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AGE AND EXPERIENCE RELATED CHANGES IN COGNITIVE PERFORMANCE OF SURGEONS WORKING DAILY DUTIES

Chernyuk V. I., Bobko N. A., Yavorskiy E. E.

State Institution «Institute for Occupational Health of National Academy of Medical Sciences of Ukraine», Kyiv

Introduction. Ageing is accompanied by a decline in a velocity of the information processing, possibility to process new and complicated information. At the same time semantic and logical memory, the ability to compare, classify and combine in mental workers remains to be high, owing to the professional importance of these characteristics. However, harmful work place conditions could affect cognitive performance.

Purpose of the study. To reveal age and experience related changes in cognitive functions of surgeons working daily duties.

Materials and methods. 64 physicians of surgical specialties were observed at their workplaces, using computer based tests on cognitive performance. Age of subjects was 24–62 years, the overall work experience – 1–42 years, experience in profession – 1–39 years, experience in daily duties – up to 39 years, the experience in weekly daily duties – up to 33 years. The Pearson's correlation at the value $p < 0,05$ was considered as a significant one, at the value $0,05 < p < 0,10$ – as a trend.

Results. Normal age and experience related worsening in short-term memory, attention switching, attention concentration velocity, under time pressure, also, in attention concentration productivity were revealed. At the same time, with an increase in age and experience the significant improvement in the quality of attention concentration was found in surgeons. Under time pressure, its keeping at the same level, with an increase in daily duty experience, accuracy of 2-second intervals' reproduction significantly reduced (of 3–5-second ones – did not change).

Conclusions. The cognitive performance of surgeons is the integral result of the normal age-related decline and professionally caused improvement, preservation (by virtue of the professional relevance) or deterioration (due to occupational hazards) in some functions of the higher nervous activity. The observed age and experience related improvement in the quality of attention concentration can reflect the professional importance of this characteristic for surgeons' work. The deterioration in the accuracy of the short time intervals' reproduction could be linked with the accelerated aging in this function under systematic night duties.

Key words: ageing, memory, attention, time perception, information flow processing

Introduction

Ageing is accompanied by a decline in a velocity and quality of the information processing [1–4], possibility to process new, complicated and sophisticated information as well as learning [5–8]. At the same time semantic and logical memory, the ability to compare, classify and combine, the quality of tasks' solutions in mental workers remain to be high [9–11] owing to the professional importance and regular training of these characteristics [12]. In this, harmful work place conditions, including night work and long working hours, could affect cognitive performance [13], which in physician professions can result in the deterioration of medical care quality [14].

Purpose of the study. To reveal the age and experience related changes in cognitive functions of surgeons working daily duties.

Materials and methods

64 physicians of surgical specialties were observed at their workplaces, using computer based tests on cog-

nitive performance, when it was possible according to the working process during the day time. Physicians worked 24-hour duties (8:00–8:00) followed by 72 hours off. They were cognitively healthy men, aged $40,7 \pm 1,3$ years old (from 24 to 62) at the general work experience ($17,0 \pm 1,3$) years (from 1 to 42), physician experience ($16,1 \pm 1,2$) years (from 1 to 39), 24-h duties experience ($15,4 \pm 1,1$) years (from 0 to 39) and weekly 24-h duties experience ($13,9 \pm 1,1$) years (from 0 to 33). According to bioethical rules each subject has signed an informed consent for taking part in the examination.

Professionally vital psychophysiological functions for mental workers include memory, attention, velocity and accuracy of the information process [15]. Depending on the real profession specific demands, some functions can be more or less important.

In order to measure a short-term memory in a physician, 12 different two-digit' numbers were shown to him on the PC screen within 30 seconds in order to remember and reproduce them in any succession during 60 seconds after 30-second keeping in memory [15]. The number of correct reproduced elements

(short-term memory span) and the number of incorrect reproduced elements (mistakes in short-term memory) were recorded.

The attention concentration was gauged by the Landolt's rings test, which contained 200 casually alternating rings with a break in one of 8 directions, conforming to 13, 15, 17, 18, 19, 21, 23 and 24 h of a clock face. The task was to cancel each ring with 13- and 15-h directions of a break. The time used, the number of cancelled wrong rings and the number of missed right rings were registered. The general volume of the processed information and the velocity of the information processing have been calculated [16].

In order to define the attention concentration under time pressure two versions of the tasks with an absent element from the known alphabet were used: simple (4-point alphabet) and complex (10-point alphabet) tasks. The tasks were given successively during 3,5 min on the PC screen under the time pressure regime, depending on the accuracy of the solution of the previous task: in case of the correct answer the following task exposure time was decreased by 10 %, in case of the wrong reply or missed task the exposure time was increased by 10 %. The accuracy of solutions and the time spent for each task were registered [17].

The attention switching was checked by red and black numbers from 1 to 24 casually disposed in 2 lines from above the PC screen (black numbers) and 2 lines from below (red numbers). The task was to find in turn the black numbers in the increasing order and the red numbers in the decreasing order, and to show, using a computer mouse, different coloured pairs that summarised in 25, i. e. «1» black and «24» red, «2» black and «23» red and so on [18]. The time used and the number of mistakes were registered.

The time perception was investigated, using 16 presentations of 2–5-second empty intervals on the PC screen. The task was to reproduce each given temporal interval as accurately as possible. The intervals were shown in the casual order successively after one's reply. The individual reproduction time and the deviation from the presented interval for each task were registered [19, 20].

Pearson's correlation was used at $p < 0,05$ as a significant level and $0,05 < p < 0,10$ as a trend.

Results and discussion

As a mean group data, short-term memory capacity in physicians was 5–6 numbers with 2–3 mistakes;

they cancelled 43–44 right rings from 50 necessary ones, using 127 seconds; under the time pressure during 3,5 seconds physicians solved in the correct manner about 44 simple tasks with an absent element or near 28 complex tasks; attention switching test took 179 seconds with 2 mistakes; individual time made about 93 % from the real one, fluctuating over an 10 % range from 87 % (time reproduction for 5-second intervals) to 97 % (time reproduction for 2-second intervals) (Table). In this, surgeons always preferred to miss the task, than to solve it correctly: under time pressure – they missed the tasks twice often, as compared to wrong solutions, under usual time regime – twenty times often. This fact could reflect the importance of the quality of attention concentration for surgeons.

The majority of the studied parameters manifested the age and experience related decreases in velocity and productivity of the cognitive performance in physicians. The highest correlation coefficients were found for age and experience related deteriorations in velocity and productivity of the information flow processing under time pressure. The number of the missed tasks under time pressure also increased with an increase in age or experience, while the number of mistakes showed no significant correlations, evidencing the long years' maintenance of the quality of the attention concentration task solutions even under time pressure.

The attention switching velocity and quality decreased significantly with an increase in age or any experience related parameter.

The memory capacity decreased in the more pronounced manner, as compared to its quality: capacity significantly decreased with an increase in age, general, professional or 24-hour duties' experience, the quality – with an increase in the general experience only.

The velocity of the attention concentration decreased with an increase in age or any experience related parameter. At the same time, no significant age or experience related decrease in productivity of attention concentration (number of the cancelled right rings, the general volume of the ring information processing) or in the number of the missed tasks under usual time regime was found (contrary to the time pressure regime, when the number of the missed tasks increased with an increase in age or experience). The number of the cancelled wrong rings significantly decreased with an increase in age, general or professional experience, evidencing the improvement in the quality of the attention concentration. Thus, the attention concentration

Table

The correlations between cognitive performance and age-experience indices of physicians

Parameters of cognitive performance	M ± m	N	Correlation coefficients with				
			Age	General experience	Professional experience	24-h duties experience	Weekly 24-h duties experience
Short-term memory volume (quantity of numbers)	5,46 ± 0,31	61	-0,322	-0,269	-0,269	-0,263	-0,244*
Mistakes in short-term memory (quantity of numbers)	2,80 ± 0,32	61	0,252*	0,271	0,221*	0,231*	-
Attention concentration duration (rings crossing out) (s)	127,00 ± 3,05	58	0,466	0,451	0,470	0,361	0,361
Number of crossed out right rings	43,59 ± 0,65	58	-	-	-	-	-
Number of crossed out wrong rings	0,22 ± 0,07	58	-0,273	-0,286	-0,268	-0,250*	-
Number of the missed rings	4,41 ± 0,65	58	-	-	-	-	-
General volume of the ring information processing (c.u.)	142,50 ± 2,35	58	-0,246*	-0,250*	-	-	-
Velocity of the ring information processing (c.u.)	1,14 ± 0,03	58	-0,454	-0,449	-0,421	-0,354	-0,376
Number of correct solutions of simple tasks under time pressure	44,05 ± 2,56	59	-0,604	-0,596	-0,570	-0,501	-0,497
Mean time of simple tasks solutions under time pressure (ms)	2098,08 ± 2,56	59	0,665	0,657	0,639	0,548	0,535
Percentage of correct solutions of simple tasks under time pressure	46,58 ± 0,62	59	-0,554	-0,565	-0,551	-0,528	-0,530
Percentage of wrong solutions of simple tasks under time pressure	17,10 ± 0,97	59	-	-	-	-	-0,256*
Percentage of missed simple tasks under time pressure	36,31 ± 1,20	59	0,430	0,407	0,414	0,449	0,483
Number of correct solutions of complex tasks under time pressure	18,26 ± 0,89	58	-0,581	-0,551	-0,570	-0,461	-0,433
Mean time of complex tasks solutions under time pressure (ms)	3925,26 ± 130,53	58	0,417	0,424	0,443	0,290	0,291
Percentage of correct solutions of complex tasks under time pressure	37,98 ± 0,98	58	-0,510	-0,451	-0,466	-0,365	-0,349
Percentage of wrong solutions of complex tasks under time pressure	20,34 ± 1,67	58	-	-	-	-	-
Percentage of missed complex tasks under time pressure	41,67 ± 1,69	58	0,266	0,220*	0,277	0,280	0,295
Attention switching duration (s)	178,81 ± 6,75	58	0,368	0,359	0,376	0,330	0,404
Number of mistakes under attention switching	2,07 ± 0,32	58	0,280	0,269	0,265	0,308	0,344
Reproduction of 2-5s (%)	92,75 ± 1,21	63	-	-	-	-	-
Deviation from presented 2-5s, %	17,62 ± 0,75	63	0,244*	-	0,213*	0,216*	-
Reproduction of 2s, %	97,16 ± 2,03	63	-	-	-	-	-
Deviation from presented 2s, %	18,23 ± 1,17	63	-	-	-	0,252	0,279
Reproduction of 3s, %	94,91 ± 1,67	63	-	-	-	-	-
Deviation from presented 3s, %	16,19 ± 1,02	63	-	-	-	-	-
Reproduction of 4s, %	91,48 ± 1,90	63	-	-	-	-	-
Deviation from presented 4s, %	18,07 ± 1,40	63	-	-	0,215*	-	-
Reproduction of 5s, %	87,44 ± 1,37	63	-	-	-	-	-
Deviation from presented 5s, %	18,00 ± 1,01	63	-	-	-	-	-

Note. Significant correlation coefficients ($p < 0,05$) and trends ($0,05 < p < 0,10$ – in italics and marked with the asterisks) are presented. Gray background shows the contrasts to normal age related changes.

quality is a professionally important parameter for surgeons. It is worth to note that no significant correlation of this parameter was found with the weekly 24-h duties experience, which could reflect the negative effect of the intensive night working on the professionally important cognitive function (the attention concentration quality) of surgeons.

The time perception showed no age or experience related changes for majority of the studied parameters. The only exception was found: the reproduction time deviation from the presented 2-second intervals significantly increased with an increase in (weekly) 24-hour duties experience. This could evidence of the negative effect of night work on the time perception accuracy of the shortest temporal intervals. Also, some age and experience related trends in the reproduction time deviations were found for the whole data pull and for 4-second intervals. No significant correlations were revealed for the mean reproduction times.

No significant differences between age and experience related correlation coefficients were found for any cognitive performance parameter. At the same time, the most big number of the most high correlation coefficients within the rows of age-experience parameters were found for parameters of «age» (7 cases) and «weekly 24-h duties experience» (6 cases), evidencing the sources of the most pronounced effects. In this, age related most high correlations showed negative effects on the short-term memory capacity, on the velocity of attention concentration and, under time pressure, – on its productivity, while weekly 24-h duties – on the attention switching (velocity and accuracy), number of the missed tasks under time pressure and the reproduction time deviation from the presented 2-second intervals. In fact, an increase in the number of the missed tasks under time pressure evidences of the rejection to give any reply, until the qualitative decision is made, and that is why this is not a negative characteristic. In support of this idea one could find a decrease trend in wrong solutions with the increase in the weekly 24-h duties experience. Finally, this fact reaffirms a many-year maintenance of the quality of the attention demanding information processing in surgeons and shows that night work experience supports this under time pressure.

Our findings on the age related deteriorations in the short-term memory capacity, in the velocity of attention concentration and ,also, under time pressure – in its productivity, correspond with the litera-

ture data on the age caused decrease in the nerve conduction velocity [21] and, as a consequence, in the velocity of solutions of many test tasks [1–4]. A similar experience related changes could be caused by significant correlations of age and experience parameters in the working populations.

The received results on the age and experience related improvement in the quality of the attention concentration, as well as under time pressure – on the conservation of it, are not consistent with the known data on the attention level decline with aging in the population [22] and could manifest a special professional importance of this characteristic for surgeons.

The mean interval reproduction time did not show dependence on age and experience related parameters, which partly corresponds with the literature data, regarding aging [23]. The revealed trends to an increase in deviation of 2–5-sec intervals' reproduction with an increase in age or some experience related parameters, also, partly correspond to the literature data, regarding aging [23, 24]. At the same time, the found isolated significant increase in deviation of 2-sec intervals' reproduction with an increase in a 24-h duty experience could evidence of the accelerated aging in this function as a specific unfavourable change in the central nervous system activity, owing to the regular night working.

Similarly, age and experience related deteriorations in the attention switching partly correspond with the literature data on age deficits in task-switching [25]. However, some higher correlation coefficients with the weekly 24-h duty experience could suggest, also, some negative effect as the accelerated aging in this function, owing to the regular night work.

Conclusion

The cognitive performance of surgeons is the integral result of the normal age-related decline and professionally caused improvement, preservation (by virtue of the professional relevance) or worsening (due to occupational hazards) in some functions of the higher nervous activity.

Normal age and experience related declines were revealed in the cognitive performance of surgeons: in the short-term memory capacity, in the attention switching, in the velocity of the information flow processing, demanding an attention concentration, under time pressure, also, in the productivity of the information flow processing.

Age and experience related improvements in the quality of the attention concentration and its preservation (independence on age or experience) under time pressure could reflect the professional importance of this characteristic for surgeon work.

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Чернюк В. І., Бобко Н. А., Яворський Є. Є.

ВІКОВІ ТА СТАЖЕВІ ЗМІНИ ЕФЕКТИВНОСТІ КОГНІТИВНОЇ ДІЯЛЬНОСТІ В ХІРУРГІВ В УМОВАХ ДОБОВИХ ЧЕРГУВАНЬ

Державна установа «Інститут медицини праці Національної академії медичних наук України», м. Київ

Вступ. З віком знижується швидкість переробки інформації, здатність обробляти нову й складну інформацію. У той самий час семантична та логічна пам'ять, вміння порівнювати, класифікувати й комбінувати в осіб розумової праці залишаються високими в силу професійної значущості цих характеристик. Однак шкідливі умови праці можуть негативно впливати на функції розумової діяльності.

Мета дослідження – виявити вікові та стажеві зміни когнітивних функцій у хірургів в умовах добових чергувань.

Матеріали та методи дослідження. 64 хірурга обстежено на робочих місцях за допомогою комп'ютерних тестів розумової діяльності. Вік обстежених становив 24–62 років, загальний стаж роботи – 1–42 роки, стаж роботи в професії – 1–39 років, стаж добових чергувань – до 39 років, стаж щотижневих добових чергувань – до 33 років. Кореляція за Пірсоном на рівні значущості $p < 0,05$ розглядалася як достовірна, на рівні $0,05 < p < 0,10$ – як тенденція.

Результати. Виявлено нормальне вікове та стажеве погіршення короткочасної пам'яті, переключення уваги, швидкості концентрації уваги в умовах дефіциту часу і продуктивності концентрації уваги. При цьому, зі збільшенням віку та стажу роботи, у хірургів виявлено достовірне поліпшення якості концентрації уваги, в умовах дефіциту часу – його збереження на попередньому рівні, зі збільшенням стажу добових чергувань – достовірно знижувалася точність відтворення 2-секундних інтервалів часу (3–5-секундних – не змінювалася).

Висновки. Ефективність когнітивної діяльності хірургів є інтегральним результатом нормального вікового зниження й професійно зумовленого поліпшення, збереження (у силу професійної значущості) або погіршення (у силу професійних шкідливих чинників) деяких функцій вищої нервової діяльності. Виявлене вікове та стажеве поліпшення якості концентрації уваги може відображати професійну значущість цієї характеристики в роботі хірургів. Погіршення точності відтворення коротких часових інтервалів можна пов'язувати з прискореним старінням цієї функції в умовах систематичних нічних чергувань.

Ключові слова: старіння, пам'ять, увага, сприйняття часу, переробка інформаційного потоку

Чернюк В. И., Бобко Н. А., Яворский Е. Е.

ВОЗРАСТНЫЕ И СТАЖЕВЫЕ ИЗМЕНЕНИЯ ЭФФЕКТИВНОСТИ КОГНИТИВНОЙ ДЕЯТЕЛЬНОСТИ У ХИРУРГОВ В УСЛОВИЯХ СУТОЧНЫХ ДЕЖУРСТВ

Государственное учреждение «Институт медицины труда Национальной академии медицинских наук Украины», г. Киев

Вступление. С возрастом снижается скорость переработки информации, способность обрабатывать новую и сложную информацию. В то же время семантическая и логическая память, умение сравнивать, классифицировать и комбинировать у лиц умственного труда остаются высокими в силу профессиональной значимости этих характеристик. Однако вредные условия труда могут отрицательно влиять на функции умственной деятельности.

Цель исследования – выявить возрастные и стажевые изменения когнитивных функций у хирургов в условиях суточных дежурств.

Материалы и методы исследования. 64 хирурга обследованы на рабочих местах с помощью компьютерных тестов умственной деятельности. Возраст обследованных составил 24–62 года, общий стаж работы – 1–42 года, стаж работы в профессии – 1–39 лет, стаж суточных дежурств – до 39 лет, стаж еженедельных суточных дежурств – до 33 лет. Корреляция по Пирсону на уровне значимости $p < 0,05$ рассматривалась как достоверная, на уровне $0,05 < p < 0,10$ – как тенденция.

Результаты. Виявлено нормальное возрастное и стажевое ухудшение кратковременной памяти, переключения внимания, скорости концентрации внимания в условиях дефицита времени и продуктивности концентрации внимания. При этом, с увеличением возраста и стажа работы у хирургов выявлено достоверное улучшение качества концентрации внимания, в условиях дефицита времени – его сохранение на прежнем уровне, с увеличением стажа суточных дежурств – достоверно снижалась точность воспроизведения 2-секундных интервалов времени (3–5-секундных – не изменялась).

Выводы. Эффективность когнитивной деятельности хирургов является интегральным результатом нормального возрастного снижения и профессионально обусловленного улучшения, сохранения (в силу профессиональной значимости) или ухудшения (в силу профессиональных вредных факторов) некоторых функций высшей нервной деятельности. Виявленое возрастное и стажевое улучшение качества концентрации внимания может отражать профессиональную значимость этой характеристики в работе хирургов. Ухудшение точности воспроизведения коротких временных интервалов можно связывать с ускоренным старением этой функции в условиях систематических ночных дежурств.

Ключевые слова: старение, память, внимание, восприятие времени, переработка информационного потока

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Контактна особа: Бобко Наталія Андріївна, доктор біологічних наук, лабораторія гігієни та фізіології змінної праці, ДУ «Інститут медицини праці НАМН України», буд. 75, вул. Саксаганського, м. Київ, 01033.
Тел.: + 38 0 44 289 46 05. Електронна пошта: nbobko@bigmir.net