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Original article

Computerized Cognitive Tests (CCT) in elderly: A psychometric review

Tests cognitifs informatisés (TCI) pour les personnes âgées : une revue psychométrique

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ABSTRACT

Introduction/aim. – Computerized Cognitive Tests (CCT) play an increasing role in the assessment of elderly cognitive impairment. In this framework, it is important to review the psychometric data of the available CCT in the detection of cognitive decline.

Method. – To analyse psychometric properties of the CCT, the available data concerning reliability and validity indices were considered.

Results. – Only eleven CCT identified with elderly were retained to systematic review. 9 of 11 CCT present some results about their reliability properties; 8 of 11 CCT present results from concurrent validity; only 4 of 11 CCT present data concerning criterion validity; and just 4 of 11 CCT present some results regarding factor analysis.

Conclusion. – There are only a few papers published with well-structured psychometric data (reliability and validity). Some results have important limitations concerning to the adequacy of reliability and validity indices and some of these CCT psychometric properties were not studied yet. Considering these limitations, more research on the CCT is needed, including systematic studies of their psychometric properties, and Item Response Theory should be considered.

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R É S U M É

Introduction et objectifs. – Les Tests cognitifs informatisés (TCI) ont un rôle croissant dans l'évaluation des troubles cognitifs de la personne âgée. Il est donc important de vérifier les résultats psychométriques disponibles des TCI pour la détection du déclin cognitif.

Méthode. – L'analyse des propriétés psychométriques a tenu compte des données disponibles de fidélité et de validité.

Résultats. – Onze TCI pour les personnes âgées ont été retenus et soumis à un examen systématique. Neuf des 11 TCI présentent des résultats sur leur fidélité ; huit des 11 TCI présentent des résultats sur la validité concurrente ; seulement quatre des 11 TCI présentent des données concernant la validité de critère ; et à peine quatre des 11 TCI présentent quelques résultats concernant l'analyse factorielle.

Conclusion. – Peu de recherches ont été publiées avec des données psychométriques bien structurées (fidélité et validité). Les résultats révèlent d'importantes limitations concernant les données psychométriques publiées et réalisées par rapport aux indices de fidélité et de validité. Ainsi, plus de recherches sur les TCI seront nécessaires, y compris des recherches sur leurs propriétés psychométriques. La Théorie de réponse à un item devrait être prise en compte.

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1. Introduction

Computerized Cognitive Tests (CCT; including tests and batteries) provide detailed descriptions of global mental functioning in elderly by checking the status of specific areas. The wealth of these data makes the CCT ideal to obtain a complete picture of neuropsychological functioning and/or subtle changes in specific areas (Zygouris & Tsolaki, 2015). CCT are being applied to older adults with and without cognitive impairment. CCT could be used to screen cognitive impairment, to rate the severity of disorder, monitoring disease progression or to contribute to a differential diagnosis (Woodford & George, 2007).

The term “computerized test” refers to a type of instrument (test) that supports all phases of evidence implementation through a computer such as: presentation of screen instructions, practical examples, items, recording data from a mouse or keyboard, registration of responses, data storage, quote and a report (Prieto, 2010). Currently, the use of computerized systems involves sophisticated operations associated with an integrative interpretation of tests results, the production of reports or even the administration of test items adapted to skills and other characteristics of the person assessed (Butcher, 2013). Computers are used for psychological testing in two ways (Kaplan & Saccuzzo, 2013): to administer, score, and interpret traditional tests and to create new tasks and to measure skills when the traditional procedures fail (e.g. virtual reality).

The main advantages of the psychological computerized tests regarding to paper-and-pencil tests include:

- a more rigorous standardization of stimulus presentation and collection of responses (data), based on a more precise control of the evaluation conditions (Gur et al., 2001; Olson, 2001);
- data collection and processing made easier, as well as the conduction of large-scale studies with lower costs, comparing to the paper-and-pencil tests (Hervey, Greenfield & Gualtieri, 2012);
- a greater accuracy in response time records and processing speed measures (Wild, Howieson, Webbe, Seelye, & Kaye, 2008);
- an integration of complex interpretive algorithms (Urbina, 2014), based most frequently on the Item Response Theory (IRT). IRT comprises generalized linear models and associated statistical procedures (algorithms) that connect observed survey responses to a person’s location on an unmeasured underlying (“latent”) trait (Mellenbergh, 1994). The advantages of IRT “include comprehensive analyses and reduction of measurement error, creation of computer adaptive tests, meaningful scaling of latent variables, objective calibration and equating, evaluation of test and item bias, greater accuracy in the assessment of change due to therapeutic intervention, and evaluation of model and person fit” (Thomas, 2011, p. 291). When a test use Computer Adaptive Testing (CAT) it generates “immediate estimates of examinees’ standings on latent variables and choose subsequent items in a manner that will maximize information. This normally involves administering a slightly more difficult (severe) item when an examinee answers affirmatively and administering a slightly less difficult item when an examinee answers nonaffirmatively” (Thomas, 2011, p.297). So, there is an adjustment of the items difficulty level to the individual characteristics through IRT models by considering the performance measured along the latent variable of the construct (using the one-, two- or three-parameter logistic analysis, which are the difficulty, the discrimination and the guessing) (van der Linden & Pashley, 2000).

Therefore, CCT allow the early detection of cognitive impairment in elderly by examining numerous skills and functions and minimizing the effects of floor (the minimum level of difficulty is inadequate [the floor effect]) and ceiling (the maximum difficulty

level is insufficient [the ceiling effect]) through a standardized format. Psychometric analyses based on the IRT are very useful in this context (Urbina, 2014; Wild et al., 2008).

However, one of the principal criticisms about CCT refers to the lack of adequately established psychometric standards in test development (Wild et al., 2008; Zygouris & Tsolaki, 2015). In this sense, the risk of producing diagnostic errors could be potentially high and poor clinical decisions could potentially arise with poor psychometric properties. Psychometric evidences are important to choose the most adequate CCT for using.

Concerning these issues, the American Psychological Association (see International Test Commission, 2006; Naglieri et al., 2004; Tests American Educational Research Association, American Psychological Association and National Council of Measurement in Education, Standards for educational and psychological testing, 2014) developed guidelines of good practices which provide recommendations to use computerized tests (development and test administration). The American Academy of Clinical Neuropsychology (AACN), the National Academy of Neuropsychology (NAN) (Bauer et al., 2012) and the European Federation of Psychologists’ Associations (EFPA; Evers et al., 2013) established that computerized tests require (as other psychological instruments) normative data and psychometric development to establish validity (e.g. construct, content, criterion, as well as sensitivity and specificity) and reliability (e.g. internal consistency, test-retest, inter-rater) for diagnosis.

As Dede, Zalonis, Gatzonis, and Sakas (2015) pointed out, analysing and comparing the psychometric data from multiple tools are necessary to increase the knowledge in the field of cognitive assessment in elderly. And the choice of a computerized test will depend on the dimensions or domains the clinician will value, the time available and supporting psychometric evidences.

Therefore, the present paper tries to answer Dede et al. (2015) concerns by focusing on the CCT psychometric properties and examining the psychometric evidence reported on studies with elderly.

Such review will help researchers and clinicians to make an informed choice of a CCT when they plan a cognition assessment of the elderly. Furthermore, it will also help moving towards the adoption of well-established and validated tools.

The main objective of the present review is to examine the more widely used and studied CCT (focusing on detection of cognitive decline in aging population) across a set of test criteria.

2. Materials and methods

Given the variety in types of studies, subjects, and data analyses, the following methodology was employed.

First, a systematic literature search was performed up to June 2017 in the databases of ScienceDirect, PsycINFO, PubMed, and Google Scholar. In this search, the following words were used: “computerized test”, “elderly”, “dementia” “cognitive deficit”, “neuropsychological”, “computerized battery”. The list of references from empirical papers and reviews on this topic was screened to detect other studies, which might not appear in the electronic search. After excluding the exact duplicate papers, another search was conducted based on the name of each CCT and in this second search only psychometric studies of the CCT were found by using the following words: “reliability”, “validity”, “factor”, “analysis”, “normative data”. Eleven CCT for elderly were retained, which included 28 papers to review.

According to the American Educational Research Association, the American Psychological Association, and the National Council of Measurement in Education (2014) every CCT requires a rigorous psychometric development. Reliability analysis (e.g. the internal consistency, analysed through Cronbach’s alpha, and test-retest

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