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THE EFFECT OF UNIQUE ENVIRONMENTAL FACTORS ON TACTILE PERCEPTION IN ATHLETES

UČINEK EDINSTVENIH OKOLJSKIH DEJAVNIKOV NA TAKTILNO PERCEPCIJO ŠPORTNIKOV

Abstract

The aim of this study was to establish the threshold of tactile sensitivity in men depending on the sport discipline they perform. In total, 155 athletes engaged in water sports, team sports, martial arts and swimming took part in the study. The control group was 120 men who do not take part in competitive sport. The subjects' ages ranged from 19 to 23 years. The Touch-Test™ Sensory Evaluator aesthesiometer (Semmes-Weinstein Monofilaments) was used for the study. The threshold tactile sensitivity was measured in two points of hand: on the pulp of the little finger and on metacarpus on the palm side of the hand, between the thenar and the hypothenar. The participants who did water sports displayed the lowest tactile sensitivity, both on their metacarpus and their little finger, and swimmers displayed the highest tactile sensitivity in two measurement points. It was noted that the differences in the results of the study were determined by the specificity of environmental factors in a given sports discipline. Contact of hands with oars, a ball or water environment modifies tactile sensitivity.

Key words: tactile perception, sport, aesthesiometer

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Izvleček

Cilj študije je bila določitev praga taktilne občutljivosti moških v odvisnosti od športne discipline, s katero se ukvarjajo. V študijo je bilo vključenih je 155 športnikov, ki se ukvarjajo z vodnimi športi, ekipnimi športi, borilnimi veščinami in plavanjem. V kontrolni skupini je bilo 120 moških, ki se niso ukvarjali s tekmovalnim športom. Starost sodelujočih je bila od 19 do 23 let. Uporabljen je bil Touch-Test™ Sensory Evaluator aesthesiometer (Semmes-Weinstein Monofilaments). Taktilni prag smo merili na dveh točkah roke: na konici mezinca in na metakarpalni strani dlani med tenarjem in hipotenarjem. Merjenci, ki so se ukvarjali z vodnimi športi, so pokazali najnižjo taktilno občutljivost na metakarpalni strani dlani in na mezincu, najvišjo taktilno občutljivost na obeh točkah pa so pokazali plavalci. Ugotovili smo, da na taktilno občutljivost vplivajo specifični okoljski dejavniki v določeni športni disciplini; nenehen stik dlani z vesli, žogo ali vodnim okoljem spreminja taktilno občutljivost.

Ključne besede: taktilna zaznava, šport, esteziometer

INTRODUCTION

The high demands that all sports present are related to the aim of the movement and its precise execution. An athlete is subject to many systematic and directed efforts, defined as technical preparation, the aim of which is developing the most appropriate motor habits in a given sports discipline. Orientation in the external environment, "perception of the apparatus and equipment" and "water perception" are also important. The basis for the perception includes various static, kinaesthetic, aural, visual and tactile sensations. They develop depending on the specificity of activities in a given sport, in which the means used are intensive and cause adaptive changes in an athlete's body; the longer the time of the effect of specialist training, the greater the changes. Many researchers have dealt with kinaesthetic perceptions, their role and development in athletes (Lejeune et al., 2004; Starosta et al., 1989; Starosta & Stronczyński, 1998; Stolarczyk et al., 2000; Wołk, 1994). There are few scientific studies on the significance of the tactile analyser in selected sports disciplines. Starosta & Szychowski (1979) attempted to explain the effect of tactile sensations on the precision of movements in sport and the significance of increasing the area of contact of equipment with the limb of an athlete for the precision of the performed movement. Rostkowska & Maśnik (2001) established the threshold of tactile sensitivity in blind swimmers and blind people not doing any sports.

The aim of this study was to establish the threshold of tactile sensitivity in men doing selected sports disciplines depending on such factors as the use of equipment (for example oars and balls) or the environment in which training and competition take place.

METHOD

Participants

The study included 155 students of the University School of Physical Education in Poznań doing water sports, team sports games, martial arts, swimming and 120 students who did not do any sports; they were a control group (Table 1). The age of the participants ranged from 19 to 23 years.

Table 1: Studied groups and their sizes

studied groups	number of subjects
- athletes doing water sports (canoeing, rowing)	47
- athletes doing team sports games (basketball, volleyball, handball)	48
- athletes doing martial arts (judo, tae kwon do, karate)	35
- swimmers	25
- control group	120
in total	275

Instruments

The Touch-Test™ Sensory Evaluator (Semmes-Weinstein Monofilaments) aesthesiometer was used in the study. It consists of 20 elements, each of which is made of a plastic handle with a nylon filament attached, for which the pressure force necessary to bend was specified by the manufacturer. Successive filaments of the aesthesiometer are characterised by a gradually growing pressure force expressed in grams and marks of filaments of the aesthesiometer (SWM[1]). Establishing the threshold of tactile sensitivity (TTS[2]) involved indicating the filament of aesthesiometer with the lowest pressure that caused a tactile sensation in the subject.

Procedure

The traditional method of measuring threshold tactile sensitivity was used. It involved touching a certain body part with the aesthesiometer in laboratory conditions when the participant was resting. The threshold of tactile sensitivity was measured in two points of the dominant hand (the right hand for the right-handed subjects, the left hand for the left-handed subjects accounted for 1.09% of the participants): on the pulp of the little finger and on metacarpus on the palm side of the hand, between thenar and hypothenar. The choice of measurement points was a consequence of involvement of these parts of the hand in performing various sports activities related to the training characteristics for specific sports disciplines. Moreover, finger tips are characterised by a high density of tactile receptors (Johansson & Vallbo, 1979), a great changeability in the thickness of epidermis and their tactile sensitivity is susceptible to the influence of various biological, mental and social factors (Kozłowska, 1998). The palm of the hand is also linked to the phenomenon of "feeling the apparatuses and equipment" and "feeling the water".

The examinations were preceded by an oral instruction; they took place in the morning and early afternoon and were always performed by the same person. During the measurement of the tactile sensitivity threshold, the subject was sitting on a chair with his eyes closed. According to the instructions for the device, successive filaments of the aesthesiometer were tested until a threshold filament was found, by attaching them to the tested place for approximately 1.5 seconds at the 90° angle and pressing at the same time until the nylon filament was arched. When the subject felt the filament, he said "I can feel it" and showed the spot where he had been touched. The test was repeated in order to check whether the proper filament had been indicated. The results of the measurements as well as the participants' age and sport were recorded in a table.

The collected material was subject to statistical analysis. Using the Kolmogorov-Smirnov test, it was found that the distributions of the dependent variable significantly vary from the normal distribution. Because of this, nonparametric tests were used for the statistical analysis: the Kruskal-Wallis H test, the Mann-Whitney U test, Wilcoxon's signed rank test and numerical values corresponding to the markings of the filaments of aesthesiometer (SWM) were selected as units of measurement.

RESULTS

In the analysis, the effect of performing specific sport disciplines on the level of TTS of the measurement points, the Kruskall-Wallis H test was used. The values of this test and the levels of statistical significance allowed the rejection of the zero hypothesis that assumed that there are no differences in the TTS between sports groups. The results of the analysis led to the conclusion that there are statistically significant differences between athletes doing selected sport disciplines, both on the little finger ($H=36.14$; $p < 0.01$), and on metacarpus ($H=37.46$; $p < 0.01$): This also permitted us to perform a detailed comparative analysis between sports groups ,which was performed using the Mann-Whitney U test.

The highest TTS (lowest tactile sensitivity), both on the little finger and on metacarpus, was found in athletes engaged in water sports, followed by athletes doing team sports, martial arts,

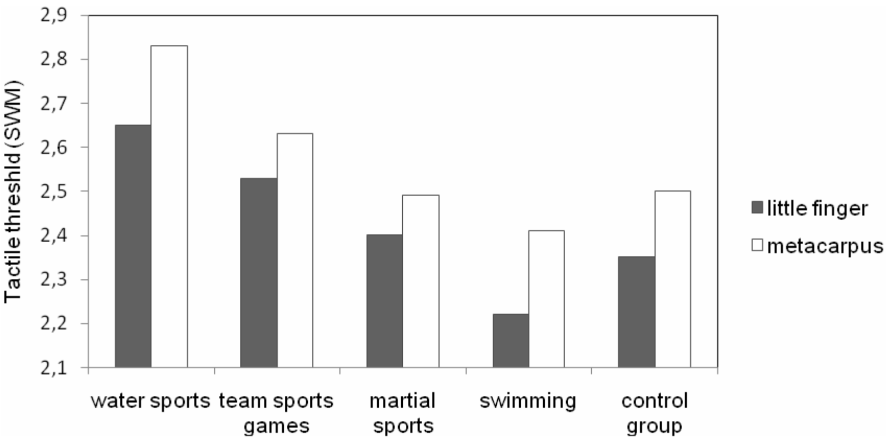

Figure 1: Comparison of the level of threshold tactile sensitivity of measurement points of studied sports disciplines and the control group

swimming (Figure 1). The differences between groups in terms of the TTS on the small finger are presented in Table 2, and on the metacarpus in Table 3.

Table 2: Differences in terms of the level of threshold tactile sensitivity on the little finger between groups (n = 275)

studied group	water sports	team sports games	martial arts	swimming
team sports games	Z=–2.01*			
martial arts	Z=–2.94**	Z=1.18		
swimming	Z=2.85**	Z=2.24*	Z=1.49	
control group	Z=–4.69**	Z=–2.44**	Z=–0.79	Z=1.37

Note: Z – result of the Mann-Whitney U test
* $p < 0.05$; ** $p < 0.01$

Table 3: Differences in terms of the level of threshold tactile sensitivity on the metacarpus between groups (n = 275)

studied group	water sports	team sports games	martial arts	swimming
team sports games	Z=–2.80**			
martial arts	Z=–3.64**	Z=0.99		
swimming	Z=3.22**	Z=1.76*	Z=1.16	
control group	Z=–5.14**	Z=–2.18*	Z=–0.78	Z=0.68

Note: Z – result of the Mann-Whitney U test
* $p < 0.05$; ** $p < 0.01$

In all studied groups, the metacarpus was characterised by a higher TTS (Figure 1). Hence, athletes doing water sports were characterised by the highest TTS both on the metacarpus and little finger, and the swimmers displayed the highest tactile sensitivity in both measurements points. The results of athletes doing team sports and martial arts take intermediate places. The differences in terms of changeability of threshold of tactile sensitivity between measurement points in the studied groups are presented in Table 4.

Table 4: Differences in the range of the level of threshold tactile sensitivity between measurement points in the studied groups

studied group	measurement points: little finger - metacarpus Palec
water sports team	Z=2,72**
sports games	Z=1,89
martial arts	Z=1,33
swimming	Z=2,68**
control group	Z=3.31**
	35
	25
	120

Note: Z – result of Wilcoxon's signed rank test
* p < 0.05; ** p < 0.01

DISCUSSION

The dependent variable examined in this study was tactile sensitivity, an ecosensitive trait, determined by many genes and at the same time susceptible to the effects of environmental factors (Kozłowska, 1998). Henneberg (1989) distinguishes two groups of environmental factors: general environmental conditions, common for groups of individuals or acting with the same intensity and in the same direction on individuals throughout their lives, and unique environmental conditions, i.e. unique, short-term and frequently changing conditions specific to individuals or short periods of their lives. The studies of touch specified the effect of various factors on tactile sensitivity, including: age (Desrosiers et al., 1996; Thorbury & Mistretta, 1981; Verrillo et al., 2002), sex (Kozłowska 1998; Weinstein 1968), body temperature (Bolanowski & Verrillo, 1982; Gescheider et al., 1997), skin hydration (Elsner et al., 1994; Verrillo et al., 1998), skin hardness (Dellon et al., 1995), intelligence (Kozłowska, 1998), changes in body posture (Zampini et al., 2005).

Sport is a unique sphere of human activity, in which various systems of the human body work at the limit of their capabilities. This creates good premises for examining manifestations of the body's adaptation to extreme conditions; even hard physical work in extreme climate conditions is not able to release such adaptive processes of the body as is observed in highly qualified athletes (Płatonow, 1990). This study examines athletes performing sport disciplines characterised by different types of physical activity, different environments of training and competition as well as differing in terms of the use of equipment and apparatus.

The highest tactile sensitivity among the studied sports disciplines was observed in athletes engaged in swimming, followed by athletes doing martial arts.

Swimming sports require active immersion in water. During swimming, adaptation to the physical features of the water environment takes place. With rowers, mainly in the hands and lower arms, the property of "perception of water" is developed, which involves the ability to detect subtle physical stimuli coming from the water environment and an appropriate motor response to them; this may be the reason for the higher tactile sensitivity. The results of the study showed the highest tactile sensitivity in swimmers, which leads to a belief that the reason for this changeability is physical activity in the water environment.

In martial arts, the basis for the activity is contact with the opponent's body or clothing. The movements should be fast, certain, precise, should occur in combinations depending on the position in the combat, but also should be very flexible, because they are a response to stimuli from the external environment. It is important to know the sensitive spots of a human body. The sports result is determined by technical and tactical abilities in relation with biological, mental and environmental mechanisms.

In the other two sports disciplines, the lowering of tactile sensitivity under the influence of doing competitive sport was found. What must be done in these sports are factors that interfere with sensitisation of the tactile analyser and have a basic effect on the development of the level of threshold of tactile sensitivity.

The lowest tactile sensitivity was found in athletes doing water sports, followed by athletes doing team sports games. These are two groups of studied sports in which athletes use the use of equipment (for example oars and balls) during training and competition. The lower tactile sensitivity of these athletes noted in the study indicates that the phenomena of "perception of apparatus and equipment" are not directly related to the perception of touch, but their basis is a deep, proprioceptive perception.

In canoeing and rowing, hands receive sensations transferred through the oars from the water environment in the form of water resistance and the correct position of the blade towards it. The abilities to control external powers that are the drive of the movement are useful here. This requires a high tactile sensitivity and experience that develops this type of ability, because a sudden change in stimuli requires fully developed sensory abilities of a fast and creative motor response. In water sports, apart from mechanical frictions exerted by the oar on the wrists and fingers, weather factors also play an important role.

In team sports games, as a part of motor activity, a player manipulates the ball; this is described as one of the main activities. Elements of the game include hitting the ball, making serves, spikes etc. In returns and passes, the finger pulps are most involved. The ability of "perceiving the ball" favours effective play, affecting the precision of a throw, pass and hit. The studies of Machnacz (1992) showed that people playing handball are characterised by a large hand size, which allows for manipulating the ball.

In all studied groups, higher tactile sensitivity was found on the little finger, and a lower one on the metacarpus. Finger pulps are characterised by a high density of tactile receptors (approx. 100-140/ cm^2), the number of which decreases towards the wrist. The change is not, however, gentle and continuous, but dramatic from the farther to closer half of the end phalanx, and a smaller leap between the base of fingers and the palm (Johansson & Vallbo, 1979). An appropriately higher density of tactile receptors is related to a higher tactile sensitivity, which, in the hand, is the highest on finger pulps. Each sensory neurone receives information with a specific tactile field, called its perception field. The smaller the perception field, the more precise the coding of the location of the stimulus. Sensory fields on finger pulps are much smaller than on the hands and back, where it is difficult to locate a point of mechanical stimulation. The location of the stimuli is coded by placing a tactile projection in the brain cortex. The pathways from the tactile receptors to the central nervous system are well known (Romo & Salinas, 1999). The functioning of tactile receptors depends, among other things, on physiological properties of the peripheral and central nervous systems and on the physical properties of the skin itself as well as the parameters of the same stimulus. The basic task of the tactile apparatus of the hand is to obtain information on the deformation of the skin during hand manipulation.

During the testing of the skin with the nylon filaments of the aesthesiometer, most probably Merkel's tactile corpuscles located in the lower layers of the epidermis were stimulated; because of them a slight uniform pressure can be felt. Some researchers also believe that Meissner's corpuscles are responsible for a slight touch, point sensitivity (Johansson, 1978). The palm of the hand is covered by thick hairless skin. The epidermis is built of many layers of cells, the number of which determining its thickness depends among other things on mechanical pressures and many frictions exerted on its given part. Changes in the thickness of the epidermis may be the reason for differences in the level of TTS observed between athletes doing selected sport disciplines. Moreover, the scaling cells of the corneous layer of the epidermis absorb water easily, both from the outside and from the inside of the body. Short-term hydration with ordinary tap water induces increased plasticity of human epidermis (Pedersen & Jemec, 1999). Sun and wind dry the skin, making the epidermis rough and coarse (Kligman & Balin, 1989).

To summarise the results, it was found that the sports discipline determines the level of tactile sensitivity threshold. It seems that the scope of this modification depends on many factors, which include the environment in which training and competition takes place and the use of equipment.

[1] SWM – unit of measurement of threshold tactile sensitivity: Semmes-Weinstein Monofilaments (marking of aesthesiometer filaments)

[2] TTS – threshold tactile sensitivity or the threshold of tactile sensitivity

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