Influence of Aging on Cognitive and Psychomotor Performance of Elderly People with Reference to Chronic Exercise

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Abstract

This study was initiated with the purpose to observe the effect of aging on cognitive and psychomotor performance of the elderly people with reference to chronic exercise. Twenty sedentary males, in each of the three age groups (Group–A: 60–69 years, Group–B: 50–59 years and Group–C: 40–49 years) were the subjects of this study. In each age group there was one experimental group (N=10) and one control group (N = 10). Experimental groups underwent in one-year exercise program. Variables for this study were simple reaction time (SRT), choice reaction time (CRT) and visual perception. Pre- and post-test data of each variable in three age groups were compared and it was observed that cognitive and psychomotor performance reduced significantly ($p<0.05$) in above 50-year sedentary people. Cognitive and psychomotor performance improved in chronic exercise participating groups. Study findings reveal that chronic exercise improved and helped in maintaining cognitive and psychomotor performance of the active elderly people. Hence, chronic exercise is a good intervention for deterioration of cognitive and psychomotor performance of the elderly with advancement of age.

Key words: Cognitive, Psychomotor, Chronic exercise.

Introduction

Consequences of aging are manifold, like – functional loss in physiological systems, slowness of behaviour along with reduced cognitive function and expose to stress easily, which influence health and well-being of the elderly people (Arba, et al., 1997). Age-related changes are associated with cognitive functions like-perception, information processing, decision making etc. Research findings suggest that there are changes in cognitive processing associated with aging and decline in subjective cognitive functioning starts somewhere in 40s and 50s of one's life and steadily increases afterward. This decline is not restricted to memory, but also involved changes in attention, mental speed, planning and decision making. Subjective health and emotional state are both related to subjective decline of cognitive functioning (Ponds et al; 2000).

Exercise has positive effect on cognitive and psychomotor performance because of its influence on the production of certain neurotransmitters within the brain, i.e. dopamine, norepinephrin and serotonin (Spirduso & Farrar, 1981; Spirduso et al., 1984). Researchers also suggest that exercise, with its different form, has a positive effect on human cognitive processing time because of its influence upon oxygen levels in the brain (Shephard & Kavanagh, 1978; Birren, et al., 1980).

Choice reaction time (CRT) can be used as a measure of cognitive function and simple reaction time (SRT) for psycho-motor function (Rikli & Edwards, 1991, Emergy & Gatz, 1990). And visual perception, measured through critical flicker-fusion (CFF), can also be used as a measure of cognitive function (Powell, 1988; Mondal, 1994).

Reaction time (RT) is an important topic on aging mainly for three reasons: (i) it is a very elementary behaviour through which neurological status of an individual be understood, (ii) it has an age-related consistent relationship and (iii) result of RT is very much related with higher cognitive functions (Salthouse, 1996).

Physical exercise programs reduce RT of the elderly (Rickli & Edwards, 1991), and there is proportionately greater effect of exercise on CRT than SRT due to impact of exercise is more in CNS than peripheral part of the RT mechanism (Clarkson & Krol, 1978; Spirduso, 1988). CFF involves the measurement of visual perception of a flicker-fusion threshold. It measures an individuals own arousal, i.e., basal arousal, as well as the external stimulation by means of physical stressor, i.e., induced arousal, which influence the threshold (Tomkiewick & Cohen, 1970). The ultimate point of determination of the CFF is in the cerebral cortex and the use of CFF is a good indicator of the cortical activity of the brain in general (Gradjean, 1970). Exercise has positive effect on the cortical functions of the elderly people (Powell, 1983; Mondal, 1994). The purpose of this study was to observe the effect of aging on cognitive and psychomotor performance of elderly people with reference to chronic exercise.

Methods

Twenty sedentary males in each of the three age groups (Group–A: 60–69 years, Group–B: 50–59 years and Group–C: 40–49 years) were the subjects of this study. Each group of volunteers were divided into one experimental group (N=10) and one control group (N=10) randomly. The three experimental groups underwent in a one-year exercise program and the three control groups remained sedentary. The exercise program was of one-year duration (5 days/week). In the beginning, the exercise program for three groups was 45–55 min/session. And each exercise session consisted of exercises and stretching of big muscles – ten minutes, rest – two minutes, brisk walking and/or jogging @ 1 km/10 min. to @1 km/15 min. for 20–30 minutes, rest – five minutes and loosening and calisthenics – five minutes. After every three months the walking/jogging time was increased by five minutes and finally the duration of a session was 65–75 minutes. Variables for this study were SRT, CRT and visual perception. Hand reaction time in response to single stimuli (SRT) and to one of the two light stimulus (CRT) were measure with reaction timer and the perception ability was measured by critical flicker-fusion test. Pre- and post-test on the three variables of each subject were conducted before and after one-year experimental period. Intra-group comparison of pre- and post-test performance (paired t-test) and inter-group comparisons (independent t-test) were done between experimental group and control group of the three age groups during pre- and also post-test performance. For statistical analysis of data, SPSS software version 10.0 was used and the level of significance was set at $p < 0.05$ level of significance.

Results

Data of the three variables and intra- and inter-groups comparisons are presented in Table No.-I. It reveals from the data that SRT increased significantly in the three control groups and it reduced significantly in the three experimental groups after the chronic exercise program of one-year duration. Significant difference between experimental and control groups was there in Group–A and Group–B during post test, however no there was no difference in pre-test. In Group–C, experimental group was significantly higher than control group in pre-test, but in post-test there was no difference between the two groups.

CRT increased significantly in the three control groups and it reduced significantly in the two experimental groups (Group–A and Group–C) and in the other experimental group (Group–B) a steady state was maintained during the experimental period. At the beginning of the study, no difference was there in CRT of experimental and control groups of Group–A and Group–B, but the difference was significant at post-test. In Group–C, the result of CRT was similar to SRT. CFF reduced significantly in experimental groups of Group–A and Group–C and it was increased in control groups of Group–A and Group–B after the experimental period. Heterogeneous results were observed in CFF when inter-group comparisons were made between experimental and control group of same age group at pre- and post-test. In CFF significant differences were observed during post-test in Group–A, pre-test in Group–B; however in Group–C there was no difference either in pre- or post-test.

Table-I
Data (Mean and SD) of Three Variables with Intra- and Inter-group Comparison

Variable	Group	Pre-test Mean ± SD	Post-test Mean ± SD	T-value (Intra-group) Pre vs. Post	T-value (Inter-group) Pre	T-value (Inter-group) Post
SRT (s)	AE	0.44±0.11	0.38±0.07	3.092*	0.383	3.847*
	AC	0.42 ± 0.08	0.50 ± 0.07	4.743*		
	BE	0.41 ± 0.07	0.38 ± 0.08	2.250*	0.271	3.229*
	BC	0.42 ± 0.07	0.49 ± 0.07	3.464*		
	CE	0.52 ± 0.10	0.41 ± 0.06	4.204*	3.371*	0.991
	CC	0.40 ± 0.05	0.44 ± 0.05	7.150*		
CRT (s)	AE	0.52 ± 0.11	0.46 ± 0.07	2.451*	0.383	3.847*
	AC	0.49 ± 0.07	0.58 ± 0.06	4.923*		
	BE	0.47 ± 0.07	0.46 ± 0.09	0.970	0.271	3.229*
	BC	0.52 ± 0.09	0.59 ± 0.08	3.464*		
	CE	0.61 ± 0.09	0.50 ± 0.07	4.204*	3.371*	0.991
	CC	0.49 ± 0.05	0.52 ± 0.05	7.150*		
CFF (Hz)	AE	38.64±2.70	36.49±1.81	3.995*	0.309	3.223*
	AC	38.99±2.23	39.60±2.33	2.728*		
	BE	37.97±2.16	36.78±1.81	1.595	2.983*	0.224
	BC	35.35±1.31	36.60±1.53	4.728*		
	CE	38.60±2.49	37.19±1.73	3.992*	1.506	2.012
	CC	40.52±2.91	39.86±3.59	0.926		

*Significant at 0.05 level

Discussion

Reduced cognitive ability, as a result of increased RT, limits the older adults in various motor performances, daily living and of recreational activities (Smith & Gilligan, 1984). Change in RT with age follows a pattern. Generally, RT performance improves with age up to early twenties then gradually declines and in old age its deceleration is remarkable (Hodjkins, 1962). Experimental studies reveal that exercise has positive effect on both cognitive and psychomotor performance because of its influence on the brain (Spriduso & Farrar, 1981; Spirduso et al., 1984; Shephard & Kavanagh, 1978; Birren, et al., 1980).

Nerve conduction velocity, in a lifetime, declines by 10 to 15% in general population (Smith & Gilligan, 1984). Changes in the neuromuscular junction of the aged include a decreased surface area because of decreased junctional fold, a wider synaptic cleft and a decreased availability of acetylcholine packets (Kinney, 1982). These changes are reflected by an increased RT for muscle contraction. Delayed muscle contraction may be the result of decreased nerve conduction rate, changes in the motor end plate and changes in the muscle fibre. A slower RT in the elderly is due to more central than peripheral nervous system changes (Spirduso, 1975). SRT increases 0.5 ms / year (average of 0.6 ms / year in this study) and it is 1.7 ms / year for CRT due to age-related decline in stimulus identification (Salthouse, 1996).

Significant improvement was found in both SRT and CRT by Rikli & Edwards (191). Dustman et al. (1984), Spirduso et al. (1988) and Mondal (1992) in their study on elderly people who underwent exercise programs of various durations (12-week to 3-year).

Measurement of CFF is a good indicator of cortical activity in general and can be used as a general index of central sympathetic response. It involves the visual perception of a flickering light beam and has been purported to reflect individual differences in nervous system function related to behaviour (Powell, 1958). The significant decrease in CFF following chronic exercise training observed in this study supports the findings of other researchers that exercise training induces an adaptive shift in central sympathetic-parasympathetic balance (Powell, 1988) and the results of this study, especially in experimental three groups, are similar to other researchers (Powell, 1988; Mondal & Banerjee, 1992; Mondal, 1994).

Central sympathetic activity as measured by CFF can reduce with a result of chronic exercise training program due to the total adaptation takes place physiologically (Powell, 1988). Significant reduction of CFF level was observed after 3-month exercise program on elderly of the same population by Mondal (1994).

Results of the present study and other similar studies suggest that physical exercise, chronic in nature, plays an important role in preventing and / or slowing down age-related retardation of cognitive and psychomotor performance of the elderly people.

Conclusions

Though the study has many limitations, yet the following conclusions are drawn on the three variables of cognitive and psychomotor performance of the elderly people of our population.

1. **On simple reaction time –** It reduced significantly in the three experimental groups and increased significantly in the three control groups after the experimental period and it became significantly reduced in experimental Group–A and Group–B than the respective control groups during post-test.
2. **On choice reaction time –** Reduced (Group–A and Group–C) and maintained (Group–B) in experimental groups and in the three control groups it increased significantly after one-year period. Significant difference was observed between experimental and control groups of Group–A and Group–B during post-test and in Group–C there was no difference in post-test though significant difference was at pre-test.
3. **On visual perception –** CFF levels reduced significantly in experimental groups of Group–A and Group–C (Group–B: almost not changed), and after the experimental period the CFF levels of the control groups of more elderly two groups (Group–A and Group–B) were increased significantly.

References

Birren. J.E, Woods. A.M & Williams. M.V, (1980), ***Behavioral Slowing With Age: Causes, Organization And Consequences.*** In: L. W. Poon (Ed.). Aging in 1980s, Washington DC: American Psychological Association.

Clarkson. P. M & Kroll. W, (1978), Practice effects on fractionated response time related to age and activity level. ***Journal of Motor Behaviour***, 10, 275 – 286.

Dustman. R. E., et al., (1984), Aerobic exercise training and improved neuropsychological function of older individual, ***Neurobiology of Aging***, 5, 35–42.

Emery. C. F & Gatz. M, (1990), Psychological and cognitive effects of an exercise program for community-residing older adults, ***Gerontologist***, 30(2), 184–188.

Gradjean. E, (1970), Fatigue, ***American Industrial Hygiene Association Journal***, 31(10).

Harba. J, Lorewz. F.O & Pachacova. Z, (1997), Age and depression in the post-communist Czech Republic, ***Research on Aging***, 19(4), 442– 461.

Hodjkins. J, (1962), Influence of age on the speed of reaction and movement in females, ***Journal of Gerontology***, 17, 385 – 389.

Kinney. R.A, (1982), ***Physiology of Aging***, Chicago: Year Book Med. Pub., Inc.

Mondal. S, (1994), Effect of chronic exercise on performance and physiological variables, Unpublished Ph. D Thesis, University of Kalyani.

Mondal. S & Banerjee. A.K, (1992), Influence of central sympathetic activity on athletes and non-athletes, ***Journal of Physical Education and Sports Sciences***, 4.

Ponds. R.W, Boxtel. M.P.J.V & Jolles. J, (2000), Age related changes in subjective cognitive functioning, ***Educational Gerontology***, 26(1), 67–81.

Powell. R.R, (1983), Flicker fusion as a typological index of nervous system reactivity. ***Perceptual and Motor Skills***, 57, 701–702.

Powell. R.R, (1988), Effect of physical conditioning on a measure of central sympathetic activity, ***Journal of Human Movement Studies***, 14, 293–300.

Rikli. R.E & Edwards. D.J, (1991), Effects of a three-year exercise programme on motor function and cognitive processing speed in older women, ***Research Quarterly for Exercise and Sports***, 62(1), 61–67.

Salthouse. J.A, (1996), Reaction time. In: J. E. Birren (Ed.). **Encyclopedia of Gerontology**, Vol.I, Academic Press: Los Angeles. 377–388.

Shephard. R.J & Kavanagh. T, (1978), Effects of training on the aging process, ***The Physician and Sports Medicine***, 6, 33–40.

Smith. E.L & Gilligan. C, (1984), Physical activity for the older adult, ***Family Practice Recertification***, 6(12), 89–107.

Spirduso. W.W & Farrar. R.P, (1981), Effects of aerobic training on reactive capacity: An animal model, ***Journal of Gerontology***, 36, 654–662.

Spirduso. W.W, Gilligan. P & Wilcox. R.E, (1984), Speed of movement initiation performance predicts differences in [3_H] spiroperiodol receptor binding in normal rats, ***Psychopharmacology***, 83, 205– 209.

Spirduso. W.W, et al., (1988), Exercise effects on aged motor function. ***Annals of the New York Academy of Sciences***, 515, 363-375.

Tomkiewick. R.L & Cohen. W, (1970), Effect of changes in arousal level of CFF and figural reversal task, ***Psychophysiology***, 6, 421–428.

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