

Title: Comparison of performance of concussed and non-concussed individuals on Subtest VIII of the C-RTT.

Abstract

The purpose of this study was to investigate auditory comprehension in concussed and non-concussed individuals using Subtest VIII of the C-RTT. Thirty non-concussed individuals were matched as closely as possible on gender, age, education and history of concussion to a group of concussed individuals. A Mann-Whitney found that the two samples were significant different at $p = .020$, and a t-test found a significant difference at $p = .008$ on the Efficiency Score (ES) of Subtest VIII. The non-concussed individuals performed better than the concussed individuals. Efficiency Score may be useful in assessing comprehension in concussed individuals.

Summary

Sport-related concussion has received increased attention over the past decade. Although this has been most evident within professional football, concussion is a serious health issue in school-aged student-athletes. The Centers for Disease Control and Prevention estimate that between 1.6 and 3.8 million sporting concussions occur each year in the United States (CDC webpage www.CDC.gov). Determining when an athlete with concussion can return to play is important in the context of preventing further disruption/damage to the brain. Assuming the athlete is properly cared for and he or she is withheld from game and practice situations, the next important decision is determining when the athlete can safely return to the classroom. The metabolic dysfunction that occurs following a mild traumatic brain injury (mTBI) or concussion disrupts the processing of information as well as the physical activity. Not only are cognitive-communicative processes and physical activity impaired, but the excessive exertion of either usually brings on symptoms such as headache, and may also delay the recovery of functions following a concussion.

The clinical assessment of a student-athlete after a concussion should include sufficient information so that decisions can be made about when a student-athlete can return to play, and also return to the classroom. In addition to assessment of memory and new learning, the status of auditory comprehension of spoken messages should be examined. Unfortunately, based upon an extensive search of the literature, there is a paucity of data that speaks to the status of the auditory comprehension following a sport-related concussion.

The Token Test and its various modifications are widely used to assess auditory comprehension of spoken sentences. Norms for children and adults are provided by Gaddes & Crockett (1973); Noll & Lass (1972); Spreen & Benton (1977); and Wertz, Keith & Custer (1971). The Token Test was developed by DeRenzi and Vignolo (1962) as a measure of auditory comprehension in individuals with aphasia. The test is a sensitive measure of auditory comprehension, requiring an individual to point to or manipulate tokens of varying shapes and colors according to spoken instructions. The Revised Token Test (RTT) is a reliable and valid assessment of auditory comprehension, for example in persons with aphasia (McNeil & Prescott, 1978), normal elderly (McNeil, Sung, Pratt, Szuminsky, Kim, Ventura, Fassbinder, Fossett, Doyle & Musson, 2008), and typically developing children (Gallardo, Guardia, Villasenor, & McNeil, 2011). Meyers & Rohling (2004) reported that among a number of different tests they assessed, the Token Test successfully differentiated between mild brain injured adults and a normal control group with a correct classification rate of 98.9% specificity and 90% sensitivity. The Computerized Revised

Token Test (C-RTT) records the accuracy and speed of responding to each linguistic unit that makes up the spoken messages. The program also automatically calculates an Efficiency Score (ES) which is based on a ratio between the number of correct responses and the speed of responding to the spoken messages by the individual. Furthermore, recent research (Pratt, Eberwein, McNeil, Ortmann, Roxberg, Fossett, Szuminsky, Durrant & Doyle, 2006) has shown that the most sensitive of the 10 subtests in the C-RTT is Subtest VIII, which assesses the accuracy and speed of individuals responses to spoken compound and syntactically complex messages (e.g., “Put the small red circle to the left of the large green square”). This subtest is not only sensitive to accuracy and speed of responding, but requires less than ten minutes to present via computer and thus does not add a significant amount of time to the assessment. For these reasons C-RTT Subtest VIII was adopted for assessing the nature and extent of auditory comprehension as measured by the Efficiency Score on Subtest VIII of the C-RTT between concussed and non-concussed student-athletes.

Participants

The records of 30 post-concussion athletes were drawn from the records of the Concussion Management Clinic (CMC) at the University of Texas at El Paso. There were 20 males and 10 females in this convenience sample. These individuals were selected because they had been referred by a physician or Athletic Trainer after sustaining a concussion, and had undergone testing in the CMC. A control sample of 30 non-concussed individuals, 20 male collegiate athletes and 10 female who played intramural and high school sports made up the control group. Individuals in the control group were matched as closely as possible on gender, age, education and history of concussion before being included. None of the individuals within the control group had been concussed within the previous twelve months. To establish the normality of this sample of convenience a Kolmogorov-Smirnoff assessment of normality was done and found not to be significant at $p = .079$. None of the participants had a history of learning or intellectual disability, nor any psychiatric history, brain surgery, brain damage, or history of epilepsy/seizure. This investigation was approved by the Institutional Review Board at the University of Texas at El Paso, project (#79163-5).

Procedure

Subtest VIII of the C-RTT was presented free-field at a comfortable listening level as determined by each athlete. The listening level varied between 45-50db, depending upon the desires of the participant. Ten spoken sentences were presented and the participant responded by moving the mouse from a standard position on the monitor screen to the first object, then clicking and dragging the object to the position requested. The speed and accuracy of the responses were automatically calculated at the end of the subtest, yielding the Efficiency Score (ES) (Eberwein, Pratt, McNeil, Szuminsky & Doyle 2007). Each element in each stimulus item was scored using a multi-dimension scoring system that permitted the assessment of reaction time and accuracy in completion of each task.

Results

Data analysis was carried out using SPSS version 17. Following the establishment of normality of the post-concussion and non-concussed samples a nonparametric and parametric analysis was done to determine if the ES of this control group was statistically different when compared to the matched group of 30 post-concussed composed of 20 males and 10 female athletes. A Mann-Whitney found that the ES of the two samples were significant different at $p = .020$, and a parametric t-test found the ES of the two samples to be significantly different at $p = .008$. The

non-concussed individuals ES was statistically significantly better than the ES of the Concussed individuals on Subtest VIII.

Discussion

Based upon the results of this study the use of the Subtest VIII C-RTT is felt to be adequate to determine the relationship between the ES of a larger group of concussed athletes on the C-RTT. These results provide valuable clinical information. First, a sport-related concussion impacts performance across a number of cognitive-communicative parameters: short-term memory for single printed words and abstract visual forms, short-memory of spoken messages, reaction time, and efficiency of responding. All of these parameters potentially impact athletic performance as well as academic performance. To date recommendations about the return to play and return to classroom are generally made based upon the findings of standardized tests like the ImPACT, which primarily include visual tasks. The addition of Subtest VIII of the C-RTT to the clinical assessment battery permits formulation of recommendations about athletes' auditory comprehension based upon objective assessment of their accuracy and efficiency in following spoken messages.

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