Neurology, Psychiatry and Brain Research 21 (2015) 128–135

Contents lists available at ScienceDirect

Neurology, Psychiatry and Brain Research

journal homepage: www.elsevier.com/locate/npbr

Integration of computers in cognitive assessment and level of comprehensiveness of frequently used computerized batteries

Eleftheria Dede[a,*], Ioannis Zalonis[b], Stylianos Gatzonis[a], Damianos Sakas[a]

[a] Department of Neurosurgery, School of Medicine, Athens National University, Evangelismos Hospital, Athens, Greece
[b] A' Department of Neurology, School of Medicine, Athens National University, Eginition Hospital, Athens, Greece

ARTICLE INFO

Article history:
Received 10 April 2015
Received in revised form 7 July 2015
Accepted 21 July 2015
Available online 8 September 2015

ABSTRACT

Computerized cognitive assessment has become a new trend in neuropsychology as, over the recent years, clinicians have recognized its advantages and several computerized tools have been produced worldwide. Automated test administration and scoring are time-saving and allow examiners to focus on the examinee's behavior during testing. Also, automation standardizes administration procedure, permits for more accurate recording of reaction time, and objectifies scoring. Furthermore its proven sensitivity to cognitive impairment and its applicability with concurrent brain imaging gives a great promise to the investigation of brain function. However various detrimental factors can influence the test results. This fact together with the lack of relative training can deter professionals from opting for this new technique. Another reason is the confusion than can ensue by the plethora of tests and their variations. The present study focused on the latest versions of seven frequently used computerized test batteries in an attempt to outline the cognitive spectrum covered by each one so as to aid clinicians in selecting the most appropriate battery for their purposes.

Contents

1. Introduction

Since the first report of the brain in an Egyptian papyrus by Edwin Smith (1700 B.C.) until Alcmaeon and Hippocrates who systematically connected the brain with behaviour and developed the so called cerebrocentric theory, which is consequently supported by experimental findings by Gross (1998), we are today in a position to discuss how technology can facilitate the assessment of cognitive functions. Indeed computers have many advantages and perspectives over traditional assessment methods but there are also issues that must be taken into account by those who develop and use computerized tools. This article attempts to summarize all the advantages and shortcomings of computerized tools so as to assist in the correct choice by clinicians interested in employing this new development. In addition, due to the large number of available computerized test batteries and their multiple versions in several cases, a table is presented displaying the contents of the latest versions of seven most popular batteries with the intention to assist furthermore in the clinician's choice. Finally,

* Corresponding author at: Department of Neurosurgery, School of Medicine, Athens National University, Evangelismos Hospital, Athens, Greece, 45-47, Ipsilantou Str., 106 76, Athens, Greece.
E-mail address: Edede@med.uoa.gr (E. Dede).

http://dx.doi.org/10.1016/j.npbr.2015.07.003
0941-9500/© 2015 Published by Elsevier GmbH.

based on the context of the cognitive spectrum, as denoted by the presence of the various tasks in the table, the relevance of each test in detecting certain types of pathology is being made.

1.1. Benefits, usefulness and prospects of computerized assessment

The advent of the micro-computers gave new impetus in the assessment of human behaviour. In the second part of the 20th century, they were first utilized in administration and scoring personality questionnaires and cognitive tests (Butcher, Perry, & Hahn, 2004). Over the years, several researchers highlighted the benefits of computerized testing in comparison to traditional testing based on paper and pencil (Bauer et al., 2012; Butcher et al., 2004; Gualtieri, 2004a; Iverson et al., 2009; Kane & Kay, 1992; Schatz & Browndyke, 2002; Wilson & McMillan, 1991; Woo, 2008). First of all, computerized testing facilitates the clinician's job, as administration and scoring are carried out automatically. This makes evaluation more objective and enables the assessment of larger groups of people by considerably cutting down testing time. Also, it provides automated development of databases that permit direct comparison between clinical groups. Moreover, it is more suitable for repeated evaluations, as it allows for the randomization of stimuli producing alternative forms of the test. Another very important advantage of computer-based testing is that it offers additional measures of performance which are the precise recording of reaction time at millisecond level and type of errors (omission and commission) for all tasks if it is considered necessary. Finally, it is noteworthy that by offering the potential for simultaneous presentations of multiple stimuli, and also, for combination of visual and auditory stimuli, computerized testing permits evaluation of more complex behaviour resembling more to that exhibited in real life.

Clinicians have gradually embraced computerized assessment and applied many instruments on several clinical populations such as dementia, epilepsy, schizophrenia, concussion and paediatrics (Barnett et al., 2010; Schatz & Zillmer, 2003; Wild et al., 2008; Witt, Alpherts, & Helmstaedter, 2013). Such instruments were proven very effective in the detection of mild cognitive impairment and lateralization of epileptic focus. According to many experts, computerized testing is better able in assessing subtle cognitive changes, as it is characterized by the precise measurement of reaction time that increases sensitivity (Schatz & Browndyke, 2002; Wild et al., 2008; Witt et al., 2013). Indeed, the measurement of response latency can appear particularly important in the detection of minimal impairment since response accuracy remains at physiological level (Hart et al., 2010). Especially, in concussion and multiple sclerosis, it is considered essential, given that the decline in reaction time has been established as a basic parameter of the cognitive profile (Achiron et al., 2007; Eckner et al., 2011).

Moreover, computerized assessment can find great usage with concurrent brain imaging (EEG, fMRI) as computer software allows for accurate synchronization between stimuli presentation and physical recording. As shown by previous combination efforts there is certainly a higher possibility of extracting further information for brain–behaviour relationships (Gevins & Smith, 2003; Gur et al., 2000; Peterson et al., 2009). A recent study has indicated that fMRI recording is feasible not only for a single task but also for a comprehensive computerized battery (Roalf et al., 2014). In any case, task-specific brain activation patterns give a new promise for better diagnosis and treatment. This is in line with Gordon's view of future medicine of the brain (Gordon, 2007), according to which, brain-related information deriving from multiple scientific fields must be integrated and validated in several clinical populations so as to produce "neuromarkers", which along with "genemarkers" could be included in the Diagnostic and Statistical Manual (DSM-American Psychiatric Association). Further evidence for the demand of combining assessment methods was provided by a recent study, according to which, while people with concussion were not different from controls in working memory performance, they, however, exhibited greater and more expanded brain activation reflecting subtle difficulties in task completion (Dettwiler et al., 2014). Finally, it is notable that computerized testing with simultaneous invasive EEG recording can be proven useful in brain surgery for decision making about extinction or sparing brain areas (Witt et al., 2013).

In the field of neuroimaging, considering that the majority of existing computerized instruments require several movements for the response, there is further challenge for development in order to bypass as much movement as possible, so as to minimize artifacts in electrical signal and echo planar images. Sources of artefacts include all types of muscle activity and physiological processes (Diedrichsen & Shadmehr, 2005; Klass, 1995). Such endeavours would be further useful in the cognitive assessment of people with movement disabilities. For example, a simple switch for only positive responses would be more suitable for these situations compared to more complex devices (touch screen, mouse, keyboard, light pen) and responses requiring intact movement abilities. In fact, a simpler response device would be, also, less dependent on previous experience preserving therefore the reliability of the measurement.

1.2. Basic principles of test selection and deterrent factors

The increasing documentation of utility of computerized assessment has led to test and battery production worldwide (Butcher et al., 2004; Kane & Kay, 1992; Schatz & Browndyke, 2002; Wilson & McMillan, 1991). From very early on, the American Psychological Association (APA) and researchers delved into computerized test development and discerned factors that may impair test quality and established guidelines (Kane & Kay, 1992). After that, several researchers focused on particular detrimental factors expounding them further. For example, Cernich, Brennana, Barker, and Bleiberg, (2007) highlighted computer related sources of errors in timing of stimuli exposition and response latency. In order to preserve the confidentiality of results, they strictly recommended that users should verify compatibility between the testing program, the operating system and the hardware, as well as to ensure the priority of the testing program during execution over other existing programs in the computer. Other researchers examined the effect of familiarity with computers on performance and showed interference (Iverson et al., 2009). Regardless of the specific aspect of focalization, over the years all researchers have stressed the need for establishing psychometric standards. According to Schlegel and Gilliland (2007) the exploration of validity, sensitivity and reliability is crucial in order to determine the level of test usefulness and readiness for wide use, even though it may constitute a direct adaptation of a traditional test into a computerized format.

Despite the increase in the production and utilization of computerized tools over the recent years, the number of applications is disproportionally low in respect to this new method's potential, and in some cases, they are extremely limited (Witt et al., 2013). Certain factors may influence the professionals' decisions about which method of cognitive assessment, traditional or computerized to employ. Rabin et al. (2014) indicated that the adoption of computerized tools was more frequent among younger and newer practitioners, the training of which coincided with the recent blossoming of this field. Also, an older study implicated an inherent computer phobia among professionals (Rosen, Sears, & Weil, 1992). Moreover, it is likely that the plethora of computerized tools and the variations of psychometric studies referred to several versions of them may cause confusion to professionals, thus