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Time of response to different simple stimuli in 45–90-year-old persons

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The aim of the current work was to investigate the rate of response to colour light (red, green and motley), sound stimuli and the catching of a free-falling line (stick) in younger and older adults (male and female) who considered themselves healthy, with the purpose of assessing the impact of aging on performing different types of simple tasks.

Two hundred thirty four (234) people who considered themselves healthy (76 men, 158 women) participated in the study. The sample was divided according to age: group I – 45–59 years (42 persons), group II – 60–74 years (114 persons), group III – 75–89 years (72 persons), group IV – 90 years (6 persons). Response time (RT) measurements were performed employing two devices: a standard chronoreflexometer and a RTM-802 time monitor (Nelson reaction timer).

The study has shown that RT response to different simple stimuli was directly dependent on age. It was significantly slower ($p < 0.01$) in the age groups of 75–89 years than in the middle-aged groups. The gender differences in RT were pronounced ($p < 0.01$) only to sound stimulus in the group aged 75–89 years. A comparative analysis of response time to a colour stimulus showed that in all age groups (except females from group IV) it was shortest to green light and longest to motley light, the red light stimulus taking an intermediate position.

The RT to a falling line in 66.7% of the cohort increased more slowly (and even at the age of 90 it was ≤ 295 ms) and in 33.3% more rapidly (and in the old age already exceed 295 ms).

Data of our study have shown that age-related delay in RT arises from a delay in peripheral sensorimotor processes. Our data corroborated the hypothesis about the deceleration of peripheral processes in the elderly. Differences in age-related decline in RT to different simple stimuli indicate a range of additional slowing in the elderly as regards different types of stimulation. This knowledge is of importance for planning intervention and physiological procedures.

Key words: response time, elderly, stimuli

INTRODUCTION

Age-related differences in RT become evident since the age of 30–50; a number of investigators have reported age-related slowing, but very few studies actually examined the data on middle-aged versus elderly adults [1, 2]. Not much is known about how RT varies with age in elderly male and female. Effects of different tasks on RT in the elderly have not been studied to date. Colcombe and Kramer [3] in meta-analyses of RTs in older people reported similar results regarding the same types of tasks and could not explain different results of responses to different tasks in the elderly. Delay in every elementary processing in this metastudy was confirmed, but the effect of age was not described precisely [3]. Analysis of literature has shown a common observation that the speed of reactions is slower among the elderly compared with middle-aged people, without indicating the course, locality or nature of the slowdown. Lange et al. [4] and Kemmer et al. [5] indicate that this may be concerned with the different nature of the slowing response to different stimuli. Furthermore, in spite of the fact that the effect of age increases with task complexity, cognitive slowing is argued to be a common phenomenon in the elderly [6].

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Age-related delay and relation of the RTs in the elderly across a wide variety of tasks of varying complexity, according to Smulders [7], represents an additional component of the effect of age.

More concrete studies of Bashore et al. [8, 9] allowed a hypothesis about the course of age-related delay in the elderly. Bashore reported both RT and P300 component of the event-related brain potential latency data in the same tasks. He supported the assertion that the effects of age on RT are multiple, and suggested a peripheral sensorimotor deficit in the elderly. Bashore concluded that not all central processing is affected by advancing age. In his opinion, the central processes involved in stimulus-relating processing are less sensitive to the effect of aging than those involved in response-related processing. The selection or recognition of certain variants is longer, as the time is needed not only for information processing. It is recommended to examine and to monitor dynamically the total (common) RT of an individual, with the aim to assess physiological changes and derangements of the cognitive function, orientation and processing prior to the early stages of diseases [1, 10].

Response time is being rather comprehensively analyzed in middle-aged people, with establishing the effect of stimulant drugs, intelligence, illness, exercise, finger tremors, fatigue, fasting, peripheral vision, gender and other factors (even dental prostheses) on response time. Many researchers have confirmed in middle-aged people that reaction to sound is faster than reaction to light, the mean auditory reaction time being 140–160 ms and visual response time 180–200 ms. Reaction time to touch is intermediate (155 ms). Jevas and Yan [1] reported that age-related deterioration in reaction time was the same in men and women. On the other hand, Dane and Erzurumluoglu [10], Miller and Low [11], Barral and Debu [12] have found that males show a faster reaction time than females. It is a well-known fact that reaction time shortens from infancy into the late 20s, then increases slowly until the 50s and 60s, and then lengthens faster as the person gets into his 70s [13, 14, 15]. Lajoie and Gallagher [16] found that old people who tend to fall in nursing homes had a significantly slower reaction time than those that did not tend to fall. The above studies were performed for middle-aged and elderly people under 60–70 years. The older group, 70–90 years in particular, received less attention. According to the available literature, subjects aged 75–90 years and considering themselves healthy were not examined. However, such investigations could be useful for assessing the ability of this age cohort to respond to light and movement stimuli, which are extremely important in everyday life.

The aim of the current work was to investigate the rate of response to colour light (red, green and motley), sound stimuli and catching of a free-falling line (stick) in younger and older adults (male and female) who considered themselves healthy, with the purpose of assessing the impact of aging on the performance of different types of simple tasks.

MATERIALS AND METHODS

Subjects. Older and elderly adults (45–90 years old) were recruited from the Vilnius community living at home. After informed consent all participants provided health information, including vision, hearing, medications. Two hundred thirty four (234) people who considered themselves healthy (76 men, 158 women) participated in the study. These subjects (right-handed, nondemented) had no history of central nervous system diseases, traumatic injuries in limbs or psychiatric illnesses, they had normal hearing and glasses-corrected vision. They had no arterial hypertension, diabetes mellitus, obesity, etc. diagnosed over the previous years. The study participants were asked not to consume strong beverages, narcotics, psychotropic and stimulating drugs and have a good rest on the day of testing.

For analysis, the sample was divided according to age: group I – 45–59 years (42 persons), group II – 60–74 years (114), group III – 75–89 years (72), group IV – 90 years (6).

Methods. RT measurements were performed with two devices: a standard chronoreflexometer and a RTM-802 time monitor (Nelson reaction timer) [17].

Using a standard chronoreflexometer as RT movement latency, the time span between stimulus onset and touching one of the buttons was measured. Before the study, each participant had his/her blood pressure measured, asked about how they felt that day, their mood, their psychological readiness to undergo examination. In the presence of BP 139/89 mm Hg, low mood or unwillingness to undergo examination on that particular day no examination was performed. The measurements were performed in the morning, at a temperature of 18–20 °C in a sound-attenuated room. Participants were seated in front of a device. They were given some time (10 min) to adapt before a measurement started. In all tasks the participants were instructed to react with pressing the buttons according to the stimuli. The reasons for which a participant was told to press a button were green, red, both green red, and sound (auditory) stimuli.

Before starting the study, a control test was performed (a triple response to each stimulus with a 10-s interval). Then the main test was done, with each stimulus repeated three times every 10 seconds. In the presence of a significant difference between control and test results, the test was repeated. Arithmetical means were calculated for the three results. RT measurements were performed on a standard chronoreflexometer device, the investigator being unable to change the intensity and duration of standard light and sound stimuli.

Reaction time to catch a free-falling line (stick) by pinching the thumb and the index finger together was measured on the right hand with an RTM-802 time monitor (Nelson reaction timer), wich is based on the law of constant acceleration of free-falling bodies and consists of a stick (line) scaled to read in time as computed from the following formula:

$$time = \sqrt{\frac{2 \times distance\ stick\ falls}{acceleration\ due\ to\ gravity}}\ .$$

Numbers on the RTM-802 represent thousandths of a second (falling a special line graduated from 70 to 295 ms). When a subject catches the stick (line), the score is read just above the upper edge of the thumb. The five slowest and the five fastest trials are discarded, and an average of the middle ten is recorded as the score. Prior to testing, each participant had been acquainted with the test procedure and undergone a control test. The device and procedure are described in detail elsewhere [17, 18]. The method is simple, it does not need complicated devices and is suitable for testing aged people.

Statistical analysis. The statistical package SPSS version 10.0 for Windows was used for data analysis. The mean values of the variables plus / minus standard deviation were presented. The chi-square criterion was used to check the data dispersion normalization. The Student analysis and Mann–Whitney test were used to compare the values. A P value below 0.05 was considered as indicating statistical significance.

RESULTS AND DISCUSSION

Investigation of reaction time to different simple stimuli has revealed that the reaction time of response to all colour light stimuli in women increases with age (Fig. 1A). To red light, in middle-aged (45–59 years) women it is on average 670 (SD ± 250) ms, whereas in 60–74-year-old women it is longer (800 ± 110 ms) and in women aged 75–89 years it reaches 1110 (SD ± 370) ms ($p < 0.02$). In the oldest group (90 years) it increased to 1180 ms.

The reaction time of response to green light stimuli increases with age too (from 500 ± 190 ms in middle-aged women to 930 ± 210 ms in elderly (75–89 years) women, $p < 0.05$, and to 1300 ms in the oldest aged 90 years). There were no statistically significant differences among reaction time to a red and to a green light stimulus in women of all age groups. The RT to a motley light stimulus increased with age, too (from 580 ± 150 ms in group I to 1220 ± 210 ms in group III, $p < 0.01$, and to 1600 ms in group IV).

In men of different age, the reaction time of response to a colour light stimulus was also age-dependent (Fig. 1B). In middle-aged (45–59 years) men it was on average 280 (SD ± 170) ms to a red colour and 260 (SD±160) ms to a green colour. In the age group 75–89 years it statistically significantly ($p < 0.05$) increased to 7300 (SD ±140) ms to a red colour and to 660 (SD ± 110) ms to a green colour stimulus. There was no statistically reliable difference between response time to red and green light stimuli in male age groups, either. Data on response to a motley light stimulus were analogous (M ± SD 310 ± 140 ms in group I and 920 ms in group III; $p < 0.02$).

Though the study revealed a longer response time to light stimuli in women than in men, the difference was not statistically reliable. This difference was more pronounced in the 90-year age group, but no conclusions were made because of a small number of participants in these groups.

Thus, according to our data, response time to a sound stimulus was longer in men aged 75–89 years 3.2 times and in women of the same age group 1.9 times as compared to their counterparts aged 45–59 years.

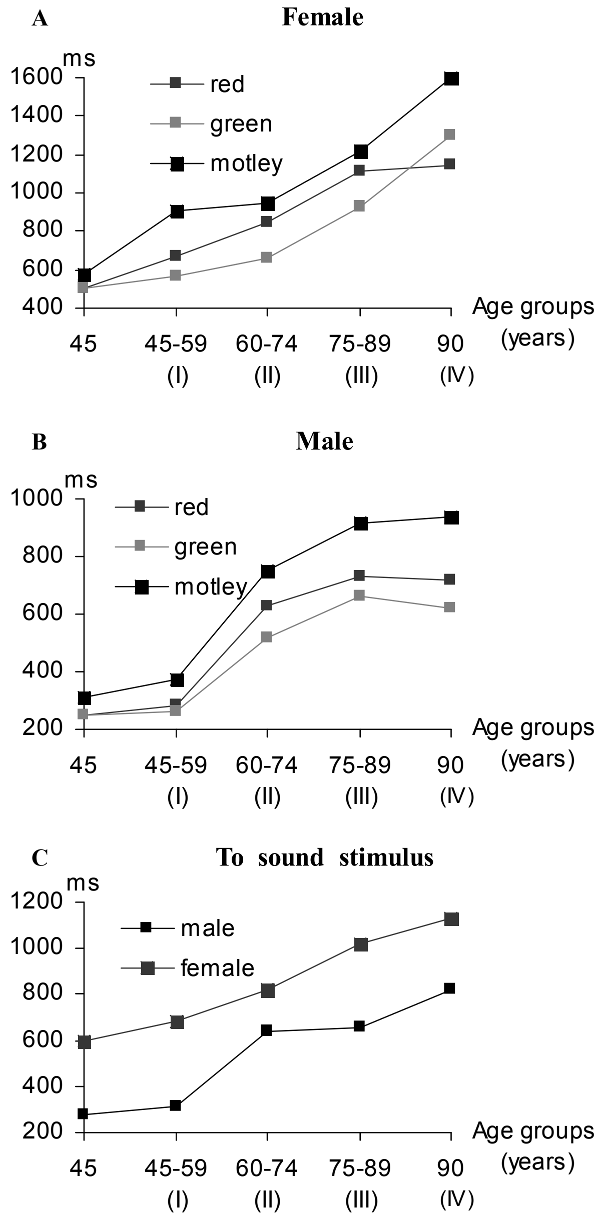

Fig. 1. Reaction time to different simple colour (red, green, motley) and sound stimuli in older people across the age groups.

A – in females to colour stimuli, B – in males to colour stimuli, C – to sound stimuli

A comparative analysis of response time to a colour stimulus showed that in all age groups (except females from group IV) it was shortest to green light and longest to motley light, a red light stimulus taking an intermediate position.

The same tendency was found in reaction time to sound stimuli (Fig. 1C). It was on average 310 (SD ± 160) ms in men aged 45–59 years and 660 (SD ± 280) ms in men aged 75–89 years ($p < 0.05$). In women aged 45–59 years (group I) it was 600 (SD ± 110) ms and 1020 (SD ± 130) ms in women aged 75–89 years (group III). The gender differences in reaction time to a sound stimulus from the groups aged 75–89 years were pronounced ($p < 0.01$).

The reaction time to catching a free-falling line was directly dependent on age, too. We were unable to measure this RT in 33% persons (70+ year women, 75+ year men), because the upper limit of the RTM-802 is 295 ms; therefore respondents whose RT is > 295 ms cannot catch the free-falling line, and it falls down. The percentage of such women (whose RT > 295 ms) was greater than of men (24.7% of women, 16.2% of men). In the age group of 90 years, only two persons (women) were able to catch a free-falling line (reaction time was 290 ms and 285 ms).

Figure 2 presents the reaction time of persons whose RT was ≤ 295 ms. In the middle-aged men it was on average 201 (SD ± 32.7; 95% CI = 196.7–210.90 ms, and in women 188 (SD ± 334; 95% CI = 184.8–201.3) ms. In the age group of 60–74 years the reaction time slowly increased to an average of 219 (SD ± 34.8) ms in men and 237.3 (SD ± 36.3) ms in women. Reaction time in the group of 75–89 years increased to 261 (SD ± 40.3; 95% CI = 253.2–270.1) ms in men and 265 (SD ± 41.6; 95% CI = 251.4–269.9) ms in women. We found a significantly ($p < 0.01$) slower reaction time in both genders in the age groups of 75–89 years versus the 55–59 age groups.

There are literature data to indicate that for young men the average reaction time to catch a free-falling line is 160 ms (range, 130 to 220 ms). Markon and Tremblay [18] found that the reaction time to a falling line for older people (age group 64–86 years, mean age 69.3 years) was 210 ms.

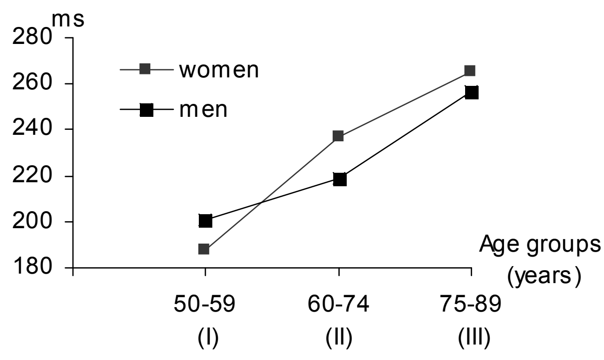

Fig. 2. Reaction time to falling line stimulus

Thus, our study showed that by the reaction to a falling line the study cohort could be divided into two groups: those whose reaction time increases more slowly and even at the age of 90 was ≤ 295 ms (66.7%) and those whose reaction time increased more rapidly and in the old age exceeded 295 ms. In the age group of 75–89 years, response time to a falling line stimulus was statistically reliably longer than in participants aged 45–59 years ($p < 0.05$). This fact has socio-economic implications, because it focuses attention on the age-related differences of response to different simple stimuli, requiring individual assessment of possibilities and adequate adaptation to the environment.

However, the factors that influence age-dependent differences in subjects (men and women) who considered themselves healthy are not yet clear. In our study, in older women the RT to simple stimuli was longer than in men; age-related physiological changes in information processing with aging in male and female (RT to visual, auditory and common stimuli) showed that task complexity affects RT in older people. A hypothesis has been raised that the main cause of RT extension is changes in peripheral processes [8, 9].

According to Cerella [19], senile changes in physiological mechanisms (decelerated muscular response and nervous impulse transduction through sensory nerves) can account for 20% of RT lengthening. It is known that independently of age, RT in men is shorter than in women. Jevas and Yan [1] maintain that age-related RT shortening is similar in both genders. A positive correlation was found between physical capacity and RT [20, 21]. More precise data on RT changes in ageing subjects were provided by a longitudinal study in the elderly (70–85 years), which lasted 7 years [3]. It showed that RT in some subjects lengthened more rapidly than the average mean value for the group, while there were subjects in whom RT remained unchanged for the whole period of study. RT is believed to be one of the most proper indices in determining the biological (physiological) age and is recommended for assessment of the physiological age of an individual [21]. Prolonged RT should be regarded as a physiological symptom of ageing, which lowers the general adaptive resources of the organism.

Our study has shown that age-dependent RT slowing to simple tasks seems to be less pronounced in old men than women. Differences in RT and inability to catch a free-falling line may be attributed to differences in finger and hand movements while performing different simple tasks and manifest a pronounced peripheral sensorimotor deficit [22].

We used a set of different simple tasks to study the effect of age, and employed two different devices. Data of our study are in agreement with the hypothesis that there is a peripheral sensorimotor deficit in the elderly. In our study, part of the elderly were unable to perform a task with hand motion (catching a free-falling line). Elderly experience an increasing lack of confidence in different task conditions, leading to a delay in response-related processes that affect RT; they have to make more effort in order to maintain their performance.

CONCLUSIONS

The study has shown that the RT of response to different simple stimuli was directly dependent on age. It was significantly slower ($p < 0.01$) in the age group of 75–89 years than in the middle-aged groups. The gender differences were pronounced ($p < 0.01$) only in RT to the sound stimulus in the group aged 75–89 years. A comparative analysis of response time to a colour stimulus showed that in all age groups (except females of group IV) it was shortest to green light and longest to motley light, the red light stimulus taking an intermediate position. Data of our study have shown that the age-related delay in RT arises from a delay in peripheral sensorimotor processes, and corroborated the hypothesis about the deceleration of peripheral processes in the elderly. Differences in age-related decline in RT to different simple stimuli indicate a range of slowing in the elderly as regards different types of stimulation. This knowledge is of importance for planning intervention and physiological procedures.

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45–90 METŲ AMŽIAUS ŽMONIŲ REAKCIJOS TRUKMĖS Į PAPRASTUS DIRGIKLIUS TYRIMAS

S a n t r a u k a

Darbo tikslas – ištirti ir įvertinti 45–90 metų žmonių reakcijos trukmės (RT) į paprastus šviesos (raudonos, žalios, kombinuotos), garso ir laisvai krentančios liniuotės dirgiklius kaitą senstant.

Tyrime dalyvavo atsitiktinės atrankos būdu atrinkti 234 save sveikais laikantys asmenys (76 vyrai, 158 moterys), kurie pagal amžių suskirstyti į grupes. I grupę sudarė vidutinio (45–59 metų) amžiaus 42 asmenys, II grupę – 60–74 metų 114 asmenų, III grupę – 75–89 metų 72 asmenys ir IV grupę – 90 metų 6 respondentai. RT matuotas dviem būdais: standartiniu chronorefleksometru ir RTM-802 (Nelsono) laiko monitoriumi.

Tyrimas rodo, kad RT tiesiogiai priklauso nuo amžiaus. Į visus dirgiklius statistiškai reikšmingas ($p < 0,01$) jos pailgėjimas išryškėja 75–89 metų amžiaus grupėje (lyginant su 45–59 m. grupe). Statistiškai reikšmingas skirtumas ($p < 0,01$) tarp lyčių nustatytas tik į garso dirgiklį 75–89 m. grupėje. Visose amžiaus grupėse, išskyrus IV grupės moterų, RT į žalią dirgiklį buvo trumpiausia, į kombinuotą – ilgiausia. RT į raudoną dirgiklį užima tarpinę padėtį. RT į laisvai krentančią liniuotę senstant ilgėjo skirtingai: 33,3% asmenų ji ilgėjo sparčiau (ir sulaukus senyvo amžiaus ji buvo ilgesnė už 295 ms), 66,7% – lėčiau (net iki 90 m. ji buvo ≤ 295 ms).

Įvertinę atlikto tyrimo rezultatus galime pritarti iškeltai hipotezei, kad su amžiumi siejamas sensomotorinės reakcijos sulėtėjimas yra ryškesnis vyresnio amžiaus grupėje.

Raktažodžiai: reakcijos laikas, pagyvenę žmonės, dirgikliai