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PSYCHOPHYSICAL FITNESS AND PAVLOV'S TEMPERAMENT TYPES

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Introduction: The article relates to the motor learning effect and the relationship between psychophysical fitness and Pavlov's temperament type. A study was conducted to determine whether the score in each of the temperament scales is associated with individual response parameters.

Methods: The study was conducted using triplicate measurements in 58 subjects. The Piórkowski apparatus was used for the assessment of visual-motor coordination and response parameters.

Results: In line with the assumptions, subject response parameters improved in sequential measurements which may be considered a motor learning effect. In addition, individuals with high mobility of neural processes (RPN) have a significantly higher rate of correct responses in the third measurement as compared to subjects with low RPN. In contrast to the assumptions, no significant differences were observed in psychophysical fitness in individuals with different stimulation strength (SPP) and inhibition strength (SPH) values.

Conclusion: Temperament traits have impact on the acquisition of skills related to motor tasks.

Keywords: reaction time, temperament, time pressure, visual-motor coordination

Figure: 1 • **References:** 29 • **Full-text PDF:** http://www.pjamp.com • **Copyright** © 2014 Polish Aviation Medicine Society, ul. Krasińskiego 54/56, 01-755 Warsaw, license WIML • **Indexation:** Index Copernicus, Polish Ministry of Science and Higher Education

INTRODUCTION

Besides examination of intellectual capacity and personality, the analysis of psychomotor efficiency is an important element in prognosing the abilities to learn new skills and assessing the operational efficiency, e.g. in driving, using machines, playing computer games or engaging in sporting activities. Instrumentation-based tests are one of the methods to verify the psychomotor efficiency levels [7]. In the methodology of psychological tests for drivers [22] a hypothesis was made that the Piórkowski apparatus could be useful for the assessment of fatigue manifesting in reduced task performance or, in case of increasing performance curves, the assessment of learning and experience gaining abilities. The hypothesis has not been validated to date. My study is an attempt of verifying if the Piórkowski apparatus is a suitable tool for determination whether one may speak of motor learning in case of tasks performed within relatively short times, as to date, the term has been used rather to describe long-term acquisition of skills, such as when learning to drive [1]. The study also attempts to verify whether there are any changes in the potential variability in the performance of individual tasks depending on the biologically determined temperament traits being measured.

Psychophysical fitness

The performance level of all tasks largely depends on psychophysical fitness. According to definition proposed by Cheiken et al. [7], tasks requiring psychophysical fitness consist in adequate differentiation of perceptive stimuli (visual, aural or tactile) followed by a motor response (limb movement, ocular movement or vocal response). Reaction speed, processing speed and accuracy may be considered the main dimensions of psychophysical fitness [7,21]. Fleishman [12] proposed that the performance level depended on interactions between the task learning process and the cognitive abilities of the subject. He postulated that overall cognitive abilities played an important role at the initial stage, while the further part of the action was dependent mainly on the subject's perceptive and motor abilities. Consequently, Fleishman identified 11 different psychomotor factors, including visual-motor coordination as well as the reaction time.

Fleishman's proposals were reflected in the skill acquisition theory [1] that divides the skill acquisition process into three stages. In the first stage, determined by the overall cognitive abilities, including attention, learning is the most important process affecting the performance. At the second stage, the performance level depends mainly on the perception speed: the ability to increase proficiency leads to faster performance and increased accuracy. The third stage is associated with gradual automation of the activity so that attention may be turned towards performing another task simultaneously. Similar conclusions are drawn from the studies by Cheiken and co-workers [7], who concluded that the initial performance level of a psychomotor task was influenced mainly by the operational memory, with processing speed gaining on importance once the task is mastered.

Reaction time

The reaction time is the time required to react to the stimulus. Depending on the complexity of the task, tests can be divided into simple response tests, where the task involves one type of stimulus and one correct response, and complex response tests, which may be either Go/NoGo-type tests (involving response to a particular stimulus and no reactions to other stimuli) or response choice tests (different reactions to different stimuli).

The reaction time is affected by the following categories of variables: number, type and intensity of stimuli, age, sex, intelligence, fatigue, agitation, personality traits.

The reaction time increases with the intensity and number of stimuli being responded to and is longer to visual stimuli as compared to aural stimuli [17].

The simple reaction time is reduced from the childhood to the end of the third decade of life, to rise again after the age of 50-60. After the age of 70, the reaction time is significantly elongated. The reaction times become continuously longer throughout the adult lives of the study patients [11].

The mean simple reaction time in early and mid-adult periods is not significantly related to subjects' sex, with complex reaction times being significantly more differentiated in women. The simple and complex reaction times in elderly patients increase much faster in women compared to men [11].

When subjects are tired, their reaction times are longer, and the largest effect of exhaustion is caused by sleep deprivation [11].

Depending on the stimulation level, the reaction time assumes the shape of the letter U: the reaction times are shortest for mean stimulation levels and increase when the subject is too relaxed or too stressed [11].

Visual-motor coordination

The concept of visual-motor coordination refers to the human ability to perform precise hand movements controlled by the vision. Visual-motor coordination covers a wide scope of activities related to manual dexterity, from intentional reaching and grasping objects to the skilled movements of fingers of pianists or surgeons [4]. A controlled, precise and fast movement requires integrated involvement of vision and movements of arms, hands and fingers [13]. The model of the standard course of a task requiring cooperation of the vision and motor organs as proposed by Bard and colleagues [4] consists of five stages:

1. visual detection of the target;
2. focus on the target;
3. perceptive identification and location of the target;
4. cognitive plan of the reaching movement;
5. activation of the arm muscles to initiate the reaching action.

The procedure requires involvement of many systems, including the sensory system, the perceptive system, the central executive system, the attention and motivation system as well as the motor system. Information from proprioceptors and the vision organ are used to adjust and correct the movement [13].

In psychological practice, Dufour apparatus and Piórkowski apparatus are used for the measurements of visual-motor coordination [22].

Performance under time pressure

Time pressure is one of the stressors that cause the anxiety and increase the dynamics of human activities. Time pressure affords a change in the processes that constitute the basis for the evaluation and decision making process [19]. Contradictory opinions can be found regarding the quality of decisions made in restricted time conditions: Svenson and Benson [14] suggest an increase in quality while other studies demonstrate a reduction in the quality of decisions made under time pressure [14] as well as reduced preference for risk-taking [19].

The negative effect of time pressure on the performance of various tasks was observed in many studies [16,18,20]. Zakay proposed that the cause of this effect was a reduction in cognitive capabilities leading to adoption of simplified behavioral strategies and thus to increased number of errors [27].

Considering the above data, one may expect that at the level of behaviors requiring psychomotor fitness, time pressure would lead to shorter reaction times and higher numbers of mistakes. Curve-like decrease in performance and increase in the number of errors as a function of increasing time pressure was demonstrated by Hendy, Liao and Milgram [15].

Pavlovian concept of temperament

Typology of temperaments according to Hippocrates and Galen

The temperament is a psychological construct that relates to relatively constant personality traits present in an individual from early childhood and having their equivalents in the animal world. Primarily determined by congenital neurobiological mechanisms, temperament undergoes slow changes associated with maturation and individually specific interactions between the genotype and the environment [26].

The existence of psychological differences between individuals as well as relative constancy of psychological traits in individual humans have been known since ancient times. In the 4th century BC, a theory which may be considered the first typology of temperament was developed. The theory is believed to be authored by Hippocrates – the pioneer of contemporary medicine, and Galen, a Greek physician. Hippocrates identified four bodily fluids (humors) responsible for its nature: blood, phlegm, bile and black bile. Diseases were to be caused by imbalances between these humors. In reference to the theory provided by Hippocrates, Galen identified four types of temperament that were due to the prevalence of one of the humors. They included: sanguinic (Latin sanguinus – blood), phlegmatic (Greek phlegma – phlegm, mucus), choleric (Greek cole – bile) and melancholic (Greek melas – black, cole – bile).

Pavlov's typology of neural system

The typology proposed by Hippocrates and Galen became widely popular, as shown by numerous references from today's researchers in the psychology of inter-individual differences [24] as well as use of the names indicating the temperament types in vernacular language. One of the most important theories of temperament, developed on the basis of this typology, is the neural system theory developed by Ivan Pavlov in the first half of the 20th century. When studying the conditional reflex behaviors in dogs, Pavlov notices a constancy of inter-individual differences in the conditioning process, associated with the speed and accuracy of the development and disappearance of reflexes as well as with their intensity. The principle of nervism, stating that each behavior is controlled by the central nervous system, led to the hypothesis that the source of such differences could be found in the properties of basic neural processes. These properties include stimulation strength (SPP), inhibition strength (SPH), balance between both these processes (RWN) and the mobility of neural processes (RPN). When identifying individual traits of the neural system, Pavlov focused on their adaptational importance rather than on their neurophysiological principles [26].

SPP is associated with functional capacity of nerve cells, i.e. with their ability to work under conditions of long-term, or short-term, albeit strong, stimulation. According to Pavlov, the main indicator of SPP is the development of inhibition that protects the central nervous system from strong, long-term or repeated stimulation. It consists in responses being inadequate to the strength of the stimulus, for example in response being reduced or disappearing, or in emotional disturbances. Subjects with strong nervous systems respond in adequate manner even to intense and persistent stimuli, while individuals with weak types of the nervous system develop protective inhibition in response to short or low-intensity stimuli.

SPH relates to the ability to maintain conditional inhibition that is manifested by delaying, quenching, or differentiating responses. According to Pavlov, the main indicators of SPH include the ease of development of inhibitory conditional reflexes by the central nervous system and the duration of this inhibition. High SPH is manifested by subject's ability to abstain from certain responses when necessary, as well as to interrupt or delay actions depending on situation.

RWN, being the ratio between SPP and SPH, is a secondary trait. its role is associated with the necessity to inhibit certain stimulations so as to facilitate adequate response to new stimuli.

RPN is manifested by the nervous system's ability to quickly switch between the stimulation and inhibition processes and vice versa. At the behavioral level, RPN is manifested by adequate responses to rapidly changing situations.

In reference to the temperament typology of Hippocrates and Galen, Pavlov identified four combinations responsible for different nervous system types (temperaments). These include: weak nervous system (melancholic), strong nervous system with predominance of stimulation compared to inhibition, (choleric), strong, balanced nervous system with low mobility (phlegmatic) and strong, balanced nervous system with high mobility (sanguinic). According to Pavlov, these types of the nervous system, although identified in dogs, can also be useful in humans. Psychometric measurement of temperament traits is facilitated by the Pavlovian Temperament Survey (PTS) [29].

Functional importance of temperament in adults

In his nervous system typology, Pavlov pointed out the importance of individual traits in the environment adaptation process. When studying the functional importance of temperament, the assumption was made that preferred styles of activity and particular stimulatory value of a given situation depended on the temperament traits. This means that the need to act in conditions inadequate to capabilities defined by individual's temperament is a stress factor that reduces the performance level and oftentimes leads to strong negative emotional responses. In a longer perspective, this might lead to mental or somatic disorders [26].

Studies on the importance of temperament usually focused on professional functioning; activity styles and efficiency in different professions were taken into consideration [25]. People were shown to perform their jobs in an individualized manner that depends on their temperament, leading to comparable efficiency of work provided by individuals with different temperament types. Another interesting conclusion drawn from these studies is that individuals performing different jobs differ in their temperament traits. Thus, a hypothesis can be proposed that the temperament, while determining individual's optimum style and form of activity with a particular stimulation profile, also determines the occupational preferences of that individual. Studies showed that workers performing jobs associated with high levels of physical stimulation (firefighters, steelworkers, train engine drivers) or social stimulation (lawyers, managers) were characterized by particularly high levels of SPP, while low SPP levels were observed in individuals performing low-stimulation jobs (librarians) [25].

An interesting problem would be to examine the temperament structure in the context of basic psychophysical fitness dimensions of visual-motor coordination and reaction time in individuals performing difficult jobs that require high levels of psychomotor fitness.

Temperament and psychophysical fitness

Considering the fact that the basic dimensions of temperament as identified by Pavlov are significantly correlated with other personality traits, one may conduct studies to consider possible correlations between the temperament and psychophysical fitness. This can be supported by the fact that according to some researchers, personality traits are biologically determined and thus personality and temperament may constitute two distinct ways to describe the same properties [29].

SPP and RPN are positively correlated with activity and endurance – traits associated with the Regulatory Theory of Temperament [24] and extraversion. De Vries and Van Heck [10] demonstrated an inverse relationship between extraversion and SPP and between SPP and susceptibility to fatigue while no significant relationships could be found for SPH and RPN. Bajcar noticed that individuals with high endurance, i.e. characterized by high SPP levels by definition, perceived the time pressure to be less intense, with no significant reduction being observed in task quality or mood. On the other hand, de Pascalis, Strelau and Zawadzki [9] observed the relationship between low endurance and longer times of reaction to unpleasant stimuli. An interesting relationship between the reaction times and extraversion was observed in studies that included the stimuli presentation rate as covariate: when the rate was slow, reaction times of extravertic individuals were significantly longer than those of introvertic subjects [5] while an opposite relationship was observed when the stimuli changed at a rapid pace; in addition, introvertic subjects provided a lower number of false positive responses [6]. The result may be due to the stimulation demand and stimulation level ensuring most effective performance being higher in extravertic individuals [26]. The fact that extravertics provided more incorrect responses in the context of their high SPP levels characterized by adequate and effective performance in strong stimulation conditions may be due to the fact that SPP is strongly correlated with both the activity and endurance wile extraversion is strongly correlated in a positive manner with activity, but poorly correlated with endurance [28].

The mobility of behavior is also associated with the perception of time pressure: individuals characterized by the ease of quickly and adequately responding to changes in the environment subjectively perceive the time flow and pressure to a small degree and their performance is adjusted to time limitations [3]. No differences were demonstrated in the reaction times between subjects with different levels of vigorousness [9], which is correlated with RPN and SPP [29].

The SPH dimension is also associated e.g. with emotional reactivity and neuroticism [29]. Individuals with high SPH levels are characterized e.g. by their ability to conceal emotions and inhibit behaviors when necessary while high emotional activity is manifested by a tendency towards intense reactions to stimuli and low emotional resistance. Highly reactive subjects experience problems with organization of performance under time pressure conditions [3] and their reaction times in psychomotor tasks are longer [9]. Individuals characterized by high neuroticism are more prone to fatigue [10] and have shorter reaction times [23]. Upon increasing stimuli presentation rates, their reactions become faster at the cost of reduced number of correct answers [8]. In addition, neurotic students were characterized by more diverse reaction times than compared to their more balanced peers [17].

The aforementioned results are consistent with the theory that subjects with higher SPP, SPH and RPN levels achieve better results when performing tasks under time pressure than subjects with lower SPP, SPH and RPN levels.

Research problems

The objective of the study was to test the performance as the function of time and to determine whether the temperament was a covariate that might lead to changes in the reaction times over time.

Relating the repeated measurement using the Piórkowski apparatus to the motor learning process one may expect that subjects would perform the task with increasing efficiency in subsequent trial runs.

Therefore, the following hypothesis may be proposed:

Hypothesis 1

In sequential measurements, the number of correct responses will rise while the number of incorrect responses, the number of stimuli ignored and the mean reaction time will decrease.

Starting from Pavlov's definition of temperament traits, one may attempt to search for correlations between those traits and the basic dimensions of psychophysical fitness. One might expect that inhibition strength (SPH), manifested in the ease to abstain from behaviors inconsistent with expectations, and therefore is related to the accuracy of performance, would affect the results obtained by the subject as regards the number of incorrect responses and numbers to light stimuli ignored using the Piórkowski apparatus. Taking into consideration the number of stimuli ignored, one might expect that subjects with high SPH levels, striving to avoid mistakes, would prefer not to respond than to respond incorrectly. This leads to the following hypothesis:

Hypothesis 2

Subjects with high SPH scale scores would make less mistakes in sequential measurements while ignoring a larger number of stimuli in the task involving the use of the Piórkowski apparatus as compared to subjects with low SPH scale scores.

SPP, related to extraversion and endurance, should be manifested in the evenness of performance. Since no emotional disorders or reduction of performance was observed in subjects with high SPP scores when carrying out tasks under physical stress, i.e. under time pressure due to the rapid pace of stimuli being displayed, one may expect that these individuals would respond quickly and accurately throughout the study or that the drop in the performance would be small as compared to subjects with low SPP scores who would be increasingly tired with the test. Therefore, individuals with SPP scores would be characterized by better visual-motor coordination. This leads to the following hypothesis:

Hypothesis 3

Subjects with higher scores in the SPP scale would provide more correct responses in sequential measurements using the Piórkowski apparatus as compared to subjects with low SPP scores, and the number of correct responses would undergo only slight changes, if any, over time. The number of correct responses from subjects with low SPPP levels would decrease in each trial run. Mean reaction times for subjects with low SPP scale scores would be longer than those for subjects with high SPP scale score and would increase in sequential trial runs while being maintained at similar levels for subjects with high SPP scale scores.

High RPN level, manifested by adequate responses to unexpected changes in the environment, the ease of switching between tasks and fast adaptation to conditions may be considered to be an element of the motor learning if it is associated with the increase in performance parameters in time relative to subject with low RPN levels. This would indicate motor automation of the response. Therefore, the following hypothesis may be proposed:

Hypothesis 4

Subjects with higher scores in the RPN scale would provide more correct responses in sequential measurements using the Piórkowski apparatus as compared to subjects with low RPN scores, and the number of correct responses would increase over time. The number of correct responses in subjects with low RPN scale scores would decrease or be maintained at a similar level. Mean reaction times for subjects with high RPN scale scores would be shorter than those for subjects with low RPN scale scores and would decrease in sequential trial runs while being maintained at similar levels for subjects with low RPN scale scores.

METHODS

Subjects

A total of 58 volunteers took part in the study, including 41 female and 17 male subjects. Study population consisted of students and working individuals aged 19-40. The mean age was 23.86 years, with standard deviation of 4.44 years and median of 22 years.

The study was conducted in one of the rooms at the Warsaw University Faculty of Psychology in the second half of April 2010. Subjects were examined individually, with examination of each subject taking about 30 minutes.

Variables

Independent variable:
- trial run

Dependent variables:
- number of correct responses
- number of stimuli ignored
- number of incorrect responses
- mean reaction time

Covariates:
- SPP
- SPH
- RPN

Materials

Covariate-related materials – Pavlovian Temperament Survey (PTS)

The study included the use of the Pavlovian Temperament Survey (PTS) by Strelau, Angleitner and Zawadzki [29]. It is useful in diagnosing behavioral characteristics of the basic traits of the nervous system. The theoretical basis is the concept of higher neural activities as proposed by Pavlov. The survey consists of three scales: SPP, SPH and RPN.

The questionnaire consists of four pages. Page 1 includes the following data categories:
1. Name of the survey and the names of the authors.
2. Personal data fields to be filled in with the responder's name (first and last), data of birth, educational level, occupation and address. The responders were asked to enter only their nicknames, year of birth and sex in these fields.
3. Table for entering raw and standardized data (standard ten scale) for each of the questionnaire scales identified by the acronyms SPP, SPH, and RPN.
4. Instruction for the subject.
5. Information on the publishing rights of the questionnaire publisher, i.e. the Laboratory of Psychological Tests of the Polish Psychological Society.

The next three pages of the questionnaire contain questions to be addressed by the responder using a 4-degree response scale. The response scale was provided on top of each page: 1 – strongly agree, 2 – somewhat agree; 3 – somewhat disagree; 4 – strongly disagree.

The PTS questionnaire consists of 57 questions, 19 per each scale, presented in random order.

Completion of the PTS questionnaire took about 15-20 minutes.

Measurement of independent and dependent variables – Piórkowski apparatus

A version of the Piórkowski apparatus by GPE Electronics was used. The device is used to measure visual-motor coordination and attention focus ability as well as to measure the temporal parameters of responses at a predefined pace. The device is widely used in occupational and transportation psychology [23].

The apparatus consists of a test keyboard sized 435 x 110 mm, a microprocessor control panel MPS-03 with LCD display, a power unit and a connection cable. The keyboard consists of 10 buttons located under 10 signal lamps. The control panel is used to adjust the test parameters (test duration, stimulation frequency). The settings of the apparatus and results of individual tests, including the number of correct responses, the number of incorrect responses and number of stimuli ignored, as well as the mean, minimum and maximum reaction times, and the percentage of correct responses are displayed on the LCD screen.

The test consists in individual lamps being lit at a steady, predefined pace. Lamps go off before the next lamp is turned on. The task of the subjects is to press the buttons corresponding to the lamps being lit in a possibly fastest and possibly most accurate manner. The study subjects perform the test in standing position using both index fingers. The proper study was preceded by a mock session (60 stimuli per minute for 20 seconds). The proper test consisted of three 60-second runs with the frequency of 110 stimuli per minute, including short breaks between each run to allow the researcher to record the displayed results. The subjects were informed that the test pace would be higher than that in the mock run.

Procedure

The subjects were informed that the test was conducted as a part of the annual empirical seminar being a part of the curriculum for the third year of the Faculty of Psychology at the University of Warsaw, that the test was anonymous and that its objective was to measure the temperament traits and psychomotor reactions measured in standard drivers' tests. Subjects were informed that the test would not measure their intelligence or personality. They were also informed that the analysis would include the overall results of the entire study group, not those of individual subjects. Having provided consent to participate in the study, the subjects separately entered the room where they completed the PTS questionnaire and were subjected to the visual-motor coordination and psychomotor response test using the Piórkowski apparatus. After completion of the study, willing subjects were provided with detailed information on the assumptions and hypotheses of the study. When asked by the subject about their performance against other subjects, the responder answered that the raw data were not analyzed yet and thus no comparisons could be made.

Statistical analysis

The statistical analysis included the repeated measure analysis of with the measurement timing as the intra-subject factor and the intensity of individual temperament traits as the inter-subject factor. The subjects were assigned to groups of high and low intensity of particular trait relative to the median value.

RESULTS

The main effect of the order of measurements in the context of correct responses was statistically significant, $F(2, 112) = 26.520$; $p < 0.001$; $\eta^2 = 0.321$. The number of correct responses increased with sequential trial runs. Significant differences were observed between the first and the second measurement ($M = 79.637$; $SD = 20.721$ and $M = 88.224$; $SD = 14.668$, respectively) as well as between the first and the third measurement ($M = 79.637$; $SD = 20.721$ and $M = 90.328$; $SD = 14.448$, respectively).

The main effect of the order of measurements in the context of incorrect responses to was statistically significant, $F(2, 112) = 21.885$; $p < 0.001$; $\eta^2 = 0.281$. The number of incorrect responses decreased with sequential trial runs. Significant differences were observed between the first and the second measurement ($M = 18.758$; $SD = 14.630$ and $M = 13.052$; $SD = 9.618$, respectively) as well as between the first and the third measurement ($M = 18.758$; $SD = 14.630$ and $M = 11.948$; $SD = 9.252$, respectively).

The main effect of the order of measurements in the context of the number of stimuli ignored was statistically significant, $F(2, 112) = 20.618$; $p < 0.001$; $\eta^2 = 0.273$. The number of ignored stimuli decreased with sequential trial runs. Significant differences were observed between the first and the second measurement ($M = 11.603$; $SD = 6.204$ and $M = 8.368$; $SD = 5.361$, respectively) as well as between the first and the third measurement ($M = 11.603$; $SD = 8.371$ and $M = 7.724$; $SD = 5.398$, respectively).

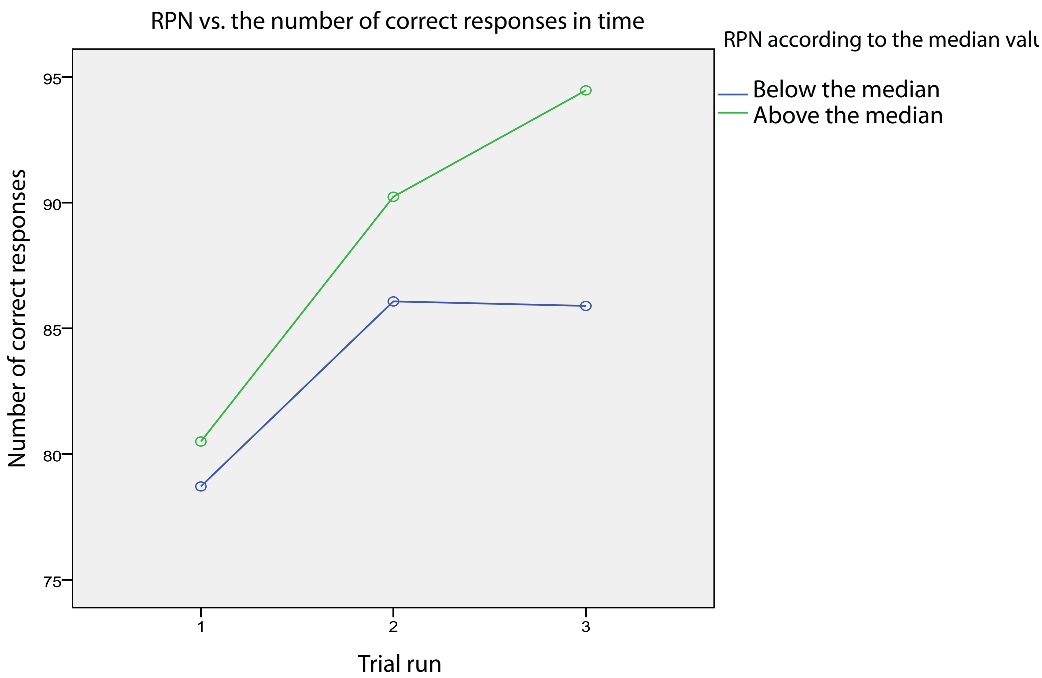

Fig. 1. RPN vs. the number of correct responses in sequential measurements using the Piórkowski apparatus.

The main effect of the order of measurements in the context of the mean reaction time was statistically significant, $F(2, 112) = 102.024$; $p < 0.001$; $\eta^2 = 0.646$. The mean reaction time decreased with sequential trial runs. The results were significantly different for each of the three trial runs (mean reaction time for the first measurement: M = 0.441; SD = 0.025, second measurement: M = 0.426; SD = 0.026, third measurement: M = 0.419; SD = 0.029).

No interaction effect was observed between the SPH level and the trial run for number of incorrect responses, $F(2, 112) = 0.059$; NS, or for the number of stimuli ignored, $F(2, 112) = 0.495$; NS.

No interaction effect was observed between the SPP level and the trial run for number of correct responses, $F(2, 112) = 2.125$, NS, or for the mean reaction times, $F(2, 112) = 0.445$; NS.

The interaction effect between the RPN level and the order of measurements in the context of correct responses was significant at a trend level, $F(2, 112) = 2.464$; $p < 0.090$; $\eta^2 = 0.042$.

Following Bonferroni adjustment, a significant difference was observed between the number of correct reactions in the third measurement in individuals with lower RPN levels as compared to individuals with higher RPN levels (M = 85.893; SD = 17.746 and M = 94.467; SD = 8.966, respectively). For subjects with RPN below the median value, significant differences were observed between the first and the second measurement (M = 78.714; SD = 23.075 and M = 86.071; SD = 18.411, respectively) as well as between the first and the third measurement M = 78.714; SD = 23.075 and M = 85.893; SD = 17.746, respectively); for subjects with RPN, significant differences were observed for all three measurements (first measurement: M = 80.500; SD = 18.617, second measurement: M = 90.233; SD = 9.933, third measurement: M = 94.467; SD = 8.966) The relationships are presented in Fig. 1.

No interaction effect was observed between the RPN level and the trial run for mean reaction times, $F(2, 112) = 1,278$; NS.

DISCUSSION

The problem discussed in the article was related to the motor learning process and the relationship between psychophysical fitness and temperament dimensions according to Pavlov's nervous system typology theory. The study consisted in responding to lamps being at a high pace in the Piórkowski apparatus. I was interested whether a motor learning effect, consisting in the increase in number of correct responses and reduction in the number of incorrect responses, ignored stimuli and the reaction time in sequential trial runs could be observed. I also reflected upon whether in the context of Pavlov's theory of temperament significant differences in task performance could be observed between subjects with low versus high levels of SPP, SPH and RPN. RWN, being secondary to SPP and SPH, was not taken into account.

The results of the statistical analyses demonstrated main measurement order effects occurring for each of the dependent variables, consisting in the parameters being changed as predicted. The reaction times were reduced significantly with every sequential measurement while the number of correct responses in the second and third measurements was significantly higher than in the first measurement. Similar relationship was observed for incorrect responses and ignored stimuli: in the first measurement, the subjects performed the task less efficiently than in the two subsequent trials, with no statistically significant differences between the latter.

The performance level was not related to temperament differences in either SPP or SPH scales. In light of the results, one may not conclude that these dimensions correlate with better performance of motor tasks.

A significant difference was observed in the third measurements between individuals with different RPN levels. Subjects with higher RPN levels provided more correct responses in the last part of the test as compared to individuals with lower RPN levels. The result is consistent with the results of the measurements of the sense of time and efficiency of performance in the conditions of time pressure [3]. However, the difference was not reflected in the measurements of the reaction times. Although contradictory to the hypothesis, this observation was consistent with the results of another study [9]. A possible interpretation is that individuals with higher RPN levels are characterized by increased psychophysical fitness, which is consistent with the description of RPN as a trait allowing for example adequate reactions to rapid changes in the environment. However, no conclusions regarding task automation processes being faster in subjects with higher RPN levels may be drawn from the results of this study.

The obtained result allows to assume that one may speak of motor learning in the context of eye-hand coordination tests using the

Piórkowski apparatus despite the fact that the duration of the activity to be learned was short, and motor learning is most commonly mentioned in reference to longer-term activities such as driving [1]. Therefore, measurements using the Piórkowski apparatus may also be used to draw conclusions regarding more complex psychomotor fitness-involving tasks. Furthermore, the obtained result raises the question regarding its placement in the Ackerman's three-stage concept of motor learning [1]. Since a significant improvement in the outcomes was observed as early as in the second measurement, one may assume that the first stage, i.e. the learning stage, was taking place during the first stage. The second stage, associated with an increase in accuracy, would be taking place during the second and probably during the third stage, as no significant differences were observed between the second and third measurement in all parameters other than the mean reaction time. According to Ackerman, the performance at this stage depends mainly on perceptive efficiency. This was somewhat confirmed by the differentiation of performance outcomes depending on the RPN level. Subjects with higher RPN levels improved their performance with every measurement, indicating that the maximum performance level had not been met to suggest automation of responses characteristic for the third stage of the learning process. No conclusion can be made as well regarding the maximum psychophysical fitness limit being met in the remaining cases, as no subsequent measurements were made and no relevant result distribution data are available. Therefore, the number of trials should be increased in future studies.

Despite the low number of trial runs, the presented study had other limitations as well. Future studies should include larger study samples. Perhaps the relatively low sample was not diverse enough, as the subjects recruited from students and intellectual workers. In addition, intelligence level and baseline fatigue should be monitored as they affect the reaction times. It would also be worthwhile to exclude the factor related to social acceptance due to the close proximity of the subject and the researcher during the measurements. It would also be interesting to extend the study to include other activities and devices measuring psychomotor fitness so as to reduce the effect of a single type of apparatus.

Despite these limitations, the value of this study consists in that no earlier studies had attempted to verify the information provided in the methodology of psychological tests for drivers [22], stating that the repeated measurements using the Piórkowski apparatus are useful in the assessment of visual-motor coordination, ability to learn and susceptibility to fatigue. According to my knowledge, no data on the effect of temperament traits on the temporal performance are also available. One may therefore assume that this was a preliminary study and that further discussion and experiments regarding the motor task learning process and the relationship between the temperament and psychophysical fitness should follow. Such studies would become useful in occupational psychology and transportation psychology for the assessment of individuals performing difficult and dangerous jobs, as well as in standard examinations of drivers.

CONCLUSION:

Temperament traits have impact on the acquisition of skills related to motor tasks.

AUTHORS' DECLARATION:

Study Design: Ewa Matuszewska; **Data Collection:** Ewa Matuszewska; **Statistical Analysis**: Ewa Matuszewska; **Manuscript Preparation:** Ewa Matuszewska; **Funds Collection:** Ewa Matuszewska. The Author declares that there is no conflict of interest.

REFERENCES

1. Ackerman PL. Determinants of individual differences during skill acquisition: Cognitive abilities and information procession. Journal of Experimental Psychology: General 1988; 117:288-318.
2. Bajcar B. Wielowymiarowość osobistych koncepcji czasu. Roczniki Psychologiczne 2000; 3:71-93.
3. Bajcar B. Wskaźniki czasu psychologicznego: przegląd najważniejszych narzędzi pomiaru. Przegląd Psychologiczny 2002; 45:411-29.
4. Bard C, Fleuy M, Hay L. Development of eye-hand coordination across the life span. Columbia: University of South Carolina Press; 1990.
5. Brebner J, Cooper C. The effect of a low rate of regular signals upon the reaction times of introverts and extraverts. Journal of Research in Personality 1974; 4263-276.
6. Brebner J, Flavel R. The effect of catch-trials on speed and accuracy among introverts and extraverts in a simple RT task. British Journal of Psychology 1978; 69:9-15.
7. Chaiken SC, Kyllonen PC, Tirre WC. Organization and components of psychomotor ability. Cognitive Psychology 2000; 40:198-226.
8. Cox-Fuenzalida LE, Swickert R, Hittner JB. Effects of neuroticism and workload history on performance. Personality and Individual Differences 2004; 36:447-56.
9. De Pascalis V, Strelau J, Zawadzki B. The effect of temperamental traits on event-related potentials, heart rate and reaction time. Personality and Individual Differences 1999; 26:441-65.
10. De Vries J, Van Heck GL. Fatigue: relationships with basic personality and temperament dimensions. Personality and Individual Differences 2002; 33:1311-24.
11. Der G, Deary IJ. Age and sex differences in reaction time in adulthood: Results from the United Kingdom Health and Lifestyle Survey. Psychology and Aging 2006; 21:62-73.
12. Fleishman EA. On the relation between abilities, learning and human performance. American Psychologist 1972; 27:1017-32.
13. Gao KL, Ng SS, Kwok JW, Chow RT, Tsang WW. Eye-hand coordination and its relationship with sensori-motor impairments in stroke survivors. Journal of Rehabilitation Medicine 2010; 42:368-73.
14. Garielidou E, Lamers MH. Landmarks and time-pressure in virtual navigation: towards designing gender-neutral environments; 2009. In Lehmann-Grube F, Sablating J. (eds.). Facets of Virtual Environments, Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering. Berlin: Springer; 2010. 60-67.
15. Hendy KC, Liao J, Milgram P. Combining time and intensity effects in assessing operator information-processing load. Human Factors 1997; 39:30-47.
16. Kellogg JS, Hopko DR, Ashcraft MH. The effects of time pressure on arithmetic performance. Journal of Anxiety Disorders 1999; 13:591-600.
17. Kosinski RJ. A literature review on reaction time 2009; Retrieved 30.10.2013 http://biology.clemson.edu/bpc/bp/Lab/110/reaction.htm
18. Lin DM, Su Y. The effect of time pressure on expert system based training for emergency management. Behaviour & Information Technology 1998; 17:195-202.
19. Maule AJ, Hockey GRJ, Bdzola L. Effects of time-pressure on decision-making under uncertainty: changes in affective state and information processing strategy. Acta Psychologica 2000; 104:283-301.
20. McDaniel LS. The effects of time pressure and audit program structure on audit performance. Journal of Accounting Research 1990; 28:267-285.
21. Nęcka, E, Orzechowski J, Szymura B. Psychologia poznawcza. Warszawa: Wydawnictwo Naukowe PWN; 2006.
22. Rotter T. (ed). Metodyka psychologicznych badań kierowców - wersja znowelizowana. Warszawa: Instytut Transportu Samochodowego; 2003.
23. Stelmack, RM, Houlihan M, McGarry-Roberts PA. Personality, reaction time, and event related potentials. Journal of Personality and Social Psychology 1993; 65:399-409.
24. Strelau J. Temperament jako regulator zachowania. Z perspektywy półwiecza badań. Gdańsk: Gdańskie Wydawnictwo Psychologiczne; 2006.
25. Strelau J. Temperament, osobowość, działanie. Warszawa: PWN; 1985.
26. Strelau J. Zawadzki B. Psychologia różnic indywidualnych. In: J Strelau, D Doliński (eds.), Psychologia. Podręcznik akademicki. Gdańsk: GWP; 2008.

27. Zakay D. The impact of time perception processes on decision making under time stress . In A. J. Maule, & O. Svenson (eds.). Time pressure and stress in human judgment and decision making. New York: Plenum Press; 1993.

28. Zawadzki B, Strelau J. Formalna Charakterystyka Zachowania - Kwestionariusz Temperamentu (FCZ-KT). Podręcznik. Warszawa: Pracownia Testów Psychologicznych PTP; 1997.

29. Zawadzki B, Strelau J. Podstawy teoretyczne, konstrukcje i właściwości psychometryczne inwentarza - „Formalna Charakterystyka Zachowania - Kwestionariusz Temperamentu”. Studia psychologiczne; 1998. vol XXXIII:49-92.

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