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The effect of motor activity on improved memory and emotional well-being in elderly women.

Influencia de la actividad motora en la mejora de la memoria y del estado de ánimo emocional de mujeres mayores.

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Abstract

This study researches the effect of a wide range of different types of intervention (cognitive versus cognitive + motor versus non-intervention) on the memory and mental state of elderly women complaining of memory loss and leading a sedentary life. Subjects (N=102, 80% women, age M/SD = 76/5 years) were distributed randomly into the three treatment groups. The cognitive training consisted of attention exercises, language, association of ideas and problem solving while the motor training consisted of proprioceptive and dynamic exercises related to the body schema, balance and movement coordination. The duration of the treatment period was 8 months. The Rivermead Behavioural Memory Test (RBMT) and the Yesavage´s Geriatric Scale of Depression (GDS) were applied before and after the treatment period.
Results showed improvements associated with both interventions but deterioration in the control group. However, only the cognitive-motor group showed relevant improvement according to the above-mentioned tests.
Results suggest that combined cognitive-motor intervention is more promising than the simply cognitive in improving memory function and the state of well-being in women who complained of subjective memory loss, and that both techniques are effective when compared with non-intervention.

Key words: ageing; complaints of memory loss; motor activity and cognitive training; mobility.

Resumen

Este estudio investiga el efecto de diversos tipos de intervención (cognitiva versus cognitiva + motora versus no intervención) en la memoria y el estado de ánimo emocional en mujeres mayores con quejas de memoria y con una vida pasiva. Los sujetos (N=102, 80% mujeres, edad M/SD = 76/5 años) se distribuyeron de forma aleatoria en los tres grupos de tratamiento. El entrenamiento cognitivo consistió en ejercicios de atención, lenguaje, asociación de ideas y resolución de problemas. El entrenamiento motor consistió en ejercicios propioceptivos y dinámicos relacionados con el esquema corporal, el equilibrio y la coordinación de movimientos. La intervención se llevó a cabo durante 8 meses. Se aplicaron el Test Conductual de Memoria Rivermead (RBMT) y la Escala Geriátrica de Depresión de Yesavage (GDS) antes y después.
Los resultados demuestran mejorías asociadas a ambas intervenciones y deterioro en el grupo de control. Sin embargo, sólo el grupo de intervención cognitiva-motora muestra una mejoría relevante según las pruebas citadas.
Los resultados sugieren que la intervención combinada cognitiva-motora es más prometedora que la intervención simplemente cognitiva para mejorar la función de la memoria y del estado de ánimo en mujeres con pérdidas de memoria subjetivas, y que las dos son eficaces en comparación con la no intervención.

Palabras claves: envejecimiento; pérdidas de memoria; actividad motora y entrenamiento cognitivo; movilidad.

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Introduction

Complaints of memory loss may reflect a neurodegenerative process due to the mere fact that in aging there is a growing incidence of the disuse of cognitive functions (Weaver Cargin, Maruff, Collie & Masters, 2006); of psycho-affective changes such as depression or anxiety (Comijs, Deeg, Dik, Twisk & Jonker, 2002; Chertkow, 2002; Ritchie, Ledésert & Touchon, 2000); and of non-psychological aspects such as reduced mobility (Inzitari, Carlo, Baldereschi, Pracucci, Maggi, Gandolfo, Boniaturo, Farchi, Scafato, Carbonin, Inzitari & Risk, 2006; Powel-Proctor & Miller, 1982; Ritchie, Artero & Touchon, 2001).

Lack of exercise (Kramer, 1999, 2003) can lead to physical difficulties (Ritchie et al., 2000; Tervo, Kivipelto, Hanninen, Vanhanen, Hallikainen & Mannermaa, 2004) that affect motor activities (such as showering, getting dressed, carrying out domestic tasks in a standing position); to changes in cognitive processes (memory, attention and performance) (Hillman, Belopolsky, Snook, Kramer & McAuley, 2004; Inzitari, Baldereschi, Carlo, Bari, Marchionni, Scafato, Farchi & Inzitari, 2007); and even to cerebral changes (Kramer, 1999). This is also related to processes such as depression (Sonstroem, 1984; Spirduso, 1995), a reduction in social activity (Cape, 1978) and a heavy burden on family caregivers (Burgio, Stevens, Burgio, Roth, Paul, & Gerstle, 2002).

Psycho-stimulation programmes (Woollacott, Shumway-Cook, & Nashner, 1986) which improve cognitive functions (Floyd & Scogin, 1997; Karlene, Berch, Helmers, et al, 2002; Martin & Kayser, 1998; Montejo & Montenegro, 2005; Montejo, Montenegro, Reinoso, De Andrés, & Claver, 1999; Verghaeghen, Marcoen, & Goosens, 1992; Wilson & Moffat, 1992) are currently being developed to treat memory loss. Based on the results of these programmes, experts affirm that cognitive deterioration in the elderly is not as severe as has been supposed and that this can partly be attributed to disuse (Anthony, Vandervoort, & Hill, 1999).

Motor activity programmes focus on proprioception (which controls the position of the body) (Thomas & Hageman, 2003) and balance (which enables us to stand and walk) (Burgio et al., 2002). Proprioception is affected by both a progressive delay in sensorial conduction and motor speed of 1m/s per decade (Olney, 1985) and a change in the sequencing of activation between the distal and proximal muscles (Thorstensson, Oddson, & Carlson, 1985). Deterioration in balance control is produced by the loss of Bezt cells in the motor cortex (Anthony et al., 1999), causing a reduction in posture control and in the organisation, selection and generation of responses, leading to an increased risk of falls and injuries (McGuire, Klein, & Couper, 2005; Thomas & Hageman, 2003).

Systematic participation in mobility programmes prevents the loss of muscle mass associated with old age and improves posture and movement, reducing injuries through falls (Feigenbaum & Pollock, 1999). Movement has also been found to prevent the deterioration of cognitive and emotional functioning (Almeida, Norman, Hankey, Jamrozik, & Flicker, 2006; Atkinson, Cesari, Kritchevsky, Penninx, Fried, Guralnik, & Willliamson, 2005; Butler, Forette, & Greengross, 2004; Taub, Uswatte, King, Morris, Crago, & Chatterjee, 2006) in the elderly, in women in particular (Yaffe, Barnes, Nevitt, Li-Yung, & Covinsky, 2001). Carrying out different activities involves not only agility training and the use of energy but also the ability to organise, plan and use the memory (Sturman, Morris, Mendes de Leon, Bienias, Wilson, & Evans, 2005). Participating in physical activities helps to detain deterioration (Podewils, Guallar, Kuller, Fried, Lopez, Carlson & Lyketsos, 2005).

The aim of this study was to test the effect of a combined cognitive-motor programme on cognitive and emotional functions in sedentary elderly people with complaints of memory loss.

Methods

Participants

The initial sample consisted of 114 elderly women, average age 76.05 years (dt=4.69). The subjects were recruited from various Social Care Centres run by León City Council. Inclusion criteria were as follows: complaints of memory loss according to Schofield et al. and Geerling et al., (Geerlings, Jonker, Bouter, Ader & Schmand, 1999; Schofield, Marder, Dooneief, Jacobs, Sano & Stem, 1997); self-sufficiency in basic, instrumental activities of daily life; non-participation in leisure-time physical activities according to the Siu, Reuben and Hays Scale (1990), adapted for use in Spain by Ruiperez (2000). Exclusion criteria were: a score of below 28 points on the Mini Cognoscitive Exam (MEC); adaptation for use in Spain by Lobo et al. (1979) of the Folstein et al., (1975) Mini Mental State Examination (MMSE); limited self-sufficiency due to sensorial deficiencies (sight, hearing).

Materials

The tests used for test-retest evaluation were: the Yesavage et al. Geriatric Depression Scale (GDS) (Yesavage, 1983), an assessment adapted for use in Spain, with high sensitivity and specification indices; the Wilson, Cockburn and Baddeley Rivermead Behavioural Memory Test (RBMT) (Wilson, Cockburn & Baddeley, 1985), designed to detect deterioration in the functioning of daily memory and evaluate change following treatment (Wilson, 1987).

Procedure

Subjects were recruited through the media (press and radio) and assigned at random to three groups in listed order: the psychostimulation group (n=35), the motor group (n=36), and the control group on a “waiting list” (n=32). The psychostimulation and motor sessions were held over the course of 8 months, with a frequency of 3 sessions per week, alternately. The exercise programme consisted of 90 sessions of 40 minutes duration for each intervention programme with groups of 5-6 women. The training programme followed a multifactorial model (Backman, 1990). The mental well-being of both treatment groups was approached by combining a work group centred on a common task and the discussion group (Wilson & Moffat, 1992) where apart from receiving information, active involvement and interchange of experiences took place which helped to mitigate personal circumstances. Those assigned to the psychostimulation programme did exercises on a) concentration (eg. rubbing out the letters of a text), b) verbal fluency (eg. forming words from others), c) numerical exercises (eg. calculating Euros), and d) problem-solving (eg. logic exercises) (Stengel, 1993; Requena 2002). Those assigned to the motor programme did exercises on: a) moving the head in the direction of an unexpected sound, causing compensatory movements in the upper limbs, trunk and legs in order to lead the head back to a vertical position; b) walking over uneven surfaces with obstacles for 20 minutes to train the foot joints and correspondingly all the joint segments located above these; head movements dissociated from the trunk and the eye sockets, and c) postural correction (movements of the head and trunk in a block for looking around) (Campbell, Robertson, Gardner, Norton & Buchner, 1999). It was aimed to maintain the intensity of the programme at a mean level of 35% and 55% of maximum heart rate (Fcmax FC), calculated according to the following estimate: Fcmáx = 220 – age, approximate measure in low intensity exercises (Bouchard, Shepard, Stephens, Sutton, & McPherson, 1990). For walking exercises subjects were given the instruction that the intensity should allow them to be able to maintain a conversation, apart from also measuring the Fcmax FC, making periodic stops and taking the pulse (radial or carotid artery). The intensity of the exercise was increased or decreased until the desired Fcmax FC was achieved. The motor programme was directed by a physiotherapist and the psychostimulation programme by a psychologist. The "waiting list" group was made up of subjects who were unable to participate in activities at that moment due to lack of availability of timetables or activities. They were told only how often they were to turn up at the centre to undertake the study.

Results

A repeated measures analysis of variance (ANOVA) with Session (pre-treatment and post-treatment evaluation) as the "within-group" factor, and treatment as the "between-group" factor was conducted on the test measures in order to evaluate significant differences between groups as a result of the treatment received. The significance level of all ANOVAs was evaluated with the Huynh-Feldt correction where appropriate, as a precaution against non-homogenous data in the variances of the means. A significance level of $p< .01$ was adopted for all main contrasts. A Bonferroni-corrected significance level of $p< .01$ was also adopted for all tests on simple effects involving multiple comparisons. Analyses were performed using SPSS v10.0 software.

GDS

Between-group analyses

A significant Session x Treatment interaction was found (F 2,100 = 91,172, $p < .0001$). Post-hoc pairwise tests revealed that there were no significant differences between groups in the pre-treatment session. In the post-treatment session the Control Group obtained significantly poorer scores for the dependent measure, as compared to the other groups ($p< .0001$ Bonferroni-corrected values). Also, the Psycho-stimulation Group and the Cognitive-motor Program Group significantly differed in measures. The Cognitive-motor Program Group obtained the lowest scores ($p< .0001$), indicating the absence of depressive symptoms (see table 1).

Within-group analyses

Post-hoc pairwise tests revealed that for the Control Group there were significant differences between sessions (p<.0001). These differences indicated an increase in the scores obtained in the post-treatment evaluation, revealing an increase of depressive symptoms. For the Psycho-stimulation Group there were no significant differences between evaluations (p= .015). Finally, the Cognitive-motor Program's post-treatment scores were significantly lower than pre-treatment scores (p<.0001). This is particularly important since mean scores varied from 12.83 points (moderate depression) in the pre-treatment evaluation to 8.03 points (normal) in the post-treatment evaluation.

Table 1. GDS Group x Session descriptive scores

Group	**Session**	**Mean**	**SD**
Control	Pre	12.844	1.59
	Post	15.563	2.03
Psycho-stimulation	Pre	12.886	2.04
	Post	12.029	2.75
Cognitive-motor Programme	Pre	12.833	1.52
	Post	8.306	1.74

RBMT

Between-group analyses

A significant Session x Treatment interaction was found (F 2,100 = 84,986, p < .0001). As for depression scores, post-hoc pairwise analyses revealed that there were no significant differences between groups in the pre-treatment evaluation. In the post-treatment session the Control Group obtained significantly poorer scores for the dependent measure when compared with the other groups (p< .0001). Also, the Psycho-stimulation and Cognitive-motor Program Groups significantly differed in the post-treatment measures (p< .0001). The Cognitive-motor Program obtained significantly higher RBMT scores as compared to Psycho-stimulation, indicating better memory function (see Table 2).

Within-group analyses

Post-hoc comparisons revealed significant differences between sessions (p<.0001) in the Control Group. These differences indicated a reduction of memory scores obtained in the post-treatment evaluation. The Psycho-stimulation Group did not show significant differences between evaluations (p= .023). The Cognitive- motor Programme Group exhibited significant differences between evaluations (p<.0001). As in the case of GDS results, post-treatment memory scores were significantly higher when compared with pre-treatment, and this increase represented a change from "moderate" memory impairment to "poor" memory performance (see Table 2).

Table 2. RBMT Group x Session descriptive scores

Group	**Session**	**Mean**	**SD**
Control	Pre	4.28	.77
	Post	2.34	.70
Psycho-stimulation	Pre	4.26	.98
	Post	4.89	1.47
Cognitive-motor Programme	Pre	4.22	.68
	Post	6.50	1.54

Discussion

Results show that the groups who received some type of programme improved significantly compared with the control group. The type of programme also affected the results, since those who received the combined pyschostimulation-motor treatment improved to a greater extent.

The difference between the results for subjects who received the intervention programme, as opposed to those who were on the waiting list may be explained by the lack of use of functions (both motor and cognitive), as the latter did not participate in any of these activities in a systematic way. One study, with a sample similar to ours, bore out that 20.1% of participants had a moderate level of memory at baseline and after the training only 7% continued to have this disorder, the remainder of the subjects gaining a better memory level (Montejo, Montenegro, Reinoso, De Andrés, & Claver, 1999). We also found research in this same direction, such as that of Lachman et al. (1992), Israel (1992) and Wilson & Moffat (1992), who used multifactorial cognitive training methods like ours and also obtained positive results for memory. The reason why better results are obtained with multifactorial results is proposed by Light (1991), who states that these methods are related to cognitive decline (decreased processing resources, alterations in memory, or recovery and in metamemory). In addition, they are the most reliable in obtaining positive results. Other authors talk of emotional implications such as anxiety and depression (Eisdorfer, Nowlin, & Wolkie, 1970).

We are less accustomed to seeing the physical dimension related to psychological processes, however the fact is that many studies confirm that movement has a positive effect on the constant reshaping of the corporal schema, on releasing the upper limbs and adjusting perceptive-motor behaviour and coordination (Comijs et al., 2002; Hillman et al., 2004; Himann, Cunnigangham, Rechnitzer & Paterson, 1988; Imms & Edholm, 1981; Inzitari et al., 2006; Inzitari et al., 2007; Kramer, 1999, 2003; O'Brein, Power, Sanford, Smith & Wall, 1983; Powel-Proctor & Miller, 1982; Ritchie et al., 2000; Ritchie et al., 2001; Tervo et al., 2004). This has the knock-on effect of improving both physical and mental functions and in this way one can continue to provide a satisfactory response to the demands posed by the surrounding environment. (Atkinson et al., 2005; Blumenthal et al., 2007; Kempermann, Gast & Gage, 2002; Knubben et al., 2007; Yaffe et al., 2001).

Numerous studies suggest that there is a relationship between exercise and cognitive function in the elderly. According to a study undertaken with magnetic resonance in a group of subjects of 55 years, it was observed that changes in the brain (the tissues shrink) are seen principally in people who do not undertake physical activity (Kramer, 1999). In a review of eighteen studies done by Kramer where the benefit of physical activity is examined, he concludes that the elderly in general, and women in particular, benefit more from physical activity and that walking for 30 minutes regularly could be sufficient to reduce cognitive loss (Kramer, 2003). A longitudinal study between 1999 and 2002 with 3,375 participants over 65 years concluded that the amount of involvement in physical activity can be an indicator of commitment to active life, as well as a greater social life - a factor which prevents deterioration (Podewils et al., 2005). On this, Schaie & Willis (1986b) assure that these results show that the reduction in mental activity in the elderly is due to the disuse of functions and is therefore consequently reversible.

An interesting aspect which we confirmed in our study is the benefit for women of physical activity programmes such as walking. A group of researchers from the University of San Francisco monitored the effect of physical activity in cognitive function, such as memory, in a group of 5,925 women. They concluded that doing exercise is not just a question of “all or nothing”, since as the participants of the study walked an additional kilometre per week, they reduced up to 13% the risk of deterioration. This was because “a little is good, but more is better” (Yaffe, Barnes, Nevitt, Li-Yung, & Covinsky, 2001). In the same vein we found data from a study undertaken with 18,766 women between 70 and 81 years which consisted of providing information on leisure time activities related to physical activity in order to calculate the energy expenditure. It was observed that the risk of memory deterioration was less in the women who walked a kilometre and a half every day, as opposed to those who walked only 40 minutes a week (Weuve, Kang, Manson, Breteler, Ware, & Grodstein, 2004).

When we talk about active participation, we do not refer only to physical activity, however. One group of researchers ran a longitudinal study with 5,437 people over 55 years and reached the conclusion that combining physical and cognitive activities (playing cards, doing crosswords, reading etc.) reduces the risk of deterioration by 2.3% per year, as opposed to watching television (sedentary life style) which does not reduce the risk (Wang et al., 2006).

Learning, the memory and the emotions are not exclusive to thought processes but rather related to the whole body. According to Dennison (1969), coordinated movements and those of balance activate the production of neurotrophines, increasing the neuronal connections between cognitive function and mood, so it is thus essential not to sit still. A study undertaken by the Centro de Alameda applied a physical activity programme (effort, balance and walking exercises) to elderly people for 20 years and observed that symptoms of depression were less present than in those who did not participate in the programme (Mazzeo et al., 1998). In addition, the Duke Centre set up an aerobic exercise programme for 156 depressed people between 50 and 77 years and results showed that mood improved as well as the cognitive abilities of the participants, data which we have confirmed in our study with subjects who received the combined cognitive-motor programme. Sonstroem (1984) proposes a number of reasons which explain why exercise causes improvement in mood and self-esteem: the increase in physical condition is visible, and the achievement reached produces a sensation of well-being and competence.

Fortunately current research on ageing indicates that cognitive deterioration is not an inevitable function in the process of ageing. According to the recommendations of the meeting "Placing Cognitive Health on Europe´s Social and Economic Agenda" (sponsored by the Alliance for Health and Future, in 2003) even though the brain changes with age for reasons which are uncertain, the results of research suggest that active social commitment, intellectual stimulus, and physical activity all play a preventive role in the health of older people (Butler, Forette, & Greengross, 2004)

It could be concluded that cognitive programmes maintain memory level and it is the combination with a motor programme which improves results (both cognitive and emotional) in the elderly who suffer from memory loss. It can thus be deduced that the elderly must not have only a mentally active life but also a physically active one (Kempermann et al., 2002; Kramer, 2003). Some authors affirm that movement facilitates thought; there are people who think better when they run, swim, shave or even chew gum (Atkinson et al., 2005; Dennison & Dennison, 1994; Powel-Proctor & Miller, 1982; Spirduso, 1995). Nevertheless, some researchers assure that a physically active life is not sufficient to prevent cognitive deterioration (Albert, Tabert, Dienstag, Pelton & Devanand, 2002) but that rather the absence of this could be a predictor of risk in cognoscitive functions (Sturman, Morris, Mendes de León, Bienois, Wilson, & Evans, 2005). On this, classic authors such as Jackson (1884) or Dupré (1907) (quoted in Da Fonseca, 1996) assure that there is a close parallelism between the development of motor and mental functions.

References

Albert, S. M., Tabert, M. H., Dienstag, A., Pelton, G., & Devanand, D. (2002). The impact of mild cognitive impairment on functional abilities in the elderly. *Current Psychiatry Reports*, 4, 64-68.

Almeida, O. P., Norman, P., Hankey, G., Jamrozik, K., & Flicker, L. (2006). Successful Mental Health Aging: Results From a Longitudinal Study of Older Australian Men. *AJGP*, 14, 27-35.

Anthony, A., Vandervoort, & Hill, K. M. (1999). Neuromuscular Performance of the aged. In M. L. Howe, M. J. Stones, C. J. Brainerd, Eds. *Cognitive and Behavioural Performance Factors In Atypical Aging*, 3, 69-101.

Atkinson, H. H., Cesari, M., Kritchevsky, S. B., Penninx, B. W., Fried, L. P., Guralnik, J. M., & Williamson, J. D. (2005). Predictors of combined cognitive and physical decline. *J Am Geriatric Soc*, Jul, 53(7), 1197-1202.

Backman, L. (1990). Plasticity of memory functioning in normal aging and Alzheimer's disease. *Acta Neurol Scan*, 82 (Supl. 129), 32-36.

Blumenthal, J. A., Babyak, M. A., Doraiswamy, M. P., Watkins, L., Hoffman, B. M., Barbour, K. A., Herman, S., Craighead, W. E., Brosse, A. L., Waugh, R., Hinderliter, A., & Sherwood, A. (2007). Exercise and Pharmacotherapy in the Treatment of Major Depressive Disorder. *Psychosomatic Medicine*, 69, 587-596.

Bouchard, C., Shepard, R. J., Stephens, T., Sutton, J.R., y McPherson, B.D. (Eds.), 1990). *Exercise, fitness and health*. Champaign: Human Kinetics Books.

Burgio, L.D., Stevens, A., Burgio, K.L., Roth, D.L., Paul, P., & Gerstle, J. (2002). Teaching and maintaining behaviour management skills in the nursing home. *Gerontologist*, Aug, 42(4), 487-496.

Butler, R. N., Forette, F., & Greengross, B. S. (2004). Maintaining cognitive health in an ageing society. *The Journal of the Royal Society for the Promotion of Health*, 124, 119-121.

Campbell, A. J., Robertson, M. C., Gardner, M. M., Norton, R. N., & Buchner, D. M. (1999). Falls prevention over 2 years: A randomized controlled trial in women 80 years and older. *Age and Ageing*, 28, 513-518.

Cape, R. D. T. (1978). *Aging: 1st complex management*. New York: Harper & Row.

Chertkow, H. (2002). Mild cognitive impairment. *Current Opinion in Neurology*, 15, 401-407.

Comijs, H. C., Deeg, D. J. H., Dik, M. G., Twisk, J. W. R., & Jonker, C. (2002). Memory complaints; the association with psycho-affective and health problems and the role of personality characteristics A 6-year follow-up study. *Journal of Affective Disorders*, 72, 157-165.

Da Fonseca, V. (1996). Estudio y Génesis de la Psicomotricidad. Barcelona: editorial INDE, 421.

Dennison, P. E., & Dennison, G. E. (1994). *Brain Gym*. (Teachers Edition revised), Ventura, California: Edu-Kinesthetics, inc.

Donat, H., & Özcan, A. (2007). Comparison of the effectiveness of two programmes on older adults at risk of falling: Unsupervised home exercise and supervised group exercise. *Donat and Özcan Clinical Rehabilitation*, 21, 273-283.

Eisdorfer, C., Nowlin, J., & Wolkie, F. (1970). Improvement of learning in the aged by modification of autonomic nervous system activity. *Science*, 170, 1327-1329.

Feigenbaum, M. S., & Pollock, M. (1999). Prescription of resistance training for health and disease. *Med Sci Sports Exerc*, 58, 38-45.

Floyd, M., & Scogin, F. (1997). Affects of memory training in subjective memory functioning and mental health for older adults: a Meta-Analysis. Vol. 12 (1), 150-164.

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). Mini-mental state: A practical method for grading the cognitive status of patients for the clinician. *Journal of Psychiatric Research*, 12, 189-198.

Geerlings, M. I., Jonker, C., Bouter, L. M., Ader, H. J., & Schmand, B. (1999). Associations between memory complaints and incident Alzheimer's disease in elderly people with normal baseline cognition. *Am. J. Psychiatry*, 156, 531-537.

Hillman, C. H., Belopolsky, A. V., Snook, E. M., Kramer, A. F., & McAuley, E. (2004). Physical activity and executive control: Implications for increased cognitive health during older adulthood. *Res Q Exerc Sport*, Jun, 75(2), 176-185.

Himann, J. E., Cunnigangham, D. A., Rechnitzer, P. A., & Paterson, D. H. (1988). Age-related changes in speed of walking. *Medicine and Science in Sports and Exercise*, 20, 161-166.

Imms, F. J., & Edholm, O. G. (1981). Studies of gait and mobility in the elderly. *Age and Ageing,* 10, 147-156

Inzitari, M., Baldereschi, M., Carlo, A. D., Bari, M. D., Marchionni, N., Scafato, E., Farchi, G., & Inzitari, D. (2007). Impaired attention predicts motor performance decline in older community-dwellers with normal baseline mobility: Results from the Italian Longitudinal Study on Aging (ILSA). *J Gerontol A Biol Sci Med Sci*, Aug, 62(8), 837-843.

Inzitari, M., Carlo, A., Baldereschi, M., Pracucci, G., Maggi, S., Gandolfo, C., Boniauto, S., Farchi, G., Scafato, E., Carbonin, P., & Inzitari, D. (2006). Risk and predictors of motor-performance decline in a normally functioning population-based sample of elderly subjects: The Italian Longitudinal Study on Aging. *J Am Geriatric Soc*, Feb, 54(2), 318-324.

Israel, L. (1992). Método de entrenamiento de la memoria. Barcelona: Ed. Laboratorios Semar.

Jackson, J. H. (1884). Evolution and dissolution of the nervous system (the Croonian Lectures). *Br Med. J*, 1, 591-754.

Karlene, B., Berch, D. B., Helmers, K. F., et al (2002). Effects of cognitive training interventions with older adults. A randomized controlled trial. *JAMA*, 288, 2271-2281.

Kempermann, G., Gast, D., & Gage, F. H. (2002). Neuroplasticity in Old Age. Sustained Fivefold Induction of Hippocampal Neurogenesis by Long-term Environmental Enrichment. *Ann Neurol*, August, 52, 135-143.

Knubben, K., Reischies, F. M., Adli, M., Schlattmann, P., Bauer, M., & Dimeo, F. (2007). A randomised, controlled study on the effects of a short-term endurance training programme in patients with major depression. *British Journal of Sports Medicine*, 41, 29-33.

Kramer, A. (1999). Walking Improves Mental Processing. *Nature*, July 29, 400, 418-419.

Kramer, A. (1999). Walking Improves Mental Processing. *Nature*, July, 29, 400, 418-419.

Kramer, A. (2003). Fitness effects on the cognitive function of older adults: A Meta-Analytic study. Stanley Colcombe, March, Vol. 14 Issue 2, 125.

Kramer, A. F. (2003). Fitness effects on the cognitive function of older adults: A Meta-Analytic study. *Stanley Colcombe*, March, Vol. 14, Issue 2, 125.

Lachman, M. E., Weaver, S. L., Bandura, M., Elliot, E., & Lewkowicz, C. J. (1992). Improving Memory and Control Beliefs Through Cognitive Restructuring and self-generated Strategies. *J. Gerontol*, 5, 293-299.

Light, L. L. (1991). Memory and aging: our hypothesis in search of data. *Ann Rev Psicol*., 42, 333-376.

Lobo, A., Gómez Burgada, F., Escolar, V., & Seva Díaz, A. (1979). El mini-examen cognoscitivo en pacientes geriátricos. *Folia Neuropsiquiátrica*, XIV, 244-251.

Martin, M., & Kayser, N. (1998). The modular memory training for older adults: development and evaluation. *Gerontol Geriatr*, 31, 97-103.

Mazzeo, R. S., Cavanagh, P., Evans, W. J., Fiatarone, M. A., Hagberg, J., McAuleye, E., & Startzell, J. (1998). Exercise and Physical Activity for Older Adults. American College of Sport Medicine. USA. Rappoort, L. (1978). La Personalidad desde los 26. Argentina: Paidos.

McGuire, S., Klein, D., & Couper, D. (2005). Aging Education: A National Imperative. *Educational Gerontology*, 31, 443-461.

Montejo, P., & Montenegro, M. (2005). Estudio del cambio en memoria subjetiva producida por el entrenamiento de la memoria.

Montejo, P., Montenegro, M., Reinoso, A. I., De Andrés, M. E., & Claver, M. D. (1999). Estudio de la eficacia de un Programa de Memoria multicéntrico para mayores de 60 años. *Revista Española de Geriatría y Gerontología*, 34(4), 199-208.

O´Brein, M., Power, K., Sanford, S., Smith, K., & Wall, J. (1983). Temporal gait patterns in healthy young and elderly females. *Physiotherapy Canada*, 35, 323-326.

Olney, R. K. (1985). Age-related changes in peripheral-nerve function. *Geriatric Medicine Today*, 4, 76-86.

Podewils, L. J., Guallar, E., Kuller, L. H., Fried, L. P., Lopez, O. L., Carlson, M., & Lyketsos, C. G. (2005). Physical Activity, APDE Genotype, and Dementia Risk: Findings from the cardiovascular Health Cognition Study. *Am J. Epidemiol*, 161, 639-651.

Powel-Proctor, L., & Miller, E. (1982). Reality orientation: a critical appraisal. *Br J Clin Psicol.*, 26, 83-91.

Requena, C. (2002). *Programa de Entrenamiento de Memoria: "Memoria Mejor"*. Universidad de León: Secretariado de Publicaciones y Medios Audiovisuales.

Ritchie, K., Artero, S., & Touchon, J. (2001). Classification criteria for mild cognitive impairment: A population-based validation study. *Neurology*, 56, 37-42.

Ritchie, K., Ledésert, B., & Touchon, J. (2000). Subclinical cognitive impairment: Epidemiological and clinical characteristics. *Comprehensive Psychiatry*, 41, 61-65.

Ruipérez, I. (2000). Escalas de valoración en contextos geriátricos. En Fernández-Ballesteros, R., Ed. Gerontología Social (pp. 383-399). Madrid: Pirámide.

Schaie, K. W., & Willis, S. L. (1986b). Can decline in adult intellectual functioning be reserved?. *Developmental Psychology*, 22, 223-232.

Schofield, P. W., Marder, K., Dooneief, G., Jacobs, D. M., Sano, M., & Stem, Y. (1997). The validity of new memory complaints in the elderly. *Arch. Neurol*, 54, 756-759.

Siu, A. L., Reuben, D. B., & Hays, R. D. (1990). Hierarchical measures of physical function in ambulatory geriatrics. *Journal of American Geriatric Society*, 38, 1113-1119.

Sonstroem, R. J. (1984). Exercise and self-esteem. *Exercise and Sport Science Review*, 12, 123-155.

Spirduso, W. (1995). *Physical dimensions of aging*. Human kinetics Campaign IL, EE.UU.

Stengel, F., Trzoska, M., Bourgeois, J. F. (1993). Entrenamiento de la memoria. Profilaxis de la pérdida de memoria, Mejora de la capacidad de memoria en personas de edad avanzada. En: Meier-Ruge, W. (Ed.), *Formación y entrenamiento en Geriatría. El paciente de edad avanzada en medicina general*. Barcelona: Sandoz.

Sturman, M. T., Morris, M. C., Mendes de León, C. F., Bienios, J. L., Wilson, R. S., & Evans, D. A. (2005). Physical Activity, Cognitive Activity, and Cognitive Decline in a Biracial Community Population. *Arch Neurol*, 62, 1750-1754.

Taub, E., Uswatte, G., King, D. K., Morris, D. M., Crago, J. E., & Chatterjee, A. (2006). A placebo controlled trial of Constraint-Induced Movement therapy for upper extremity after stroke. *Stroke*, 37, 1045-1049.

Tervo, S., Kivipelto, M., Hanninen, T., Vanhanen, M., Hallikainen, M., & Mannermaa, A. (2004). Incidence and risk factors for mild cognitive impairment: A population-based three-year follow-up study of cognitively healthy elderly subjects. *Dementia and Geriatric Cognitive Disorders*, 17(3), 196-203.

Thomas, V. S., & Hageman, P. A. (2003). Can Neuromuscular Strength and Function in People With Dementia Be Rehabilitated Using Resistance-Exercise Training? Results From a Preliminary Intervention Study. *J Gerontol A Biol Sci Med Sci*, 58, 746-751.

Thorstensson, A., Oddson, L., & Carlson, H. (1985). Motor control of voluntary trunk movements in standing. *Acta Physiological Scandanavica*, 125, 309-321.

Verhaeghen, P., Marcoen, A., & Groosens, L. (1992). Improving memory performance in the aged through mnemonic training: a metaanalytic study. *Psychology and Aging*, Vol. 7 (2), 242-251.

Wang, J.Y.J., Zhou, D.H.D., Li, J., Zhang, M., Deng, J., Tang, M., Gao Li, J., Lian, Y., Chen, M. (2006). Leisure activity and risk of cognitive impairment: The Chongqing aging study. *Neurology*, 66, 911-913.

Weaver Cargin, J., Maruff, P., Collie, A., & Masters, C. (2006). Mild memory impairment in healthy older adults is distinct from normal aging. *Brain and Cognition*, 60, 146-155.

Wendy, J. T., Thomas, J., & Bouchard, Jr. (2005). The structure of human intelligence: It is verbal, perceptual, and image rotation (VPR), not fluid and crystallized. *Intelligence*, 33, 393–416.

Weuve, J., Kang, J. H., Manson, J. E., Breteler, M. M. B., Ware, J. H., & Grodstein, F. (2004). Physical Activity, Including Walking, and Cognitive Function in Older Women. *JAMA,* 202, 1454-1461.

Wilson, B. (1987). *Rehabilitation of memory*. NY: The Guilford Press.

Wilson, B. A., & Moffat, N. (1992). *The development of group memory therapy*. En: Wilson, Moffat, eds. Clinical management of memory problems. San Diego, California, USA: Singular Publishing Group.

Wilson, B., Cockburn, J., & Baddeley, A. (1985). *The Rivermead Behavioural Memory Test*. Thames Valley Tests Company: Bury St Edmunds.

Woollacott, M. H., Shumway-Cook, A., & Nashner, L. M. (1986). Aging and posture control: Changes in sensory organization and muscular coordination. *International Journal of Aging and Human Development*, 23, 97-114.

Yaffe, K., Barnes, D., Nevitt, M., Li-Yung, L., & Covinsky, K. (2001). A Prospective Study of Physical Activity and Cognitive Decline in Elderly Women Who Walk. *Arch Intern Med*, 161, 1703-1708.

Yesavage, J. A. (1983). Development and validation of a geriatric depression screening scale: a preliminary report, Vol. 17, 1, 37-39.