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ACTIVE COMMUNITY REINTEGRATION OF GREEK OLDER ADULTS WITH MILD COGNITIVE IMPAIRMENT

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Abstract:
The original research presented in this paper constitutes partial fulfilment of a 15-month study funded by the Partnership Agreement for the Development Framework 2014-2020 (Project title: Translation Prototypes for the Appropriation of Foreign Language Cognitive Disorder Screening Tests and Cross-Scientific Networks of Neuropsychological Intervention; Project code: MIS 5005306). Our main task was to evaluate the activation of mother tongue verbal memory under different non-pharmacological interventions (foreign language learning, workout and computer learning, sleep hygiene and walking) designed for Greek older adults diagnosed with Mild Cognitive Impairment (MCI). Through our research, we aimed at energizing the relevant local market of services so that they broaden their scope and mission and include MCI clients, as the first step of their reintegration in society. The results of our research have shown that the most successful interventions were foreign language learning and computer training, i.e. language use orientated activities. In both cases, speech was the main means of interaction between instructors and trainees and speech was the modality which was measurably improved. In line with recent research, physical activities and sleep hygiene contributed less to the enhancement of the mental lexicon. The benefits from our study are twofold: MCI older adults clearly profit from non-pharmacological interventions; additionally, private sector institutions involved in lifelong education and continuing training may create programmes tailored to meet the needs of this large cognitively able clientele.

Keywords: reintegration, MCI, older adults, non-pharmacological, intervention

1. INTRODUCTION

The ageing of the global population is an inescapable reality faced by professionals in the medical, paramedical, and educational fields. The number of older adults has been augmenting, hence the need for thorough and effective research focusing on senior diseases. Remarkably, oldest adults (aged 80+) are bound to constitute the most increasing population group in the future. According to the World Health Organization (WHO), the demographic transition from young to old population accounts for the rise of neurodegenerative diseases, such as Alzheimer's disease (AD) and other dementia types (WHO, 2006). Dementia has a massive financial impact on patient families and national economies because it is a chronic condition accentuated by the prolonged life of older adults. AD neurodegeneration onset is thought to begin 20-30 years before clinical symptoms onset. During this pre-morbid phase, another condition of subtle cognitive decline, termed Mild Cognitive Impairment (MCI), may occur. MCI usually presents with memory or other cognitive dysfunctions perceived by the individual and the people in their immediate environment. The medical diagnosis for MCI is given following clinical examination that is a medical and a neuropsychological assessment. Most of the time, neuropsychological tests, which focus on various aspects of the cognitive status of the patient, are translated versions of English tests adapted to local languages. After the diagnosis, the patient may join a stimulation programme in order to maintain their cognitive skills level for as long as possible.

The preservation of linguistic abilities is a core issue in dementia (Forbes-McKay & Venneri, 2005) since communication is mainly effectuated through language. The engagement of MCI patients in a systematic second language learning process might enhance their cognitive ageing (Antoniou & Wright, 2017). The targeted training of the brain in the acquisition of new knowledge reinforces and alters neural activity while improving neuroplasticity (Koizumi, 2004). In spite of the age, the brain retains its ability to mould by responding to experiential and environmental factors (Greenwood & Parasuraman, 2010), such as teaching and learning (Goswami, 2014). Nonetheless, it should be clinically proved which combination of such activities and in what time leads to more normal ageing (Stern, 2012). A vast body of scientific research has focused on the potential cognitive benefits of bilingualism against dementia (Calvo et al. 2016). However, foreign language (FL) learning is a more controllable situation than bilingualism: within the FL setting, the quantitative and qualitative exposure of the learners to the FL, the course design and material, along with the frequency and duration of lessons are greatly conditioned by the teacher. The effects of FL on the prevention of dementia are still insufficiently researched.

Physical exercise and mental work are positively correlated and affect cognitive functioning and reaction time in older adults. Research has shown that increased levels of physical activity reduce the risk of cognitive decline (Laurin et al., 2001). Additionally, physical exercise, as a component of a multifactorial intervention, has proved effective in reducing the risk and rate of decline among community-dwelling older adults (Sherrington et al., 2016). A further study has corroborated these findings, giving additional support to the association of physical exercise with dementia syndromes and cognitive decline (Müller et al., 2017).

As regards the positive effects of information technologies on MCI, research has shown that after computer training, improvement in older adult attention and memory of word naming, verbal comprehension and writing skills, social skills, mood, and emotional management has been observed (De Luca et al., 2014). The affordances of technology may also be used for the detection of mild functional changes (e.g. attention, working memory, episodic memory, executive function), which may signal incidence of MCI in older adults, especially those living on their own (Kaye et al., 2016).

Sleep disorders are a common condition in MCI and AD patients (van der Linde et al., 2010). MCI patients who report daily drowsiness at first examination are twice as likely to progress to dementia over the next three years compared to those without somnolence (Foley et al., 2001). McKinnon et al. (2014) were among the first to prove that the circadian rhythms and sleep in MCI patients differ significantly compared to healthy people, in a way similar to the changes noticed in AD. It has been shown that if sleep disorders were identified in the precursor stage of dementia, appropriate therapies could be directly recommended and delay the worsening of the clinical picture and patient function (Guarnieri et al., 2015). Nonetheless, the underlying mechanisms implicated in the effect of sleep on cognitive functions have not been fully clarified, even though specific brain areas appear to be particularly sensitive to the lack of sleep (Durmer & Dinges, 2005). However, there is evidence that sleep improvement interventions can boost verbal memory (Valencia-Flores et al., 1996).

Experimental research has revealed that a predicting factor of early brain dysfunction may be the evaluation of the mental lexicon. The term *mental lexicon* entails the visualised location in the brain of lexical unit representations for words known to the reader. The traits stored in the mental lexicon for each learnt word concern pronunciation, spelling, syllable number, grammatical features, along with syntactic, semantic, and pragmatic information (Coltheart, 2004; Kehayia, 2002, pp. 139-172). The mental lexicon is usually assessed with printed lexical decision tests comprising sight words and non-words. These tests are simple, short, not timed, and not cognitively demanding. Such an example is the Swedish Lexical Decision Test (SLDT) (Alkmvist et al., 2007), which assesses pre-morbidity through the visual perception of single word units. The SLDT was translated and adapted for the creation of a Greek lexical decision test tailored to meet the requirements of Greek pre-morbid seniors. The first SLDT-based Greek translated test (Neofytidou, 2018), henceforth General Lexicon Test (GLT), was generated from an electronic oral speech lexical units mining database of healthy Greek older adults. The database was formulated in 2016 at the Applied Informatics Laboratory of the University of Macedonia, Thessaloniki, Greece, and comprised the recording and processing of word-to-word transcribed healthy senior narrations of their life stories. The participants had spoken about their life and special traits of their daily routine (Neofytidou et al., 2016).

The original research presented in this paper constitutes partial fulfilment of a 15-month study funded by the Partnership Agreement for the Development Framework 2014-2020 (Project title: *Translation Prototypes for the Appropriation of Foreign Language Cognitive Disorder Screening Tests and Cross-Scientific Networks of Neuropsychological Intervention*; Project code: MIS 5005306). Our main task was to evaluate the activation of mother tongue verbal memory under different non-pharmacological interventions, which focused either on cognition or on physical activity and which were designed for Greek MCI older adults. Three intervention types were chosen, namely FL learning (researcher: E.T.), workout and computer learning (researcher: E.N.), and sleep hygiene and walking (researcher: E.K.). Apart from the administration of the GLT, new localised versions of the test were created, which derived from actual specialised language use depending on the experimental condition.

The primary goal of our short-term research was to investigate the possibility of Greek MCI older adult reintegration. We aspired to demonstrate that when MCI seniors are engaged in a new activity, they develop new skills, which they seek to continue, and acquire new specialised vocabulary, from which they benefit cognitively-wise. Moreover, we aimed at suggesting that private sector services be re-designed and initiated with the purpose of including the large clientele of pre-morbid older adults. The needs of this large age group are usually met by various institutions and non-governmental organisations (NGOs); the presence of private sector services is yet to be expected.

2. MATERIALS AND METHODS

2.1 Participants

The experimental participants were recruited from a cohort of volunteers who had expressed their willingness to join one of the aforementioned intervention programmes. They were all community-dwelling, diagnosed with MCI, and had no record of auditory or visual impairment. Baseline cognitive level was determined with the administration of a battery of neuropsychological examinations (MMSE, MoCA, FRSSD, FUCAS, GDS). The research was conducted at the day care units for patients with dementia of the Greek Association of Alzheimer's Disease and Related Disorders, in Thessaloniki, Greece. All seniors signed consent forms to participate in the research sub-study of their choice.

2.2 Foreign language learning intervention

Participants: The experimental group comprised 11 MCI Greek senior educated participants (6 male, 54.5%; 5 female, 45.5%; mean age: 70, SD±5.64; mean years of education: 12, SD±2.57). The participants either had no prior knowledge of English or had taken some lessons when they were young that is four or more decades before. Their EFL competence ranged between the A0 and A1 levels, according to the according to the Common European Framework of Reference for Languages (CEFR, 2001, pp. 22-29). Their performance was compared to a control group comprised by 11 Greek female retired teachers of English as an FL (mean age: 66, SD±6.38; mean years of education: 16.55, SD±0.82). *Course Design:* The MCI seniors were divided into two groups of 5 and 6 people, respectively, and were taught English as an FL for 6 months (October 2018 – March 2019). Each week the participants attended a consecutive two-hour class (total: 44 hours) delivered in the classroom by the first author, who also chose the content of the coursework. The level of English conformed to the A Level of language competence, i.e. basic knowledge (according to the CEFR). *Evaluation:* The experimental group was evaluated three times: at the beginning of the course, three months after the lessons had started, and at the end of the course. Each time, the assessment tools were two: the GLT and a re-translated English version of the test, adapted to the participants' level of English competence. The control group was evaluated on the GLT and a re-translated English version adapted to the B Level of competence (according to the CEFR).

2.3 Physical exercise & computer learning intervention

Participants: The physical exercise experimental group comprised 20 MCI Greek senior educated participants (3 male, 15%; 17 female, 85%; mean age: 73.5, SD±5.9; mean years of education: 10.9, SD±4.68). The computer training experimental group also comprised 20 MCI Greek senior educated participants (4 male, 20%; 16 female, 80%; mean age: 69.75, SD±6.67; mean years of education: 11.35, SD±4.2). Another 20 cognitively healthy older adults were recruited to constitute the control group (3 male, 15%; 17 female, 85%; mean age: 68.1, SD±7.64; mean years of education: 12.75, SD±3.9). *Evaluation:* The experimental groups were assessed on the same test as the control group twice; before joining the training and after 3-4 months of training. Additionally, they were evaluated post-intervention on two specialised versions of the GLT, which were formulated with vocabulary employed during the physical and computer training, respectively. The control group was assessed on the GLT once.

2.4 Sleep hygiene intervention

Participants: A total of 20 MCI Greek senior educated participants (2 male, 20%; 18 female, 80%; mean age: 71, SD±6.65; mean years of education: 10.9, SD±4.12) diagnosed with sleep disorders were included in the study. They all had their medical history taken, with an emphasis on sleep disorders, underwent neuropsychological assessment, and were examined on the modified Pittsburgh Sleep Quality Index (mPSQI) and the GLT. *Intervention:* After the initial evaluation, they were asked to wear an actigraphy monitoring device for 4 days, in order for the researcher to objectively monitor and analyse their sleeping habits. The participants were then divided into two groups of 10 people each. The active control group was given general instructions on a sleep hygiene programme. The experimental group, additionally to the instructions on the sleep hygiene programme, was asked to walk for 30 minutes, 4 days a week. The intervention lasted for 15 days. Upon the end of the fortnight, all of the participants wore the actigraphy monitoring device for another 4 days, were all re-assessed on the mPSQI, the GLT, and were given a specialised version of the latter test, which was formulated with vocabulary employed during the medical history interviews concerning sleep disorders.

2.5 Statistical analysis

Upon the completion of all experimental periods, the data from the scores of all participants on the GLT and its adapted versions were statistically analysed for each intervention separately. Since the sample size was small for all stimulation programmes, the most appropriate statistical tests to use were non-parametric ones, which make no assumptions about the data. The Kolmogorov-Smirnov and the Shapiro Wilk tests were <0.5, designating that the populations were not normally distributed. P values less than 0.05 were considered statistically significant. The analysis was conducted with the SPSS 24.0 (IBM Inc., Armonk, NY) statistical software.

3. RESULTS

3.1 Foreign language learning

The experimental group was evaluated on the GLT and its English-adapted versions three times during the 6-month English language course: at the beginning (pre-), in the middle (mid-), and at the end (post-) of the intervention. The triple evaluation was decided because FL learning is directly related to the development of the mental lexicon. The English course was the only intervention involving systematic natural language teaching and learning, hence the need for more frequent re-assessment (3 time points) and stricter statistical analysis. Additionally, because language learning is a dynamic process, the level of English slightly increased along the course of time, providing an additional staging factor to the intervention.

The repeated measures Wilcoxon Signed Ranks Test showed no statistically significant differences in the pre-mid or the mid-post performance scores on the GLT. However, the participants' performance increased significantly in the pre-post intervention measurement (median=54 vs. median=55, z=2.33, p=0.020). The mean rank before the programme (5.19) was reduced to 3.50 after the programme. A z-score of 2.33 has less than a 2% likelihood of arising by sampling error. We can conclude, then, that the intervention was effective in enhancing the native language mental lexicon.

As regards the English-adapted versions of the GLT, there were not statistically significant differences in the pre-mid performance scores. Nonetheless, the seniors' performance decreased significantly in the mid-post intervention measurement (median=48 vs. median=42, z=2.15, p=0.032). The mean rank in the middle of the programme (3.25) was increased to 6.06 after the programme. A z-score of 2.15 has less than a 2% likelihood of arising by sampling error. We can conclude, then, that the intervention was not effective in enhancing the FL mental lexicon. This could be due to the increased level of lexical units acquired during the second half of the intervention, which formed part of the English-adapted test. Alternatively, the more cognitively demanding the intervention, the better cognitive transfer effects can be observed; in spite of the groups' diminished performance in English, their mother tongue mental lexicon test was significantly improved. The pre-post intervention comparison revealed a statistical trend towards significance without yielding a statistically significant difference (median=48 vs. median=42, z=1.72, p=0.086).

Finally, the post-intervention scores of the experimental group were compared to the control group, both on the GLT and its respective English-adapted versions. The Mann-Whitney Test showed no statistically significant difference on the GLT between the two groups. However, as to the English-adapted versions of the GLT, the Mann-Whitney Test showed that the control group (median=54) significantly outperformed the MCI seniors (median=42). The Mann-Whitney U was found to be 12 (z=-3.22) with an associated probability of 0.001, which shows that the higher ratings of the control group were not due to sampling error. There is evidence, then, to conclude that the high vocabulary competence in English, due to the long-term engagement with FL teaching, is preserved beyond retirement. All results are presented in Table 1:

Table 1: Total median scores on all tests of English intervention

Total scores (median)	General Lexicon Test		English-specialised versions	
	MCI	Controls	MCI	Controls
pre	54		48	
mid	55		48	
post	55	55	42	54
Statistical significance	pre-post p=0.020		mid-post p=0.032	controls > MCI p=0.001
			pre-post p=0.086	

3.2 Physical exercise & computer learning

The physical exercise experimental group was evaluated on the GLT twice during the 4-month intervention (pre-post) and once on its physical-exercise-adapted version post-intervention. The repeated measures Wilcoxon Signed Ranks Test showed no statistically significant difference in the pre-post performance scores on the GLT. A further analysis was performed using Spearman's rho correlation coefficient. The correlation between the GLT scores and its physical-exercise-adapted version was 0.77. Such a strong correlation has only a very tiny chance of arising by sampling error (p<0.001).

The computer training experimental group was evaluated on the GLT twice during the 3-month intervention (pre-post) and once on the computer-adapted version of the test post-intervention. The repeated measures Wilcoxon Signed Ranks Test showed that the participants' performance on the GLT increased significantly in the pre-post intervention measurement (median=54 vs. median=55, z=2.58, p=0.010). The mean rank before the programme (9.35) was reduced to 2.88 after the programme. A z-score of 2.58 has less than a 2% likelihood of arising by sampling error. We can conclude, then, that the intervention was effective in enhancing the mental lexicon.

3.3 Sleep hygiene

All of the participants were evaluated on the GLT twice during the 23-day intervention (pre-post) and once on the sleep-adapted version of the test post-intervention. The repeated measures Wilcoxon Signed Ranks Test showed that the pre-post intervention comparison revealed a statistical trend towards significance without yielding a statistically significant difference (median=53 vs. median=55, z=1.80, p=0.072). A further analysis was performed using Spearman's rho correlation coefficient. The correlation between the scores on the GLT and its sleep-adapted version was 0.46. Such a correlation has a small chance of arising by sampling error (p<0.042).

Table 2: Total median pre-post scores on the GLT of all interventions

General Lexicon Test								
Total scores (median)	English		Physical exercise		Computer training		Sleep hygiene	
	MCI	Controls	MCI	Controls	MCI	Controls	MCI	Controls
pre	54		51.5		54		53	
post	55	55	53.5	55.5	55	55.5	55	
Statistical significance	pre-post p=0.020				pre-post p=0.010		pre-post p=0.072	

Table 3: Total median post scores on all tests of all interventions

Post General Lexicon Test scores vs. Post specialised lexicon tests scores								
Total scores (median)	English		Physical exercise		Computer training		Sleep hygiene	
	MCI	Controls	MCI	Controls	MCI	Controls	MCI	Controls
post GLT	55	55	53.5	55.5	55	55.5	55	
post specialised	42	54	41		39		55	

4. DISCUSSION

The originality of our research lay on the fact that we implemented preventive non-pharmacological interventions which activated the cognition or the physical activity in our MCI participants for the benefit of their verbal memory. The improvement, as it was measured on the GLT and its specialised versions, was statistically significant for the English course and the computer training, because both are cognitively challenging processes. Physical activity and sleep hygiene interventions did not yield statistically significant results because they are related to actions rather than speech and they would be unlikely to activate verbal memory. Our findings are in line with recent research (Wu, 2016) on the mental lexicon and semantic models: brain imaging has shown that the processing of object and action words is neurally separable, as the processing of words from different grammatical categories apparently engages partially distinct neural networks. In general, our results (Tables 1, 2, 3) provide encouraging evidence as to the feasibility of MCI older adult reintegration. Our seniors' performance on tests assessing both the general lexicon and specialised acquired lexicon has shown that they can be actively re-involved in their social environment because they respond to intervention activities. The attendees themselves believe that their participation in such programmes is meaningful and affects their daily routine positively because they are engaged in activities with people in a similar condition, are relieved from inactivity, are socially and emotionally aroused, learn new things, and acquire new habits.

Our study could not be void of limitations its main drawback being the small sample sizes. However, it needed to conform to the EU funded programme constraints within which it was conducted. Another issue to stress was the participants' intervention acquaintance: many of them – concurrently with our research – attended other cognitive stimulation programmes at the day care units, meaning they were trained people. Additionally, they were recruited from a cohort of individuals who are generally open to research, as various experimental studies are conducted at the day care units. Finally, more extensive statistical analyses may have been performed to unveil the correlations among the three intervention types. Nonetheless, we are convinced that this research could be replicated in the future, with larger samples and probably improved paradigms, in order to verify these primary results.

5. CONCLUSIONS

Due to the non-neglectable economic dimension of dementia, the notions of prevention and reintegration as regards pre-morbid older adults acquire greater importance and are still innovative. We thus applied the decision-making structure in order to achieve two goals: initially, to evaluate our experimental research; additionally, to energize the private sector market to collaborate with scientists of other fields towards the reintegration of MCI seniors. Currently, in Greece, MCI older adults may attend various physical, cognitive or artistic stimulation interventions within day care units of institutions or NGOs. However, there are serious limitations as to the services provided in these premises concerning quality, duration, equipment, staff training, accessibility, and availability. It is therefore important that private sector institutions involved in lifelong education and continuing training create programmes tailored to meet the needs of this large cognitively able clientele. Older adults are a vital part of any local market of services that are in a position to attend carefully designed programmes and ameliorate both their mental status and their sociability. Viewed from a different perspective, MCI senior reintegration entails caregiver integration, as well. The social inclusion of MCI older adults would relieve some of their caregivers' burden and alleviate their feelings of exclusion, work-life imbalance, and loneliness.

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