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Neuropsychological assessments of cognitive aging in monolingual and bilingual older adults

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A R T I C L E I N F O

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A B S T R A C T

Standardized neuropsychological tests are routinely used as diagnostic criteria in aging populations and are an important piece of evidence for the identification of clinical pathology and neurodegenerative conditions such as Alzheimer's disease. Tests include such measures as the Mini Mental Status Exam, Delis-Kaplan Executive Function System, Montreal Cognitive Assessment, and others. These tests cover a range of functions including working memory, verbal fluency, prospective memory, and task switching. Interpretation of test results is based on comparison of the participant's score to standard scores that have been normed on a population database. However, a growing body of research has shown that the skills underlying these tests may be significantly different in monolingual and bilingual older adults, especially for those experiencing cognitive impairment, yet the standardized test scores do not account for such differences. Therefore, results of neuropsychological tests may be different for bilingual populations than for monolinguals, and those differences may be misinterpreted. The issue is important because the consequences of these interpretative errors may be over- or under-diagnosis of cognitive impairment. The present study examined the neuropsychological test scores of monolingual and bilingual older adults who were experiencing healthy aging or cognitive impairment to establish patterns in these scores that can more accurately guide the interpretation for bilingual older adults by considering group differences in the underlying abilities.

It has become axiomatic to begin discussions of cognitive aging with the observation that there is a significant demographic shift towards an older population. This increase in the aging population impacts all aspects of life and carries enormous consequences for personal well-being and independence, the economic conditions of individuals and societies, and health care resources as they relate to both personal and national priorities. Understanding these aging processes, therefore, is a vital precondition to planning.

Cognitive aging has a special status in the array of factors included in discussions of aging because of its direct relation to the ability of an individual to live independently. Accordingly, there is great interest in discovering approaches to maintaining cognitive function in older age with the hope of delaying or preventing dementia and the neurodegenerative diseases that accompany it. To this end, considerable effort has been placed in developing new pharmacological treatments for dementia in general and Alzheimer's disease (AD) in particular; Zhu et al. (2013), for example, conducted a large-scale multi-site study on

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the effect of two classes of drugs commonly used in the treatment of AD, cholinesterase inhibitors and memantine, and reported moderate success for both in prolonging life. The authors note, however, that the results are not simple in that these effects depended on a wide range of patient characteristics that influenced the outcomes. Moreover, other studies investigating the same two drug therapies have found no benefit in prolonging life. Lopez et al. (2009), for example, studied these same two drug interventions and reported no evidence for differences in life expectancy but did note that there was a delay in time until nursing home admission. Thus, the results of such pharmacological studies are highly variable. Reviews of this literature also show that even when beneficial effects are found, the efficacy of these therapies for prolonging life, including studies of cholinesterase inhibitors and memantine, are modest and typically yield small effect sizes (Massoud & Gauthier, 2010; Rockwood, 2004).

In the absence of an effective and reliable pharmacological treatment for Alzheimer's disease and other dementias, attention has turned to the lifestyle activities that have been shown to maintain cognitive function in older age. These activities, collectively known as cognitive reserve (Stern, 2002), include education, occupational status, socio-economic class, aerobic exercise and involvement in physical, intellectual and social activities (Bennett, Schneider, Tang, Arnold, & Wilson, 2006; Bennett et al., 2003; Stern et al., 1994). However, a major gap in this research is an understanding of the mechanism by which protection due to these activities takes place (Stern, 2012). The two main categories of explanation are based on the notions of brain reserve, in which more resilient brains resist neuropathology (e.g., Landau et al., 2012; Valenzuela, Sachdev, Wen, Chen, & Brodaty, 2008), and cognitive reserve, in which intact brain functions compensate for the activities of impaired ones (e.g., Bennett et al., 2006). This issue remains unresolved, but it is most likely the case that both of these mechanisms or some interaction between them are necessary for effective cognitive reserve (see Stern, 2012; for discussion). The implication is that cognitive reserve activities have consequences for brain structure, brain function, and cognitive performance.

With substantial evidence for the importance of cognitive reserve in the preservation of cognitive function in healthy aging and dementia but little understanding of the mechanism by which this protection takes place, it is important to have a full picture of the types of activities that lead to cognitive reserve. One such activity is bilingualism. Lifelong bilinguals show better cognitive function in older age than comparable monolinguals (e.g., Bialystok, Craik, Klein, & Viswanathan, 2004; Gold, Kim, Johnson, Kryscio, & Smith, 2013; for review,; Baum & Titone, 2014). Many studies with younger adults have not shown these effects (e.g., Paap & Greenberg, 2013), a discrepancy that has been discussed elsewhere (Bak, 2016; Bialystok, in press; Kroll & Bialystok, 2013). However, with a few exceptions (e.g, Kirk, Fiala, Scott-Brown, & Kempe, 2014; Kousaie & Phillips, 2012), the results with older adults are more consistent in their outcome.

More importantly than performance on these tasks, bilinguals demonstrate symptoms of dementia at a significantly older age than monolinguals (e.g., Alladi et al., 2013; Craik, Bialystok, & Freedman, 2010; for review,; Bak & Alladi, 2014). This delay of symptoms is consistent with the notion of cognitive reserve: “Individuals with high cognitive reserve, by definition, will present with disease-related clinical symptoms later than individuals with low cognitive reserve” (Stern, 2012, p. 1009). Moreover, Schweizer, Ware, Fischer, Craik, and Bialystok (2012) demonstrated that for matched groups of monolingual and bilingual patients who had been diagnosed with Alzheimer's disease but were equivalent on all clinical and neuropsychological measures, the bilingual group had significantly more disease pathology than the monolinguals. This, too, is a criterion for the identification of cognitive reserve: “… at any given level of clinical severity in Alzheimer's disease, the degree of pathology will be greater in individuals with higher cognitive reserve than in those with lower cognitive reserve” Stern (2012, p. 1008). By these criteria, therefore, bilingualism satisfies the requirements as a source of cognitive reserve.

The importance of establishing that bilingualism is a source of cognitive reserve is that it shifts the expectations for cognitive performance for groups that have this protection compared to a similar group without reserve. From the perspective of cognitive aging, this is a good thing because it means that higher levels of cognitive function are expected to be maintained with aging in the high reserve group. Thus, bilingual older adults typically outperform monolinguals on a range of cognitive tasks that are generally used to assess executive functioning, such as the Stroop task (e.g., Bialystok, Craik, & Luk, 2008a), and Simon task (e.g., Bialystok et al., 2004, 2005) among others (Baum & Titone, 2014). These tasks typically include conflict or require attending to target information in the context of misleading distraction. However, bilinguals also perform more poorly than monolinguals on verbal tasks, a trend found across the lifespan (Bialystok, 2009), specifically for tasks requiring language production, naming, or fluency (Gollan, Fennema-Notestine, Montoya, & Jernigan, 2007; Gollan, Montoya, & Werner, 2002; Gollan, Montoya, Fennema-Notestine, & Morris, 2005; Kohnert, Hernandez, & Bates, 1998; Roberts, Garcia, Desrochers, & Hernandez, 2002). For this reason, tasks that assess executive function but are based on verbal stimuli show a disadvantage for bilinguals; the same tasks using nonverbal stimuli are typically performed better by bilinguals (Wodniecka, Craik, Luo, & Bialystok, 2010).

From the perspective of clinical diagnosis, however, the situation is more complex. Bilingual patients who perform equivalently to monolinguals on neuropsychological measures that are used for diagnosis turn out to have more advanced disease (Schweizer et al., 2012), meaning that the disease had gone undetected for some time. Therefore, the standard measures used in neuropsychological testing are insufficiently sensitive to small changes in cognitive level from a group of older adults with high cognitive reserve. The situation is complicated by the reliance of many of these tests on verbal ability, an area in which bilinguals are weaker than monolinguals. The combination of possibly better executive function and poorer verbal function may mask indications of cognitive impairment for bilingual older adults.

The problem in using standardized tests that have been normed on monolingual populations for the assessment of bilinguals has been known for a long time in the developmental literature. The clinical issue for children is the difficulty of

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