in the province of Chefchaouen (Morocco) was obtained to conduct this study in the aforementioned schools. Informed consent was then obtained from a parent of each of the participants.

Instrument

The CCTT (Llorente et al., 2003). The CCTT measures speed of visual attention, sequencing, mental flexibility, and motor function among children ages 8–16. This test consists of two parts—Parts 1 (CCTT1) and 2 (CCTT2). Part 1 (CCTT1) is comprised of a page with 15 randomly arranged numbered and colored circles, with the even numbers printed in yellow circles and the odd numbers printed pink circles. The child uses a pencil to rapidly connect circles numbered 1–15 in sequence. Part 2 (CCTT2) is comprised of a series of colored circles, also numbered 1–15. Each number (from 2–15) is presented twice—once in a pink circle and once in a yellow circle. The child rapidly connects the numbered circles in sequence, alternating between pink and yellow circles. The examiner records the time needed to complete each trial and all errors committed. In this study, completion time for each trial and the interference score ($CCTT1 - CCTT2/CCTT1$) were used as variables for analysis.

Procedure

Initially, the senior author met with the directors of the respective schools to explain the objective and the process of the study. This meeting, as well as all other aspects of the research conducted in Morocco, was done so in Arabic (the native language of the senior

author). Each of the schools' directors verbally agreed (as is the custom) to allow their students to participate in the study. An empty classroom was provided in each school to conduct the study. Participants were then randomly selected from each school's list of students and assent to participate in the study was obtained from each participant (also, the custom). The CCTT was subsequently individually administered to the participants during the academic day. The CCTT was administrated according to the administration guidelines provided by the manual of the CCTT (Llorente et al., 2003). Completion time for each trial was recorded.

Statistical Analysis

Descriptive statistics regarding performance according to age, gender, and location (school) were initially obtained. Student's *t*-test was then used to study gender differences, and a one-way analysis of variance (ANOVA) was used to study age differences. Finally, eight estimated *t*-tests were conducted using the GraphPad software to test differences in CCTT performance between Moroccan and North American children (Llorente et al., 2003) according to age and gender.

Results

Descriptive Data From the Two Forms of the CCTT

Means and standard deviations for CCTT1 and CCTT2 completion time and the interference score were calculated according to age and gender (Table 1).

Table 1. Means and standard deviations of CCTT variables by age and gender

| Age (years) | <i>n</i> | | Time completion CCT1 (<i>M</i> [<i>SD</i>]) | | Time completion CCT2 (<i>M</i> [<i>SD</i>]) | | Interference (<i>M</i> [<i>SD</i>]) | |
|-------------|----------|-------|--|---------------|--|----------------|--|-------------|
| | Boys | Girls | Boys | Girls | Boys | Girls | Boys | Girls |
| 7 | 24 | 26 | 82.9 (30.19) | 78.67 (29.17) | 137.87 (54.40) | 134.56 (47.50) | 0.81 (0.76) | 0.83 (0.75) |
| 9 | 26 | 26 | 59.98 (26.03) | 54.03 (18.79) | 90.99 (30.73) | 87.11 (28.61) | 0.64 (0.50) | 0.70 (0.52) |
| 11 | 26 | 26 | 45.07 (16.19) | 36.75 (12.40) | 73.33 (17.11) | 58.54 (18.19) | 0.77 (0.61) | 0.68 (0.49) |

Table 2. Results of a one-way ANOVA evaluating age differences in CCTT performance

| Variables | 7 years (mean [<i>SD</i>]) | 9 years (mean [<i>SD</i>]) | 11 years (mean [<i>SD</i>]) | <i>F</i> -value | <i>p</i> -value |
|--------------|------------------------------|------------------------------|-------------------------------|-----------------|-----------------|
| CCTT 1 | 80.72 (29.44) | 57.01 (22.68) | 40.91 (14.89) | 38.52 | <0.0001 |
| CCTT 2 | 136.15 (50.43) | 89.05 (29.46) | 65.94 (19.01) | 52.42 | <0.0001 |
| Interference | 0.82 (0.75) | 0.67 (0.51) | 0.72 (0.55) | 0.78 | 0.461 |

Gender Differences

Student's *t*-test was used to examine gender differences in CCTT performance. There was no statistically significant effect of gender on CCT completion time variables. Similarly, no gender differences were found in the interference index.

Age Differences

A one-way ANOVA was used to evaluate differences in CCTT performance according to age. Results indicated a statistically significant influence of age on the completion time of both the CCTT1, $F(2,151) = 38.52, p < 0.0001$, and CCTT2, $F(2,151) = 52.42, p < 0.0001$. No statistically significant age differences were found in the interference index, $F(2,151) = 0.78, p < .461$. A posteriori comparisons (Bonferroni) indicated that children aged 11 faster than children ages 9 and 7 in time completion for both CCTT trials, and no statistically significant differences were found between children aged 9 and 7 (Table 2).

Geographical Differences

Student's *t*-test was performed to evaluate differences in CCTT performance according to the geographical location. Results indicated no significant differences between children from the downtown area and children from the border area in CCTT1 completion time, CCTT2 completion time, or the interference score.

Table 3. Differences between North American children and Moroccan children in CCTT time to completion

| Age | CCTT1 | | | | | | CCTT2 | | | | | |
|-----|--|--|-----------------|---|---|-----------------|--|--|-----------------|---|---|-----------------|
| | American boys (<i>M</i> [<i>SD</i>]) | Moroccan boys (<i>M</i> [<i>SD</i>]) | <i>p</i> -value | American girls (<i>M</i> [<i>SD</i>]) | Moroccan girls (<i>M</i> [<i>SD</i>]) | <i>p</i> -value | American boys (<i>M</i> [<i>SD</i>]) | Moroccan boys (<i>M</i> [<i>SD</i>]) | <i>p</i> -value | American girls (<i>M</i> [<i>SD</i>]) | Moroccan girls (<i>M</i> [<i>SD</i>]) | <i>p</i> -value |
| 9 | 24.42 (11.70) | 59.98 (26.03) | <0.0001 | 22.38 (11.70) | 54.03 (18.79) | <0.0001 | 52.80 (18.90) | 90.99 (30.73) | <0.0001 | 51.95 (21.13) | 87.11 (28.61) | <0.0001 |
| 11 | 21.41 (8.42) | 45.07 (16.19) | <0.0001 | 15.82 (5.05) | 36.75 (12.40) | <0.0001 | 49.27 (19.57) | 73.33 (17.11) | <0.0001 | 35.82 (13.42) | 58.54 (18.19) | <0.0001 |

Cultural Differences

To examine the effect of culture on CCTT performance, the Moroccan data obtained in the present study were compared with the North American data provided in the CCTT manual (Llorente et al., 2003). Results indicated significant differences between groups, in that the American children were much faster than the Moroccan children in completing both trials of the CCTT (Table 3).

Discussion

Normative data for psychological and neuropsychological tests are necessary for appropriate assessment and interpretation. The aim of the present study was to obtain preliminary CCTT data for Arabic children and also to examine the effect of culture on CCTT test scores. Results indicated that age has a potential effect on completion time for the two trials of the CCTT. No gender differences were found between boys and girls or between the two geographical areas identified in the CCTT performance.

Despite the CCTT being presented as a culture-free test by its authors, results indicated that completion times of the CCTT1 and CCTT2 for Moroccan children were higher than those provided in the professional manual for North American children (Llorente et al., 2003). In other words, Moroccan children were significantly slower than North American children in completing the two CCTT trials. In applying the North American norms to the Moroccan children (controlling for age and gender), we found all Moroccan children to be in the clinically impaired range; similar results were found when comparing the normally developing Moroccan children with North American children who have learning disabilities, mild neurological conditions, or learning disabilities with attention deficits (Llorente et al., 2003; Williams et al., 1995). These findings are consistent with those of Stanczak and colleagues (2001), who found that normal Sudanese adults perform similar to North American patients with brain damage on the Expanded TMT. The significant difference in CCTT performance between Moroccan and North American children as demonstrated in the present study may be due to the effect of cultural factors on cognitive functions; in other words, the test itself may not be truly “culture-free.” Differences in the degree of importance placed on time in the Moroccan and North American cultures may have also impacted these differences in performance, particularly given that the CCTT is a timed test. In other words, American children may be more exposed to living with time constraints in their culture when compared with Arab children, who may not have received such exposure. Additionally, the educational system in Morocco is generally more flexible with time than is the American educational system. For example, Moroccan teachers design the day’s schedule according to the ability of children in understanding the subjects; also, more time is often given to Moroccan children during their exams. Furthermore, the American culture may be more competitive in nature than the Arab culture. This may be the case in other cultures as well. A study conducted by Agranovich and Puente (2007) suggested that American adults performed better than Russian adults on the CCT and other timed tests due to the familiarity of the American participants with timed testing procedures. Another factor which may impact cultural differences may be familiarity with standardized testing and/or with this type of test. In fact, most of the children who participated in this study have not been exposed to testing. Some research has in fact indicated that familiarity with tests could be a cultural factor that has an effect on neuropsychological test performance (Ardila, 2005; Puente & Perez-Garcia, 2000).

Age had a significant effect on CCTT performance in the present study, as older age was associated with faster CCTT1 and CCTT2 completion time. This is most likely a result of the normal neurodevelopment in these children, particularly given that this finding is consistent with results from studies in the normative sample as well as in with other cultures (Koo & Shin, 2008; Llorente et al., 2003; Williams et al., 1995). Although previous research has suggested a small effect of gender on CCTT performance (Llorente et al., 2003; Williams et al., 1995), our results did not find any such differences to be statistically significant. This is in contrast with findings reported by Llorente and colleagues (2003), who found that girls complete the CCTT1 more quickly than boys, and also in contrast with those of Williams and colleagues (1995), who found that girls were faster than boys in completing the CCTT2. However, our results are in agreement with those of Mok and colleagues (2008), who found that the CCTT is not influenced by gender.

Finally, it is important to consider that in some variables the magnitude of the differences between the two groups is double. Although there are few studies about cultural differences among children, other studies revealed similar differences to the present results in the Children’s TMT (Leon-Carrion, 1989) and other nonverbal tests (Rosselli & Ardila, 2003). Furthermore, differences between groups should consider standard deviations. Previous research has demonstrated that standard deviations in non-verbal tests are different across groups from different cultures (Rosselli & Ardila, 2003). For example, if the standard deviation of the Moroccans group in the CCTT1 is used, 9-year-old Moroccans children scored 1.36 *SD* less than the U.S. sample. At the same time, when using the standard deviation of American children, the Moroccan group scored 3.03 *SD* less than the U.S. one. We hypothesize that cultural differences may be more robust in children than in adults. This could be because education can reduce such differences (Ardila, Ostrosky-Solis, Rosselli, & Gómez, 2000) or that the interface between culture and development

make differences more likely. This effect can also be seen in the present results. Differences in 11 years old Moroccan and American children are lower than those in 9-year-old groups.

The present study does have several limitations. First, the sample was collected only from the city of Chefchaouen, which is located in northern of Morocco and is generally considered a rural area. The generalizability of these findings to urban children or those living in other areas of the Arab world is not known. Secondly, variables such a socio-economic status and IQ that could conceivably affect CCTT performance were not measured or controlled for in the present study. Finally, this study was conducted among healthy children and does not include a clinical sample.

Nevertheless, this study is the first of its kind to provide data regarding CCTT performance in Moroccan-Arab children. Our results do suggest that cultural factors have an effect on CCTT performance, thus highlighting the need for further development of the CCTT before it is be considered to be truly the culture-free test. These findings also emphasize the need to consider culture-specific tests in clinical neuropsychology. Finally, this study further supports the need to consider culture as important as other demographic variables, such as age and education, in neuropsychological assessment.

Funding

This research is a part of project (Project number: PI18X) that has been carried out with the financial of the *Centro de Iniciativas de Cooperación al Desarrollo (CICODE) - Granada University-Spain*.

Conflict of Interest

None declared.

References

- Agranovich, A. V., Panter, A. T., Puente, A. E., & Touradji, P. (2011). The culture of time in neuropsychological assessment: Exploring the effects of culture-specific time attitudes on timed test performance in Russian and American samples. *Journal of the International Neuropsychological Society*, 17, 692–701.
- Agranovich, A. V., & Puente, A. E. (2007). Do Russian and American normal adults perform similarly on neuropsychological tests? Preliminary findings on the relationship between culture and test performance. *Archives of Clinical Neuropsychology*, 22, 273–282.
- Ardila, A. (1995). Directions of research in cross-cultural neuropsychology. *Journal of Clinical and Experimental Neuropsychology*, 17, 143–150.
- Ardila, A. (2005). Cultural values underlying psychometric cognitive testing. *Neuropsychology review*, 15, 185–195. doi:10.1007/s11065-005-9180-y.
- Ardila, A., Ostrosky-Solis, F., Rosselli, M., & Gómez, C. (2000). Age-related cognitive decline during normal aging: The complex effect of education. *Archives of Clinical Neuropsychology: The Official Journal of the National Academy of Neuropsychologists*, 15 (6), 495–513.
- D'Elia, L. F., Satz, P., Uchiyama, C. L., & White, T. (1996). *Color trails test: Professional manual*. Odessa, FL: Psychological Assessment Resources.
- Dugbartey, A. T., Townes, B. D., & Mahurin, R. K. (2000). Equivalence of the color trails test and trail making test in nonnative English-speakers. *Archives of Clinical Neuropsychology*, 15, 425–431.
- El-Sheikh, M., El-Nagdy, S., Townes, B. D., & Kennedy, M. (1987). The Luria-Nebraska and Halstead-Reitan neuropsychological test batteries: A cross-cultural study in English and Arabic. *International Journal of Neuroscience*, 32, 757–764.
- Greenfield, P. M. (1997). You can't take it with you: Why ability assessments don't cross cultures. *American Psychologist*, 52 (10), 1115–1124.
- Jacobs, D. M., Sano, M., Albert, S., Schofield, P., Dooneief, G., & Stern, Y. (1997). Cross-cultural neuropsychological assessment: A comparison of randomly selected, demographically matched cohorts of English and Spanish-speaking older adults. *Journal of Clinical and Experimental Neuropsychology*, 19, 331–339.
- Khalil, M. S. (2010). Preliminary Arabic normative data of neuropsychological tests: The verbal and design fluency. *Journal of Clinical and Experimental Neuropsychology*, 32 (9), 1028–1035.
- Koo, H. J., & Shin, M. S. (2008). A standardization study of Children's Color Trails Test (CCTT). *Journal of the Korean Academy of Child and Adolescent Psychiatry*, 19, 28–37.
- League of Arab States: Central Agency for Public Mobilization and Statistics. (2011). *Arab countries, figures and indicators* (3rd ed.). Retrieved from <http://www.arableagueonline.org>.
- Lee, T. M. C., Cheung, C. C. Y., Chan, J. K. P., & Chan, C. C. H. (2000). Trail making across languages. *Journal of Clinical and Experimental Neuropsychology*, 22, 772–778.
- Leon-Carrion, J. (1989). Trail making test scores for normal children: Normative data from Spain. *Perceptual and Motor Skills*, 68, 627–630.
- Lezak, M. D. (1995). *Neuropsychological assessment*. New York: Oxford University Press.
- Llorente, A. M., Voigt, R. G., Williams, J., Frailey, J. K., Satz, P., & D'Elia, L. F. (2009). Children's color trails test 1 & 2: Test-retest reliability and factorial validity. *The Clinical Neuropsychologist*, 23, 645–660.
- Llorente, A. M., Williams, J., Satz, P., & D'Elia, L. F. (2003). *Children's color trails test-professional manual*. Lutz, FL: Psychological Assessment Resources.
- Luria, A. R. (1976). *Cognitive development, its cultural and social foundations*. Cambridge, MA: Harvard University Press.
- Mitrushina, M. N., Boone, K. L., & D'Elia, L. (1999). *Handbook of normative data for neuropsychological assessment*. New York: Oxford University Press.
- Mok, N., Tsang, L., Lee, T. M. C., & Llorente, A. M. (2008). The impact of language on the equivalence of trail making tests: Findings from three pediatric cohorts with different language dominance. *Applied Neuropsychology*, 15, 123–130.

- Ostrosky-Solis, F., Ramírez, M., Lozano, A., Picasso, H., & Vélez, A. (2004). Culture or education? Neuropsychological test performance of a Maya indigenous population. *International Journal of Psychology, 39*, 1, 36–46.
- Puente, A. E., & Ardila, A. (2000). Handbook of cross-cultural neuropsychology. In E. Fletcher-Janzen, T. Strickland, & C.R. Reynolds (Eds.), *Neuropsychological assessment of Hispanics* (pp. 87–104). New York: Plenum Press.
- Puente, A. E., & Perez-Garcia, M. (2000). Handbook of multicultural mental health. In I. Cuellar, & F.A. Paniagua (Eds.), *Neuropsychological assessment of ethnic minorities: Clinical issues* (pp. 419–435). New York: Academic Press.
- Rabin, L. A., Barr, W. B., & Burton, L. A. (2005). Assessment practices of clinical neuropsychologists in the United States and Canada: A survey of INS, NAN, and APA division 40 members. *Archives of Clinical Neuropsychology, 20*, 33–65.
- Reitan, R. M. (1971). Trail making test results for normal and brain damaged children. *Perceptual and Motor Skills, 33*, 575–581.
- Reitan, R. M. (1979). *Trail making test. Manual for administration and scoring*. Tuscon, AZ: Reitan Neuropsychological Laboratory.
- Rosin, J., & Levett, A. (1989). The trail making test: Performance in a non-clinical sample of children aged 10 to 15 years. *South African Journal of Psychology, 19*, 14–19.
- Rosselli, M., & Ardila, A. (2003). The impact of culture and education on non-verbal neuropsychological measurements: A critical review. *Brain and Cognition, 52* (3), 326–333. doi:10.1016/S0278–2626(03)00170–2.
- Sobeh, J., & Spijkers, W. (2012). Development of neuropsychological functions of attention in two cultures: A cross-cultural study of attentional performances of Syrian and German children of pre-school and school age. *European Journal of Developmental Psychology, 2012*, 1–19. doi:10.1080/17405629.2012.674761
- Stanczak, D. E., Stanczak, E. M., & Awadalla, A. W. (2001). Development and initial validation of an Arabic version of the Expanded Trail Making Test: Implications for cross-cultural assessment. *Archives of Clinical Neuropsychology, 16*, 141–149.
- Strauss, E., Sherman, E. M. S., & Spreen, O. (2006). *A compendium of neuropsychological tests: Administration, norms, and commentary* (3rd ed.). New York: Oxford University Press.
- Williams, J., Rickert, V., Hogan, J., Zolten, A. J., Satz, P., D'Elia, L. F., et al. (1995). Children's color trails. *Archives of Clinical Neuropsychology, 10*, 211–223.