
A Quick Test of Cognitive Speed as a Measure of Normal Aging and Aging with Dementia

*Elisabeth H. Wiig¹, Niels Peter Nielsen², Elisabet Londos³
and Lennart Minthon³*

¹Department of Communication Disorders, Boston University, Boston, Knowledge Research Institute, Inc., Arlington, USA.

²Vesterbro-Enghave Psykiatrisk Center, Copenhagen, Denmark.

³Clinical Memory Research Unit, Department of Clinical Sciences Malmö, Lund University, Sweden.

Abstract

Cognitive speed, defined as perceptual speed plus cognitive overhead resulting from demands on attention, working memory, and set shifting, is required for real-time performance in many domains, including reading and driving. Societal and technological changes and globalization place increasingly greater demands on real-time performance as part of societal expectations. This chapter introduces *A Quick Test of Cognitive Speed (AQT)*, a cognitive processing-speed test for adolescents and adults and integrates the clinical research completed to date.

The design of AQT is first compared with that of other commonly used processing-speed tests (e.g., Stroop Color-Word Test, Trail-Making-Test) to delineate differences in design, outcomes and applications. As a background for the clinical research with AQT, we introduce the theoretical bases for using processing speed to measure the cognitive status of adults, who are aging normally and adults with cognitive impairments that may indicate the onset of dementia. Relationships between AQT cognitive-speed measures and cortical and subcortical activation registered by regional cortical blood flow (rCBF) and functional MRI imaging are presented for normal adults. In normally aging adults, functional imaging during AQT color-form naming indicates that the occipital-temporal-parietal regions are activated bilaterally with concurrent suppression of

activation in the frontal regions of the brain. Regional cortical blood flow (rCBF) images are also presented for adults with mild-to-moderate Alzheimer's disease. In adults with mild-moderate Alzheimer's disease (AD), cognitive speed is significantly reduced and temporal-parietal cortical activation suppressed bilaterally.

In normal child development, cognitive speed increases monotonically with age between 5 and 13-15 years of age, when there is a leveling off. Cognitive speed is reduced in developmental disorders such as specific language impairments (SLI) and ADHD. In normal aging cognitive speed is remarkably well preserved between ages 15 and 95 and decreases by only about 1 second per decade. The statistical characteristics of the AQT color, form and color-form naming tests indicate high test-retest reliability and high sensitivity and specificity values. Performances on the color-form naming tests are moderately associated with WAIS-III Performance IQ and MMSE in neuropsychiatric patients. The AQT processing-speed measures differentiate Alzheimer's disease and dementia with Lewy bodies in the early stages and have been used to monitor treatment of Alzheimer's patients longitudinally. In conclusion, we introduce a screening model for establishing individual cognitive-speed baselines in midlife for potential lifetime monitoring of changes in cognitive status.

Introduction

The *Diagnostic and Statistical Manual of Mental Disorders – 4th Edition (DSM-IV-TM)* (1994) indicates that memory impairments for previously learned materials or for new learning are required symptoms to diagnose dementia, including Alzheimer's Disease (AD). It further states that "Memory may be formally tested by asking a person to register, retain, recall, and recognize information" (p. 134), emphasizing that content-based assessments are required to identify cognitive impairments. Tests of memory for content and verbal learning have thus become accepted standards for screening for and evaluating cognitive impairments characteristic of Alzheimer's disease (Folstein, Folstein & McHugh, 1975; Rosen, Mohs & Davis, 1984; Molloy, Alemayehu & Roberts, 1991; Siegerschmeidt, Mosch, Siemen, Forstl & Bickel, 2002). Content-based assessments of cognition rely heavily on memory for verbal-symbolic content that is predominantly associated with left-hemisphere functions.

It requires a paradigm shift to accept that the progressive cognitive impairments associated with dementia can be identified and monitored with processing-speed tests that do not rely on testing memory for content or verbal learning. Processing-speed tests that require naming of highly familiar visual stimuli can identify deficits in executive functions such as attention, working memory, response inhibition to interference, and mental set shifting (Hick, 1952; Repperger, Jacobson, Walbroehl, Michel & Goodyear, 1985; Stroop, 1935; Teichner & Krebs, 1974; Wiig, Nielsen, Minthon & Warkentin, 2002, 2003, 2005). These tests probe executive functions required for real-time processing speed for visual input in the preclinical or early stages of the disease process (Salthouse, 1991, 1992, 2004). The Stroop Color-Word Test is the classical example of a processing-speed test (Stroop, 1956) and it has a long history that has established its power to identify deficits in response inhibition, an executive function disorder associated with pre-frontal lobe lesions (Vendrell, Junque, Pujol et al., 1995)

Processing-speed deficits for visual input are increasingly reported to be among the significant characteristics of both developmental neuropsychological disorders and