Effects of computerized cognitive training

CHAPTER FIVE:

DISCUSSION

This chapter will discuss... it will also discuss its public health significance... and also report strengths and limitations of the review.

5. 1Summary and discussion of the evidence:

5. 1. 1To what extent was the intervention effective?

The overall aim of this study was to investigate the effects of computerized cognitive training aimed at improving cognitive function in individuals at a high risk of developing dementia. The ten trials that have been included in this study are spread widely across different countries. They vary enormously even within each subdomain analysed in terms of sample size, intervention characteristics (overall length of duration, number of training sessions and their frequency) and outcome measures used. Participants were assessed on a number of cognitive outcome measures that were unrelated to the trained tasks, this was necessary to show that cognitive improvement was not task specific as suggested by previous studies (Ball *et al* . 2002). The results from these ten studies suggest that computerized cognitive training is a promising approach for improving cognitive performance in persons with mild cognitive impairment. Participants showed improvements over a wide variety of neurocognitive outcome measures, such as memory, attention, executive function, working memory, visuospatial ability, general cognition and speed of processing. Among these cognitive domains the most consistent improvements across all studies were

observed in visual and verbal memory, attention, and executive function. Improvements in cognitive outcome measures suggests that individuals with MCI, despite cognitive deficit retain significant amount of neuroplasticity (Rosen *et al* . 2011) which makes them responsive to cognitive training.

These findings are consistent with previous studies that demonstrate positive effects of cognitive training on cognitive performance in individuals with MCI (Brum *et al* . 2009; Ball *et al* . 2002; Rapp *et al* . 2002). Previously it has been suggested that training gains are influenced by the frequency and duration of the intervention (Gates *et al* . 2011), however, findings show no difference in training effects among studies with longer duration of intervention and those with smaller duration (Rozzini *et al* . 2007).

The inability to conduct a meta-analysis due to heterogeneity of diagnostic criteria, intervention characteristics and outcomes measured made it difficult to precisely identify which cognitive domains benefited the most from the training.

It has been pointed out several times over the years that unless accompanied by behavioural, psychological or other changes, changes in cognition let alone are not sufficient to justify a cognitive intervention (Woods, 2006). Out of the ten studies included, five studies assessed behavioural, psychological and everyday functional symptoms apart from neurocognitive outcome measures (Gaitan et al. 2013; Gagnon and Belleville, 2012; Finn and McDonald, 2011; Rozzini et al. 2007; Galante et al. 2007). The findings revealed positive effect of the intervention on some aspects of subjective measures of memory. Depressive symptom scores

decreased most consistently. This was followed by reduction in anxiety levels. However, no significant improvements were observed in self-reported activities of daily living or everyday functioning memory. This could be explained by the fact that as individuals were carefully screened out in order to meet criteria for MCI, the participants were not impaired in everyday functional abilities and hence, it was difficult to assess the effect of training in terms of transferability to real world outcomes. No changes in well-being were reported. This is in contrast to the findings by Belleville et al. (2006) which reported positive impact of computerized cognitive training on the participant's feelings of well-being. This can perhaps be explained by the inclusion of pre-training sessions on stress, self-esteem and imagery that were part of the intervention in their study. Despite the importance of quality of life to patients and caregivers, none of the studies measured quality of life. According to Rozzini et al. (2007) although use of cholinesterase inhibitors has also been associated with reduced depressive symptoms, but computerized cognitive training supersedes pharmacological therapy as no negative or adverse effects of training have been found in participants, contrary to adverse effects and high dropout rates reported in drug trials in MCI (Clare et al. 2003).

5. 1. 2To what extent were the effects maintained after the intervention?

Four studies included a follow up assessment ranging between 3 months to a period of 12 months (Gaitan et al. 2013; Herrera et al. 2012; Galante et al. 2007; Rozzini et al. 2007) and one study used a longitudinal design (Valdes et al. 2012) to ascertain if the training gains lasted longer, showed stability over time and hence, could possibly contribute to preventing future cognitive

decline. General cognitive function remained stable up to 9 months post training (Galante et al. 2007); recognition, attention and recall improvements were maintained at 6 months (Herrera et al. 2012); executive function (Gaitan et al. 2013), episodic memory and abstract reasoning (Rozzini et al. 2007) showed improvement trends at 12 month follow up; and effects on speed of processing were maintained at 5 years after the end of the training programme (Valdes et al. 2012). Two studies showed reduction in behavioural disturbances such as depression and anxiety (Gaitan et al. 2013; Rozzini et al. 2007) at a 12 month follow up. Evidence suggests that computerized cognitive training is at least effective in slowing or delaying the progression of cognitive decline and onset of dementia. Moreover, it also suggests that if computerized cognitive training show cognitive gains, these improvements are likely to be preserved at follow up. In summary, computerized cognitive training justifies Swaab's (1991) phrase " use it or lose it" used to explain the relationship between declining neuronal activity and neurodegeneration.

Overall, these results show findings similar to a recent meta-analysis by Li *et al* . (2011) that showed improved overall cognition, domain specific cognitive improvements and positive training effects on follow up in the intervention group after receiving traditional cognitive training.

According to literature, computerized cognitive training has shown to be more effective than traditional cognitive training (Kueider *et al* . 2012), the results from this study suggest that structured computerized cognitive training produce significantly greater benefits in individuals with MCI as compared to those engaged in cognitively stimulating activities only.

Evidence reveals that individuals with MCI that were randomized to intervention group showed larger cognitive gains as compared to active control groups.

5. 2Public health Significance:

With the elderly population of the world increasing rapidly, the numbers of older adults suffering from dementia are bound to rise. With 1 in 3 people above 65 years developing dementia, the number of individuals with dementia are projected to be as high as 135. 46 million in 2050 (Alzheimer's Disease International, 2013). Dementia has several devastating consequences. The economic impact of dementia globally is quite alarming. This has diverted attention not only towards the treatment of dementia itself but also towards preventive therapies specifically aimed at individuals with MCI. In 2007, the average cost of care for a patient with Alzheimer's disease in the United Kingdom was estimated to be around £29, 746 (Alzheimer's Society, 2008). This makes the principles of disease prevention and health promotion particularly relevant to dementia (Geda, Negash and Petersen, 2011). The prevention of a disease involves the identification of groups that are at high risk; MCI indeed, is a high risk state for dementia particularly of the Alzheimer's type (Alzheimer's Disease International, 2013). Individuals with MCI are identified as high risk groups as they are 3 to 5 times more at risk of developing dementia than those without MCI (Alzheimer's Society, 2014).

As findings from this study reveal that many of the cognitive domains retain effects from as low as 6 months up to 5 years post computerized cognitive

training and demonstrate delay in the progression of cognitive impairment. This can have positive implications for public health. This is because according to the Alzheimer's Society (2007) delaying the progression of cognitive decline and hence onset of dementia merely by 5 years would halve the number of deaths that are directly attributable to dementia. It would also reduce the huge economic costs associated with dementia care borne by the carers and the government. In addition, it would also cut down the costs borne by individuals or their carers as computerized approach itself is a cost effective approach as explained earlier.

Growing evidence on the positive effects of computerized cognitive makes it a strong candidate to be on the priority agenda for policy making on tackling dementia in coming years. As demonstrated, much evidence in literature exists highlighting the positive impact of cognitive training on cognitive performance. NICE guidelines (2011) recommend the use of structured cognitively stimulating programmes for individuals with mild to moderate dementia irrespective of the drugs prescribed for the treatment of cognitive symptoms of dementia. Results from this study indicating the potential of computerized cognitive training and other relevant evidence in literature advocates that the use of computerised cognitive training for MCI patients can be included in the clinical practice guidelines. However, for that to be practically useful, there needs to be developed a structured computerised cognitive training service which can be commissioned when needed. Such service should identify in particular the software to be used, the duration and frequency of training sessions and sequencing of training sessions. Kueider *et al* . (2012) highlighted that older adults did not need to be tech savvy in

order to complete and benefit from the intervention. Moreover, these findings could have positive implications as contrary to the old belief that older adults may not welcome the idea of using technology; research suggests that older adults in many cases are the fastest growing users of computer and internet technology (Wagner et al. 2010). Moreover, as mentioned earlier, computerized cognitive training offer flexible and personalized approach as the difficulty level can be adjusted according to the user's performance, hence, keeping it engaging and enjoyable for users.

5. 3Strengths and limitations of the study:

The review was undertaken after a thorough search of literature available around the research question. To the author's knowledge this is the only systematic review to-date that has been conducted on this topic and includes up to date evidence. Another strength of this study is the strict inclusion criteria in terms of study design. Only randomised controlled trials were included in the review. Although there were other relevant studies available having other study designs but according to the Cochrane review guidelines (Higgins and Green, 2011), the author decided to limit the final studies to randomised controlled trials. This helped to decrease bias and increase the methodological quality of the overall review. The author intended to synthesize the results from best available evidence.

Although efforts were made to ensure a transparent and reproducible review, a number of caveats need to be mentioned that might have influenced the results.

5. 3. 1Time frame:

The time frame to conduct a systematic review was extremely limited keeping in view that there was only one researcher carrying out the entire procedure. Maximum time was spent searching through different electronic databases and other sources and reading the abstracts of different articles in an attempt to identify relevant studies. There may be a possibility of selection bias as the selection and screening of studies was done solely by one reviewer. However, in order to minimise such bias, the search and screening of articles was done twice.

5. 3. 2Methodological limitations:

Across the literature on computerised cognitive training common but notable methodological limitations emerge. One of the general limitations of this systematic review was small sample sizes used in majority of the studies. The small sample sizes led to reduced statistical power which may have obscured the detection of potential differences between the groups. Larger groups could have allowed detecting smaller gains in performance.

A second limitation was that several studies lacked an adequate active or placebo control group. Failure to include a proper control group may not only have had an impact on the results but also made interpretation of results difficult as attribution of cognitive benefits could have originated from other sources besides computerized cognitive training. These issues impact on the main aim of the study which was assessing how computerized approaches compare with traditional approaches. Only two studies used an active control group indulged in activities similar to traditional cognitive training (Gaitan et al. 2012; Herrera et al. 2012) making it difficult to directly compare both the

approaches. The review supports findings from previous studies (Sitzer et al. 2006) that intervention groups show larger effect sizes when compared to waitlist instead of active control conditions. Several studies reported inclusion of participants receiving pharmacological therapy (Cholinesterase Inhibitors) raising the possibility that the cognitive gains were not because of the training solely but were a result of the synergistic effect between pharmacological therapy and training.

An important limitation of this study was the scarce availability of data for individuals with mild cognitive impairment despite the relatively large time span covered. Furthermore, although most studies used the Petersen's criteria to diagnose and assess individuals with MCI but modifications in the exact application of this definition existed e. g. the use of MMSE- scores – one of the included studies used MMSE scores ≥ 24 () while one study used MMSE scores of 23 ().

Additionally the heterogeneity of the outcomes measured across studies made cross-comparison difficult but at the same time highlighted the need of developing robust research designs for cognitive training intervention studies.

According to the inclusion criteria, only studies that were randomised controlled trials were to be included. This led to the exclusion of many quasi-experimental studies that were related to the research question and that could have contributed to the results (Talassi et al. 2007; Belleville et al. 2006; Cipriani et al. 2006; Tarraga et al. 2006; Schreiber et al. 1999).

5. 3. 3 Dual vs Single person data extraction:

The Cochrane Collaboration (Higgins and Green, 2011) expects each study included in the review to be data extracted by at least two independent researchers who are blind to the study authors and institution from which the study has been published. This however, was not possible owing to the time limitations and practicality of an MSc degree and therefore, data extraction was carried out by a single reviewer. According to Edwards *et al* . (2002) study screening and data extraction by two or more researchers increases the reliability and accuracy of the systematic review.

5. 3. 4Language limitation:

The requirement of studies being published in English language led to the exclusion of two studies deemed relevant by their abstract as the body of text was published in German and Spanish (Ott-Chervet *et al* . 1998; Fernández-Calvo et al. 2011).

Summary:

This chapter discussed on the results that were generated in the previous chapter. Computerized cognitive training had positive impact on multiple aspects of cognition, including behavioural and psychological symptoms. The effects of training on multiple outcome measures were retained for as less as 6 months to 5 years after the end of the training programme. This showed that the effects of training were not only immediate but also halted cognitive decline. These findings were extremely important from the public health.