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Review

The impact of cognitive training and mental stimulation on cognitive and everyday functioning of healthy older adults: A systematic review and meta-analysis

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ABSTRACT

This systematic review and meta-analysis investigates the impact of cognitive training and general mental stimulation on the cognitive and everyday functioning of older adults without known cognitive impairment. We examine transfer and maintenance of intervention effects, and the impact of training in group versus individual settings. Thirty-one randomised controlled trials were included, with 1806 participants in cognitive training groups and 386 in general mental stimulation groups. Meta-analysis results revealed that compared to active controls, cognitive training improved performance on measures of executive function (working memory, $p = 0.04$; processing speed, $p < 0.0001$) and composite measures of cognitive function ($p = 0.001$). Compared to no intervention, cognitive training improved performance on measures of memory (face-name recall, $p = 0.02$; immediate recall, $p = 0.02$; paired associates, $p = 0.001$) and subjective cognitive function ($p = 0.01$). The impact of cognitive training on everyday functioning is largely under investigated. More research is required to determine if general mental stimulation can benefit cognitive and everyday functioning. Transfer and maintenance of intervention effects are most commonly reported when training is adaptive, with at least ten intervention sessions and a long-term follow-up. Memory and subjective cognitive performance might be improved by training in group versus individual settings.

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1. Introduction

Cognitive impairment that does not reach the threshold for dementia diagnosis is not only associated with increased risk for progression to dementia (Fratiglioni and Qiu, 2011; Petersen, 2004; Winblad et al., 2004), but also increased health care costs (Albert et al., 2002), increased neuropsychiatric symptoms (Lyketsos et al., 2002), and increased functional disability (McGuire et al., 2006). Age-related decline in episodic memory, attention, and executive function is reported in both longitudinal (Meijer et al., 2009; Tucker-Drob et al., 2009) and cross-sectional studies (Coubard et al., 2011; Kray and Lindenberger, 2000). Decline in executive function is also associated with impaired functioning in activities of daily living (Royall et al., 2000). The high prevalence of cognitive impairment with advancing age (Plassman et al., 2008), together with rapid demographic ageing, underlines the importance of developing interventions to improve or maintain cognitive function in later life.

Interventions comprising modifiable lifestyle factors, such as cognitive, social, and physical activity, that may reduce the risk of cognitive decline have been gaining increasing interest (Coley et al., 2008; Mangialasche et al., 2012). Of these strategies, cognitive interventions are specifically targeted at improving cognitive performance. In the research literature, cognitive interventions for older adults without known cognitive impairment are delivered either in group or individual settings, and consist of either (i) cognitive training or (ii) general mental stimulation.

Cognitive training comprises specifically designed training programmes that provide guided practice on a standard set of cognitive tasks, aimed at improving performance in one or more cognitive domains (Martin et al., 2011). While a number of randomised controlled trials (RCTs) have shown that cognitive training can improve cognitive performance in healthy older adults (Reijnders et al., 2012), improvements often do not exceed those seen in active control conditions (Martin et al., 2011). Furthermore cognitive training can lack ecological validity, with little evidence of generalizability to everyday cognitive tasks (Papp et al., 2009). In light of these limitations, cognitive interventions comprising general mental stimulation may present a promising alternative.

General mental stimulation refers to interventions that promote increased engagement in mentally stimulating activities. Examples include activities that might be undertaken by individuals as part of daily living; for example, reading, playing music or playing chess. Epidemiological evidence suggests that higher levels of engagement in mental stimulation are associated with lower rates of cognitive decline (Scarmeas et al., 2001; Wilson et al., 2002a, 2002b, 2007), with less decline specifically noted in working memory and processing speed (Wilson et al., 2002b). However most of the evidence to date is correlational and only a limited number of RCTs have examined the efficacy of mental stimulation on cognition. A further difficulty is that either mental stimulation RCT's are not included in reviews of cognitive interventions, or reviews consider cognitive training and mental stimulation as one; making it difficult to determine the relevant effects of either intervention (Papp et al., 2009; Reijnders et al., 2012; Tardif and Simard, 2011).

There are several relevant criteria emerging from the literature that support the efficacy of cognitive interventions. Effective interventions can be considered in terms of improvements in performance on targeted cognitive tasks, maintenance of improved performance over time, transfer of training effects to different tasks within the same cognitive domain (near transfer) or other domains (far transfer), and generalisation of effects to everyday functioning (Klingberg, 2010; Martin et al., 2011). Maintenance; or the temporal durability of training effects after the intervention has ceased, has been reported in several RCTs of cognitive training (Rebok et al., 2007; Reijnders et al., 2012; Verhaeghen, 2000), however evidence for transfer is somewhat limited (Owen et al., 2010; Papp et al., 2009). If transfer is reported, it is often only to untrained tasks within the same cognitive domain (Kueider et al., 2012; van Muijden et al., 2012; West et al., 2000). Generalisation of training effects to everyday functioning is of particular importance if cognitive interventions are to impact older adults' cognition and independence in a meaningful way. Evidence for generalisation is limited however, as cognitive intervention RCT's and reviews rarely include everyday functioning as an outcome measure (Martin et al., 2011).

The aim of this paper is to update the extant literature, and to address shortcomings noted in prior reviews. We examine existing evidence from RCT's of cognitive interventions to determine the impact of both cognitive training and general mental stimulation on the cognitive performance of older adults without known cognitive impairment. We also investigate the potential of cognitive interventions to promote transfer and maintenance of intervention effects, discuss generalisation of cognitive interventions to everyday functioning, and explore whether training in a group has any added benefit over training in individual settings.

2. Methods

2.1. Search strategy

We searched the databases PubMed, Medline, the Cochrane Library, and ClinicalTrials.gov to identify randomised controlled trials written in English and published between 2002 and 2012. Search terms included "cognitive intervention", "cognitive training", "cognitive stimulation", "cognitive rehabilitation", "brain training", "memory training", "mental stimulation", and "healthy elderly", "older adults", "ageing", "cognitive ageing", "cognitively healthy" OR "cognition" (full search strategy, Appendix A). We supplemented database searches with reference lists in review papers, authors' own files, and Google Scholar. We screened titles and

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