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Perceptive ability of female students of the University of the Third Age and its links with physical fitness and mood

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abstract

Background The aim of the study was to determine the speed and failures of perception and attention among female students of the University of the Third Age (U3A) and their links with physical fitness and mood.

Material/Methods The study involved 114 women aged between 50 and 88 years old (M = 68.17) participating in U3A lectures at the University of Physical Education in Warsaw. Perception ability was investigated using Ciechanowicz and Stańczak's Attention and Perception Test. Physical fitness was assessed with the Fullerton Fitness Test and the Romberg manoeuvre to evaluate the ability to maintain balance. The participants were also assessed with the Matthews, Chamberlain and Jones UWIST Mood Adjective Checklist (UMACL) and the Yesavage Geriatric Depression Scale.

Results Compared with standard values for adults, the subjects had average failure of perception, slightly slower perception speed and lower failures of attention. The perception speed was negatively correlated with the age and the education level, and positively correlated with static balance and lower body strength. Perception failures were positively correlated with age and negatively with the education level and energy levels at the time of the study. No significant correlation was found between attention and age and the education level, physical fitness and mood at the time of the study; none of the indicators of perception ability were correlated with mood and depression indicators during the previous two weeks.

Conclusions Regular physical exercise in elderly people can be used to maintain physical fitness and perception ability.

Key words Elderly people, functional ability, cognitive ability

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INTRODUCTION

We are currently seeing a slow and gradual extension of the average lifespan, with people aged 65 and over constituting the fastest growing age group in industrialised societies. Their percentage share in the population is also increasing. Maintaining satisfactory health, physical fitness and independence in old age is becoming a major challenge. Deterioration in the cognitive function is one of the most obvious manifestations of ageing. As people age, their senses become less responsive; the range of information about the environment becomes limited and less detailed, and it takes longer to reach the brain. The ability to merge sensory information of different modalities is reduced, which means a lowered perception of complex stimuli, especially when several simple processes are being implemented at the same time [1].

An important element affecting the effectiveness of human behaviour is the ability to distinguish stimuli which differ by certain defined features. It enables avoiding dangerous and detrimental situations and noticing changes in the environment. The ability varies on the individual level in terms of the size of the area being searched and the number of errors in processing. In the process of selecting stimuli, perception is closely linked to attention which decides on what we notice. Also important is sensory memory (iconic memory for visual stimuli) which preserves a trace of the sensory stimulus for a short time [2]. The process of stimulus selection becomes less effective with age – older people are slower to recognise their surroundings and respond to stimuli [3]; their perception function is less effective. The changes have a major impact on the behaviour of older people by deteriorating their connection with reality and orientation in their surroundings [1]. As such, activities aiming to slow down this process are of increasing importance.

Ageing drives many irreversible changes in the body structure and function. The process occurs at different rates and intensities and it is closely linked to the individual’s earlier life. Changes occur to posture and movement, with close links to muscle mass and strength and aerobic efficiency. Muscle mass loss usually starts between the ages of 50 and 60 (at a rate of approx. 1.5% per year); after 60, the rate accelerates rapidly to up to 3% per year [5]. Muscle mass is lost significantly faster in the lower limbs than the arms; this is due to reduced physical activity, in particular locomotion. Men lose muscle mass at a higher rate than women [6].

The motor function is linked with the cognitive function. Elasticity of cognition, memory, movement and ability to plan activities is especially important when it comes to acquiring and modifying movement and when external and internal conditions suddenly change. During involution, motor ability is reduced and cognitive dysfunction starts appearing; this may have an impact on motor ability, in particular walking, and in turn increase the risk of falls, which can have significant consequences for elderly people [7].

Studies into links between cognitive and physical ability and the effect of physical activity on the cognitive function do not reveal a clear link. Results of an early review of research into the effect of physical exercise on cognitive ability in elderly people, conducted by Tomporowski and Ellis [8], indicate clear discrepancies, which the authors explain by methodological differences. Of the 14 experimental studies included in the more recent review by Boutcher [9], only five confirm a positive effect of aerobic exercise on cognitive processes in elderly people. Etnier et al. [10] conducted a meta-analysis of 134 studies and found a small but significant improvement in the cognitive function. In experimental studies, a weaker effect was observed for one-off exercise and it was limited to an improvement in simple reaction times; however, a negative correlation was found between physical exercise and differential and conditional reactions. The effect was more powerful for regular exercise programmes, with the benefits being most notable when physical fitness was significantly improved. Comparative studies found even higher indicators.

The cognitive function in elderly people is also linked with activity. This is especially clear in people suffering from depression, who may also show symptoms of pseudo-dementia. Low mood and lowered motivation result in significantly poorer results in intelligence and memory tests, although the ability to orientate in time and space remains stable. Links between depression and cognitive deficit go both ways. An awareness of a worsening cognitive function, progressing with age, may lead to a lower mood, while depression is frequently accompanied by a reduced cognitive function [11, 1]. Links between the symptoms of depression and the intellectual function have been found in research conducted in Poland into the effects of fitness training on the affective sphere and the cognitive function [12, 13].

Perceptive ability is reduced with age; information about the environment becomes limited and less detailed. The ability to multitask, concentrate and focus selectively is reduced, which in turn hinders the ability to make decisions and slows reaction times at the cognitive level. All these changes mean a reduced ability to interact with reality and orientate in the environment. Halting the process contributes to maintaining a higher quality of life. As such, it is important to study the factors involved in perception and attention in elderly people so they can be used as part of deliberate activities aiming to slow the rate of involution. They include affective factors (mood and emotional state during the study) and physical fitness. The significance of demographic factors was also investigated. The aim of the study was to determine the speed and failures of perception and attention in female students of the U3A and their links with physical fitness and mood.

MATERIALS AND METHODS

The study involved 114 women aged between 50 and 88 years old (M = 68.17; SD = 6.395) participating in U3A lectures at the University of Physical Education in Warsaw. The majority of respondents had a higher education (58.8%); 39.5% had a secondary-level education, and just two individuals (1.7%) had a primary education. 46.5% were married, 29.8% widowed, 16.7% divorced, and 7% never married.

Perceptive ability was assessed with the Attention and Perception Test [14], whose aim is to identify and mark certain numbers, letters or symbols as fast and as accurately as possible. We used version 6/9. The test provides indicators of the speed of perception (number of symbols analysed), perception failures (number of wrong answers) and attention failures (number of omissions). The test is designed to assess adults, using a set of answers given by 175 people aged between 18 and 80 years old. While the test was being normalised, the results were shown to deteriorate with the participant's age; therefore, it should be noted that using standards developed for adults to assess participants in our study, with a mean age of 68, may carry a margin of error. The test was conducted in groups in the lecture hall; the participants received standard instructions and were given three minutes to complete the test.

The Fullerton Fitness Test ([15, 16]) was carried out to assess physical fitness. It included six consecutive stages:

1. arm curl to assess upper body strength,
2. 30-second chair stand to assess lower body strength,
3. back scratch test to assess the mobility of the upper body,
4. chair sit and reach test to assess the suppleness of the lower body (mainly hamstrings),
5. 8-foot up and go and 6-minute walk to assess agility (dynamic balance) and long-distance aerobic resistance,
6. if the respondent cannot complete the 6-minute walk, the 2-minute step in place test is carried out to assess aerobic endurance.

The test is simple, requires minimal space and does not need to be conducted in a laboratory. It assesses key physiological parameters (strength and suppleness of the lower and upper body, aerobic endurance, motor coordination and balance) which reflect functional fitness in elderly people. However, the standards were developed for the American population which means that a reliable, multidimensional assessment of the health and physical fitness of the Polish population is impossible [17].

We also used the Romberg manoeuvre with open and closed eyes to assess the ability to maintain static balance.

Mood was assessed using the Matthews, Chamberlain and Jones UWIST Mood Adjective Checklist (UMACL) adapted for Polish by Goryńska [18], comprising 29 statements (adjectives) on three scales: Tension Arousal (nine positions), Energetic Arousal (ten positions) and Hedonistic Tone (ten positions). The scale has good psychometric properties. Answers apply to the previous week (mood) and time of test (emotional state).

The 15-point Yesavage Geriatric Depression Scale includes 15 statements describing basic symptoms of depression; the respondents gave yes or no answers relating to the two weeks preceding the test.

STATISTICAL ANALYSIS

In order to determine the relationship between the indicators of perception and demographic variables and the indicators of physical fitness, mood and depression, we calculated the Pearson correlation coefficient; the predictors were defined using stepwise regression analysis.

RESULTS

Table 1 shows the distribution of sten scores for the speed of perception against standards for adults. It should be noted that using these standards in the study of students of the U3A with a mean age of 68 may carry a degree of error. The participants generally fell into the third sten; over half (51.8%) were below average (2-4 sten; Tab. 1). It should be stressed that no results fell in the first sten and very few in the second sten.

Table 1. Distribution of sten scores indicating perception speed (number of symbols worked through)

sten	1	2	3	4	5	6	7	8	9	10
%	0	1.8	34.2	15.8	14.9	18.4	6.1	2.6	0.9	5.3

Average results (5-6 sten) were attained by a third (33.3%) of all participants, with almost 15% scoring highly. Perception speed across the entire group is lower than average for adults. The high number of very high scores is unexpected; these were attained by the youngest participants.

Table 2. Distribution of quartile results of the number of missed symbols (attention failures)

quartile	1	2	3	4
%	24.6	37.7	23.7	14.0

Due to the low empirical variability of the missed symbol indicator (median in adults = 7), authors of the test divided the raw results into quartiles used as a reference point in our study (Tab. 2). The majority of respondents obtained results falling into the second quartile; the percentage of people whose results fell in the first and third quartile was similar. This suggests that the participants have a lower than average rate of failure of attention. Just 14% had a high result which indicates a high failure rate.

Due to an even lower number of errors, test authors use the number of people who made no errors as the indicator. In normalisation studies, in the population of adult women the indicator is 90%, and 93% for the total population. 92.1% of participants made no errors, 7% made a single error and 0.9% made two errors. This suggests that the perception failure rate is similar to that found in adults aged between 18 and 80. Table 3 shows the Pearson correlation coefficient showing the relationship between perception and other variables (Tab. 3).

The attention failure indicator (number of omissions) did not return results which were statistically significant or approaching significance; therefore, they are not included in the table. The indicators of depression and mood during the two weeks prior to the test did not show a significant correlation with perception speed and failure; therefore, they are also not presented.

Perception speed (number of symbols) was directly proportional to physical fitness (balance, lower body strength and aerobic endurance). The relationship with education level was inversely proportional. No relationship was found with mood and emotional state at the time of the study.

Table 3. Relationship between perception with demographic and emotional variables and physical fitness (Pearson correlation coefficient)

Group	Variable	Perception speed	Perception failures
Demographic variables	Age	-0.200*	0.458***
	Education	-0.267**	-0.190*
Physical fitness	Left arm strength	0.116	0.027
	Right arm strength	0.155	0.063
	Balance (left leg, eyes open)	0.249**	0.030
	Balance (right leg, eyes open)	0.229*	0.160
	Balance (left leg, eyes closed)	0.178[t]	-0.091
	Balance (right leg, eyes closed)	0.040	-0.147
	Aerobic endurance (walking)	0.185[t]	0.011
	Suppleness (bending down)	0.121	0.018
	Mobility of the upper body (left arm)	0.022	-0.058
	Mobility of the upper body (right arm)	0.030	-0.045
	Lower body strength (sitting)	0.204*	-0.028
	Agility (getting up)	0.091	0.006
Emotional state	Hedonistic tone	0.047	-0.074
	Energetic arousal	0.036	-0.203*
	Tension arousal	0.076	0.127

[t] approaching significance ($0.1>p>0.05$); * $p<0.05$; ** $p<0.01$; *** $p<0.001$

Perception failures (number of errors) were positively correlated with age and negatively with education level and energy levels at the time of the study. No significant relationship was found between physical fitness and mood.

We also conducted a stepwise regression analysis introducing different groups of factors in turn (demographic variables, physical fitness, mood and emotional state during the study). The only positive predictor of perception speed was balance (left leg, eyes open) (beta = 0.238). The model explains just under 5% of variability of the number of symbols ($R^2 = 0.045$; F = 5.037; $p = 0.027$). Demographic factors, mood and depression indicators and emotional state at the time of study enable predicting the speed of viewing the symbols.

Perception failures can be predicted in just under 20% ($R^2 = 0.185$; F = 8.276; $p = 0.007$) based on age (beta = 0.459) – the higher the respondent's age, the higher the number of errors. Physical fitness and mood were not significant. We can expect a lower number of errors from respondents with a higher energy level at the time of study (beta = -0.203); the predictor explains only 3% of variability ($R^2 = 0.032$; F = 4.29; p = 0.041).

We did not determine a predictor for the number of missed symbols as an indicator of attention failures.

DISCUSSION

Assessing the results obtained by female students of the U3A against the standard results for adults aged between 18 and 80, our respondents had a comparable level of perception failures, slightly lower perception speed and a lower rate of attention failure. It should be noted that our group is not representative of the population of Polish women aged 50 and above. Our respondents were women who are physically and mentally active, participating in lectures, physical exercise and other classes held as part of the University of the Third Age at the University of Physical Education in Warsaw; therefore, the results cannot be extrapolated to the rest of the population.

The results confirm that perception ability in women deteriorates with increasing age. The strongest relationship is the positive correlation between age and perception failures, or the number of errors made in the Attention and Perception Test; age was also a strong predictor. Perception speed also slows with age, reducing the number of processed symbols. Similar results were found in normalisation studies for the Polish version of the Attention and Perception Test [14]. Results obtained by respondents aged 60 and over were worse than those obtained by younger respondents in terms of speed and number of errors, regardless of gender. Our data suggests that in women aged 50 and above, the ability to successfully complete tests involving visual searching and ability to distinguish perception materials deteriorates with age. This is in agreement with existing data on changes of cognitive function during ageing: the acuteness of the senses is reduced, and information takes longer to reach the brain [1]. The majority of cognitive processes slow down in advanced age. This is likely due to reduced brain mass and the number of neural connections, which slows down sympathetic conduction velocity. The deteriorating ability to perceive visual stimuli also makes it difficult to complete tasks involving sight quickly and correctly [20].

Neither the normalisation study nor our own research showed a significant correlation between age and attention failures as measured by the number of missed symbols, suggesting that attention function (selective attention) deteriorates less with age. Attention failures measured as the number of missed symbols may be linked with perception style [21] – different ways of performing cognitive tasks, in this instance perception tasks. Individuals who tend towards self-reflection may be more concerned with obtaining correct results than completing the task quickly. Further research is required to evaluate this.

Another factor correlated with perception speed and perception failures is education level. The higher the education level attained by our respondents, the lower their rate of perception failures (number of errors). Similar relationships were found in normalisation studies in adults and in professional soldiers [14]. It should be noted that the education level of our respondents was negatively correlated with perception speed (number of symbols), while in normalisation studies, individuals with a higher level of education worked faster than those with a lower level of education [14]. It is difficult to determine the reason behind these differences. Perhaps older people with a higher level of education tend to favour giving correct answers over reaction speed; as a result, they review fewer symbols while making fewer errors, revealing cognitive reflection [21]. Neither our own research nor the normalisation studies found a relationship between education level and attention failures (number of omissions). Further research is required due to the low number of study groups.

Our research confirms the relationship between cognitive function and physical fitness of our respondents. Perception speed was positively correlated with three of the four balance indicators; results in one of the balance tests (left leg, eyes open) correlated with the number of symbols reviewed. Additionally, this result of the Attention and Perception correlated with lower body strength and aerobic endurance. The higher the fitness level of our respondents, the better their performance of tasks involving attention and visual perception. However, this relationship was not found for the indicators of perception and attention failures. Results of comparative studies suggest that cognitive function in elderly people who are more physically fit is more effective, while the relationship between physical fitness and performing cognitive tests depends on the type of test [22].

Colcombe and Kramer [23] found that physical activity has the highest impact on performing tasks requiring executive control, followed by tasks involving information processing and spatial and visual tasks; it has the lowest impact on tasks requiring fast reaction speeds. Tasks forming the Attention and Perception Test involve attention and visual function, and they require fast reaction speeds. According to the authors, they should be related to physical activity. However, the relationship between performance and physical fitness was weak, and in three of the five examples they were only approaching significance.

It is unsurprising that perception speed was the most closely correlated with balance test results. Results of previous studies show that cognitive function plays a key role in the regulation of balance (and walking) [24]. Walking engages higher mental processes such as attention, memory and cognitive function [7]. A relationship between general cognitive function and the risk of falls was also found [25, 26]. An important role in these relationships is played by the cerebellum; it controls the learning of motor patterns, models time sequences and muscle speed and strength [27] as well as being involved in cognitive function including spatial and visual function.

Boutcher [9] links the positive relationship between physical activity and fitness and the cognitive sphere with improved cerebral circulation and neurotrophic stimulation which influence the survival, growth and function of nervous tissue and neuronal efficiency. The role of mental processes cannot be excluded, since participating in physical activity programmes may help with motivation to solve cognitive tasks.

Dustman, Emmerson and Shearer [28] state that physical activity modifies age-related changes to cognitive processes; however, the brain’s ability to benefit from physical activity is reduced with age, so it is essential that adults are encouraged to lead healthy lifestyles as early as possible.

Some of the respondents were asked to complete the Attention and Perception Test twice: at the start of their course and after completing two semesters of physical activities at the U3A. The number of participants was too low to be published in a research journal; however, in the group of twenty women a significant improvement was seen in the number of symbols reviewed (p = 0.011) with no changes to the number of errors and omissions. The data suggests that regular physical activity may help improve perception speed in visual function. Similar results in attention and memory were found in elderly people taking part in six-week gerontology rehabilitation programmes. They were more significant in women than in men [29].

Explanations of the positive impact of physical exercise on the cognitive sphere indicate changes in other aspects of functioning which may mediate these processes [8, 22], in particular lowered indicators of depression and improved mood. However, the study does not confirm previously noted relationships between cognitive function and mood in elderly people [12]. It should be noted that the aims of previous studies were more complex than evaluating perception speed. Improved mood and lowered indicators of depression were linked with improvements in speech fluency. However, no relationship was found between mood and spatial and visual orientation and construction abilities. It is known that clinical depression is linked with a significant deterioration in cognitive function [11], although the vast majority of our respondents (94%) showed no symptoms of depression. Perhaps this is why we found no relationship between indicators of depression and cognitive functions (perception and attention).

The research focused on the role of emotions in modifying cognitive processes in terms of content rather than efficiency. Negative emotions may deteriorate attention processes (lower their quality and efficiency) and prioritise the processing of information with negative valence [30]. Researchers tend to be more focused on the latter type of consequences, especially the influence of fear and anxiety on the selectiveness of attention, and sadness on maintaining focus on negative stimuli. The effect of concordance with emotions being experienced was also found in perception in that stimuli consistent with the affective state are easier to recognise [31]. Visual stimuli (symbols) used in the test were emotionally neutral, which is likely why no relationship was found between mood and the speed and reliability of perception and attention. Emotional state at the time of the study did not show significant correlation with Attention and Perception Test indicators apart from a single case: negative correlation between perception failures and the level of energetic stimulation.

It should be stressed that only limited conclusions can be drawn from these results. Firstly, the study participants were female students at the University of the Third Age, who are by definition physically and mentally active and who have good perception. Secondly, the number of respondents was low and their age was highly varied. This limits our ability to draw general conclusions from the results. The correlative model makes it impossible to formulate cause-effect conclusions.

Our results suggest a link between perception and attention in elderly people with their physical fitness. Results of previous studies indicate that physical activity may bring benefits in the cognitive sphere. Maintaining the right level of physical activity in old age is important for the physical benefits and because of their relationship with important cognitive function involved in the perception and selection of environmental information. Everyday activities carried out in advanced age are usually insufficient to meet WHO guidelines on minimum physical activity and maintaining physical fitness at the right level [32]. In order to maintain optimum physical fitness, it is necessary to carry out a basic level of physical exercise every day [33]. Authors frequently stress that the best kind of physical exercise is similar to everyday activities of elderly people [34]. Physical activities should aim to improve aerobic efficiency, stabilise joints, improve suppleness, increase muscle strength, improve static and dynamic balance and improve motor coordination [35, 36]. By combining them with cognitive activities, improving attention, memory and thinking is the best way of maintaining quality of life in old age.

CONCLUSIONS

Regular physical exercise in elderly people can be used to maintain physical fitness and perception ability. Physical activity should form a major part of programmes aiming to maintain physical fitness and preserve or slow down the rate of deteriorating cognitive ability in elderly people, in particular visual perception and attention. Exercise on an unstable surface requiring maintaining balance and developing aerobic efficiency and lower body strength is especially effective (for example Nordic walking).

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