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THE HERO IN VICTORY AND LOSS

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BACKGROUND: Every game and competition contains the suspense caused by the possibilities of winning or losing. Adding to this, most cultures incorporate the concept of a hero and its significance in the life of the citizens.

OBJECTIVE: The objective and purpose of this paper is to explain the importance of the concept of hero. This includes a discussion of the "agon motive", that is the principle distinguished by interpersonal rivalry and by the process of the acceptance of challenges.

METHODS: Our methodology is a historical, rhetorical, and philosophical perspective outlining the history of the concept of hero. Further argument focuses on important concepts of agon, rivalization, and perfectionism.

RESULTS: Our results and findings call attention to the differences between army agon and sport agon and their possible transformations. First, we discuss the distinction between reaching for victory by "rivalization" and "perfectionism". Rivalization means antagonizing or encountering another person in order to win in competition. Perfectionism implies who is the best person during the competition. Second, we distinguish the phenomenon of a fair victory from the phenomenon of "victory at any costs". Such adoration of victory over other values like health or respectable competition is not a sign of being a hero. Third, we show how this has resulted in a contemporary image of a one dimensional carnal hero whose main goal is to achieve victory. And, fourth, we discuss how the archetype of a hero has changed from Homer's hero who connects physical force with intellect and compassion, to a person who lives in only a physical dimension in order to achieve victory.

CONCLUSIONS: Hence, it is important to evoke the values of losing and to highlight the meaning of loss which can spread the goal of competition into the context of one's life.

Keywords: Hero, victory, loss, competition, rivalization, perfectionism, agon motive.

INTRODUCTION

The meaning of the word "hero" is not clear or stable. We can understand it rather as a field of meanings, as a net of similarities in different usages, as a word without strong boundaries. We would like to show how the notion of "hero" has changed through history. While hero had some ethical features in Antique times, today its medial knowledge is sufficient for the celebration of somebody as a hero. The boundary between hero and celebrity slackens. Unfortunately, the sport hero is also very often devaluated into a one dimensional personality with only a basic character. We are sure the understanding of history and historical conception of hero could help us with philosophical arguments about the holistic approach to the personality and a human way of being. Philosophy and philosophical anthropology in a holistic paradigm can bring back the wider and ethical extent of hero, from the attention of the media for a celebrity to a creditable act of a real hero.

Introduction to the concept of hero

The notions "hero" and "athletic heroism" have a very old tradition in history. On the other hand, the athletic hero is not only a topic of the past. The hero is a symbol of a sport person as a cultural figure (Zeigler, 1988). Some parallels were obvious between the myth and sport, such as in archetypical symbolic intensity: "the athlete can be interpreted as representing a 'myth', instantiating a sort of 'mythical' figure of a Herculean-Promethean kind" (Lenk, 1976, p. 16). The symbol of hero can also be seen as promoting a new paradigm "already familiar to children and adolescents that can bring passion and motivation into the research process: the hero's journey" (Holmes, 2007, p. 19). Why is the symbol of a hero so useful? The hero such as Ulysses, Samson, or Hercules typically leaves his/her home, experiences adventures, and struggles between life and death. The hero sacrifices his/her personal life, and he/she returns to his/her society with something new and important that enriches the culture and people's life. "The myth of hero should not provide icons for adoration, but lead a person to his/her own heroic inclination. Myth shall lead to imitation or participation, not to passive contemplation" (Armstrongová, 2006, p. 132). And it is this activity, a heroic act, that is the typical attribute of sport and competition.

It is necessary to emphasize that victory and loss provide a structural moment of a competition. Competition in which one is winning and the other one is losing is a common form of a rivalry in the area of movement culture. This is unlike many situations, where it is possible to solve the situation by using a win – win form, when one opponent doesn't have to be an underdog. However, if a competition is led only in winner – loser situations, it brings us specific lessons and ethical possibilities. For example, aggression, power, dominance over others, and financial gain are connected with victory, whereas empathy, vigilance, and attendance constitutes a specific feminist theory of the ethics of care, adding a "female morality" (Singleton, 2003) which is connected more with win – win situations.

Therefore, the purpose of this paper is to outline the nature of athletic heroism. We discuss here the following topics: The agon motive and how it has changed. The various types of competition as seen in the light of rivalization and perfectionism. What is the value of records for the hero? How do we define victory and loss? And, what is the hero archetype in the past and present?

The agon motive and its changes

The process of a challenge, interpersonal rivalry, and the endeavor to achieve victory is clearly recognized in any society. This common social principle is known as "an agon motive" (Morford, 1986). *Agon* is the ancient Greek word expressing competition, encounter, and contest. Ancient Greeks had another name for struggle, *polemos,* which means contest as a war. It is possible to find some common as well as different features concerning sport and war (Oborný, 2001b). Hence there are parallels between sport and war; sport can be considered as "a secondary war", a symbol of real agon. Naturally it is not a surprise that the original martial agon was transformed into sport agon. Full agon has the goal to beat a rival as well as killing one's opponent. Whereas sport agon is connected with temporal sequels, which negate risk of death, but keep the value of victory at a higher level than life.

We can see the examples of this agon motive in the Greeks of Homer's era. The norm of a sport competition and the Olympic agon is described in the 23rd canto of Homer's *Ilias,* in particular the organization of games to the homage of Patrocles. We can see it in the feudal society of medieval Europe, as well as in the Samurais in Japan or Native American Indians in North America (Morford, 1986). Shortly, the individual endeavor to be exceptional, perfect, personally honored, or superior is reached by accepting a high level of hazardous competition and it is seen in every society. Agonal behavior is kept and cultivated in a sport context where it reaches a high form of competitions and games. Adding to this: "In war, rule exists wholly as a result of victory; in sport, victory exists as a result of rule" (Fischer, 2002, p. 31). Although the real (war) agon has acquired a symbolic shape in sport, the spontaneity of a challenge, an inner value of appreciation, and an external prize such as money or social status are seen in connection with sport performance. The transformation of agon and its role in society are not obvious. Concepts such as *pseudo-agonal* or *post-agonal* are used for the transmission of real agon to its present symbolic form.

The understanding of this change from real agon (war) to symbolic agon (sport) can be seen as very simple, but such simplification leads to stereotypes. For example, that the ancient Greek sportspersons' played active roles in participation at *gymnasion,* or that the Roman spectators passively watched sports shows in a circus. We can encounter this step by step evolution from activity to passivity or from participation to spectatorship which documents this agon transformation in its symbolic forms. "The process of transition is completed when agonal athletic displays are engaged in by only a handful of individuals performing before large crowds of spectators. Imperial Rome and contemporary western society are such examples" (Morford, 1986, p. 11).

This picture of history is, however, oversimplified; the real situation was different. Nevertheless, this schematic view of turning activity into passivity is used very often. For example, it means that sportspersons as well as spectators are part of agon. Agon is a broader phenomenon, with fighters and spectators as participants. For example, the number of competitors was extremely low at the beginning of the Pan-Hellenic games and only the free Greek citizens could be participants. Men and aristocracy markedly dominated. But many people were watching them – there was no restriction for spectators, except for married women, at the Olympic Games for cultic reasons. Not only the political and intellectual elite, but also marketers, craftsmen, citizens of *polis,* very often women, children, and barbarians watched the games with interest. Antique *stadiums* were built for masses of spectators, not only for active participants in competitions (Lämmer, 1988).

The wish to fight, to find the best is a constitutive aspect of personality and society. This agon motive has taken on different shapes in various historical and cultural environments, and it is seen in some form in every culture. Through the centuries the real antagonism was substituted for by symbolic modalities. The most important part of these symbolic forms of the agon motive is sport. The agonic competition can, however, have two basic modes: rivalization and perfectionism.

Modes of competitions: Rivalization and perfectionism

The word competition (as representative of a clear form of the agon motive) doesn't mean only the modus of champion – loser, as aspiration for beating an op-

ponent, but also *com-petitio,* the common search for excellence. "In fact, good competition presupposes a cooperative effort by competitors to generate the best possible challenge to each other. Each has the obligation to the other to try his or her best. Although one wins the contest and the other loses, each gains by trying to meet the challenge..." (Simon, 1991, p. 23). The competition is not a situation of all or nothing, win or lose, but this is the answer to the question about personal perfection posed by the challenge.

The realization of winning and achievement of the victory can be understood in two ways, via two evaluations. Lipiec (1999) calls them rivalization and perfectionism. *Rivalization* is a way of the mortification of a weaker person, answering the question "Which one is better?". It is not an encounter with an idea, but a fight with a human being. This sportsperson doesn't wish to pass over a general boundary, but he/she needs to evaluate himself/herself by overcoming a living human being, the rival. It is overcoming now and here, at this concrete place, in a concrete fight, of these individuals. It is a validation of oneself in competition with others. Rivalization allows various forms of tactics in order to win without an attempt at self perfection. For example, with the lack of maximum endeavor to overcome a weak opponent, one could minimize the performance and thus minimize its value. "An inner (intrapersonal) aspect of competition atrophies in the meaning of rivalry, it falls into the shade. Animal and amoral demonstrations of competition, analogical egoism and corrected functional missanthropism, emerge to the surface, too" (Oborný, 2001a, p. 78).

However, rivalization should have a second face: the winner helps the loser by this lesson to work on himself/herself for maximum achievement. The loser can be glad to be close to the winner and can wait for reciprocation. In essence, rivalization is not automatically bad.

On the contrary, *perfectionism* doesn't need a rival. This is when the competitor wishes to overcome only him/herself, to become better, or to reach the absolute boundaries of human possibilities. Perfectionism answers the question "Who is the best?". This is a competition with a value, not with an individual who would be abased by defeat. Accomplishment of the best record is the victory over all competitors. It is the sign of being the best without any epithet. At the same time every record is a challenge for each successor, for every concerned person to overcome. It is not an encounter only with a human being, but with a value at a concrete level of a certain measurable unit, which is expressed by the abstract competition record. Also, perfectionism has some downsides such as narcissism, lack of concern for others, or some meaningless value such as some records from the Guinness Book of World Records. "The ideal of competition with others was only replaced by a so called competition with oneself" (Simon, 1991, p. 24). Lenk (1982a) who refers to Schubert distinguishing four types of victory on the basis of various ways of competing: a classical competition with one winner, a dimensional competition with the endeavor to achieve maximum success, a mitigated competition aimed at not letting the others overcome me, and exam like events. Adding to his thoughts, we don't need four types, but rather only two: rivalization and perfectionism are a sufficient differentiation of competitive ways.

The Agon motive, which we can see in every society, has two basic forms: rivalization and perfectionism. The first one is agon competition with some person (my opponent or enemy), the second one is a fight within oneself and with the idea of breaking some (athletic) record without the necessity of agonal behavior with other people. To achieve a record is the goal of competition in the modus of perfectionism.

Record and value of victory

The record is a specific phenomenon from the movement culture area. The record is a clear manifestation of the contradictory principles of freedom and order which are dialectically conditioned by each other. For example: "Only an athlete who is freely devoting himself to a strenuous regimen of training is capable of extraordinary accomplishments: You can command somebody to march but not to establish a world record" (Lenk, 1984, p.12). There are sports that offer space for the development of the will by overcoming oneself or even self devotion to the extent which can be understood as heroism. This may take place when one is exerting all powers leading to the collapse of the organism, such as completing the race with a fracture, or a blind athlete learning to ski despite falls, are examples which can not be evaluated just as a mechanical, manipulative output of the muscles. Such demonstrations of sport efforts are not realizable without extraordinary heroic motivation, initiative, and personal caring (Lenk, 1982b). These examples show us the power of rivalization and perfectionism in human life. The agon motive, visible in competition (rivalization as well as perfectionism forms) gives energy to the personality aspiring for some record (in perfectionism) or humiliation of another fellow (rivalization).

Success, especially if it is connected with an attempt at the maximum effect, is interconnected with the ideal of progress, justice, and also with ascetism and discipline. The success of this achievement doesn't prevent athletes from taking further actions, on the contrary, it motivates one to achieve higher success (Krawczyk, 1974). The victory as a sign of achievement is a typical phenomenon of modern times by reflecting ideas of progress, growth, development, and prosperity. The value of victory brings an *ethos* of equal chances, and it

is subordinated to equal chances for possible winning at the start. If equal chances are not kept for all participants, the victory could not have a full meaning. If somebody who lost did not have a fair chance to win, the value of victory would not be worthwhile (Caille, 1996). An effort to achieve something, to overcome it, is the substance of over fullfilment. However, if the victory becomes the most important value and the only factor for the measurement of sports, then sports are reduced to the function of the victory, to those with the most power. "The ideologization of sport leads to the adoration of achievement, because achievement is an advertisement of political ideas and other ideas" (Hogenová, 1999, p. 18).

Adoration of the victory unambiguously casts a holistic approach to reality and humanity. If we can not perceive the wholeness of personality in physical, psychological, spiritual and social unity, then this fetishism of victory and the record leads to the break up of inner harmony, toward the lower levels of human personality. Every person who sees the victory (the successful realization of the agon motive) as the most important value in his/her life, breaks the philosophically substantiated holistic approach to being human (also in his/her personality). The superiority of victory and record over any other values (health, friendship and others) changes the inner potential of perfectionism (as the pronouncement of the agon motive) in rivalization against him/herself or his/her opponent...

If the value of victory and success exceeds an ethical frame, and it is elevated over humanistic values, if victory is superior over personality and health in axiological and instrumental terms, if the victory becomes a *fetish,* then the implication is non sporting behavior, a respective projection of values which does not belong in sport. In essence, the overvaluation of victory leads to brutalization in sport (Volkwein, 1991). For example, if one is willing to break the limits of safety, health or even life by doping in order to achieve victory or there is the overvaluation of money, prestige, and the social status of sportspersons manifested by the interest of spectators or media. Or, the evaluation of humans by means of money and accordingly by the purchasing and selling of players. It applies to such cases that "the platonic ideal of beauty and goodness (kalos kagathos) is liable to erosion. Physis stands again separated from psyche" (Lipiec, 1988, p. 97).

Victory and loss

Perfectionism and rivalization as two forms of agon motive's process could have two different results: victory and loss. One could initially suppose that it is only victory, which is worthy in competition, because every participant strives for the victory. However, the effort of the fight itself is of a higher value than mere victory; the process of this effort has greater value for the hero than the accomplishment. We emphasize that loss has the value of authenticity and could be equally as important as the victory. "The victory and the loss create the ethos of sport in the same proportions under certain conditions, and they have the same share in its ensouling. Not only its final end reverberates in the ethical evaluation of top sport. The motives and the way to the victory itself are important as well" (Oborný, 2001a, p. 24). Victory does not mean achieving a purposeless win at any cost, including one's health.

Some hypotheses about the origin of the Olympic Games state that these imposing religious celebrations were based on the memory of the defeated Cronus by his son Zeus (Kratochvíl, 1998). The possibility to deeply experience loss affirms its complexity and deeper meaning. However, if we appreciate that the negative sides of experience can also enrich our lives, we start to understand loss as an important part of life. For example, Frankl's logo therapy of appraising pain or affliction as sacrifice (Frankl, 1994; Frankl, 1997) indicates the full respect to loss as an art of the same value as the ability to win. "Suffering dies down to be, in a way, suffering when it discovers meaning, perhaps the meaning of sacrifice" (Frankl, 1994, p. 74). Similarly Williams and Bendelow (1998) state: "The pain however could signalize something positive or creative, not only in the sense of child birth, but as well in terms of physical, emotional, art and spiritual achievements, or it could serve as a much needed 'accelerant' for important changes in our life (p. 163)."

The value of victory and loss is visible on the competitor and their body language. Body language, especially facial features during competition is a phenomenon indicating much about the victory and the loss. The facial language appearing in conventional disproportions, composure and stability, at a high degree of distemper is the evidence of the emotional drama connected with the extreme position of the sport person in competition. The face with expressions of victory or loss indicates certain interconnections of physical or spiritual emulation. "In any kind of sport which defines the possibilities for the top physical achievements in competition, the victory is the highest gradation of physical tension and – as for consciousness – the sharpest separation from everything that is not a protagonist's self... The individual achieves the sharpest separation and differentiation from other individuals in the victory. The victory is thus the top of the highest individualization" (Ränsch-Trill, 1999, p. 76).

The victory is unique, in its separation from the others, it is the top measurement of individualization, the symbol of Eros as the principle of life, the wish for uniqueness. It means that temptation "to bring oneself to his/her extreme ability" (Ränsch-Trill, 1999, p. 84).

The beingness which characterizes the victory such as the trophy, award, cup, or medal, the way of holding them, and the triumphal presentation are also complex symbols of the sign of overcoming a rival. The loss is perhaps the experience leading to emptiness, extinguishment, and the abrogation of oneself, to the descent into death. In addition this can open the way for learning during these difficult times (Roberson, 2005).We affirm that the loss is as important as the victory.

But, society doesn't teach us to lose, because loss is not an appreciated achievement. We must resist the common evaluation of victory as the most important part of sport competition, as one form of many social agon motives. We must go beyond our shallow thoughts to realize the negative aspects of rivalization and perfectionism (pain, loss, effort) have more value and importance than only victory and especially victory at any cost. Fair loss is more valuable than victory that does not respect one's partner, health, or fairness. This is an ethical, pedagogical, and philosophical issue. This argument lies in axiological discourses concerning the value of non winner situations. Anthropological reflection and the holistic understanding of the human being is in direct contrary and antagonism with the understanding of sportspersons as only instruments of victory. Doping and other negative aspects of sport are not possible if we understand the arguments above.

The hero archetype in the past and in the present

How can we describe or picture a hero in a fair fight, or the mode of perfectionism in the agon competition, or the one who honors not only the value of victory, but loss as well? The ancient Greek tradition conserves Homer's idea of a fighter, a courageous hero, who acts through his physical power in harmony with his intellect and magnanimous heart (*megas thymos*). This happens where there is a connection of the physical, rational, and ethical aspects of our personality. However, today's hero is dominated by practicalities such as techniques, salary, endorsements, image, and equipment.

The idea of harmony originating in the school of Pythagoras was anthropologically used by Plato. Intellect in a platonic way of thinking plays a leading role toward harmony; it is a coordinator and guardian which aims for dominance over greed and sensuality through will power and moral power. Adding to this, the historic Greek ideals of *arête* and *kalokagathia* form an ethical dimension for the sport's hero. "The morality, beauty and perfection of human acts result from practical wisdom which is based on an ability to choose with respect to a rational principle, indicating a suitable measure; a proportion of behavior. In accordance with this, overcoming a good act will be the act between superabundance and deficiency" (Zowisło, 2001, p. 35). However, this discourse in the Greek understanding of Hero and the harmony of *arête* have been changed. For example, Homer's hero from Troy was changed by philosophical cultivation. And this is seen by thinking and reflection as seen in Nietzsche's (1992). Overman by means of courage, openness, physical, and spiritual insight. However, the notion of Latin *virtus,* in which the value of physical power and courage increases, is closer to him, and virtue (morality) as Greek *arête,* is becoming an affirmation of the will to gain power.

An archetype of the hero survives in our culture as an ideal to be followed such as Achilles, Robin Hood or Superman, demonstrating that the hero is still important in today's society. The hero here is a model and example of looking for perfectionism, or for competition not only by physical power, but also with a "big heart". The big heart is characterized by an ethical framework of fair play and passionate captivation. However, we don't often meet a person reflecting this harmony that connects physical power, a big heart of moral ethos, and ethical deepness. Our time shows sport heroes living separately from philosophy and its accent on harmony and the holistic approach to the human being and human behavior. We can say that some part of today's sport hero is not a philosophically cultivated personality, that he or she is only a physical hero, lacking Homer's complex spirit comprised of physical, intellectual, ethical, and spiritual aspects. "It is possible to characterize the basic difference between ancient and contemporary times in that the ancients conceived their heroes as representing the personification of something unambiguous, whereas the modern times can see the person in his/her inner complexity and contradictions" (Machovec, 2004, p. 71).

The hero then draws attention by his/her courageous acts where it is possible to perceive a specific higher purpose. The condition of heroism is not only an attitude and an act, but also the fact of whether the hero "transcended him/herself or did not" (Wolf, 1998, p. 85). Also a sport hero as an example of perfection achieved by a human effort in the fight for the victory is a sign of transcendence on a physical, mental, spiritual, and social level. The hero leads us into an environment with qualities such as braveness, admiration, courage, and a higher purpose. This is similar to Roberson's (2005) ideas that each person learns specific lessons as a result of difficulty, hardship, and pain.

Today, not only *arête* and *virtus* are gone, also the sport gentleman abiding with noble principles of social contact is very rare. The pattern of the hero for most people is only the sportsperson of their fan club. There are no heroes respected by the whole society. The winner is the hero and a present prototype of the hero is a triumphant sportsperson. Such a representative of the hero, however, should not be generally accepted. Although the victory has value over all for the winner, it is a proof of his/her individualization. It is a signifi-

cantly selective situation, which doesn't comprehend the complexity in life's decision making. "Performances are easily measurable. The competition is thus a simplification of the human situation and a reduction of life's difficulties to only a single task... For example, the winner in 100 meter hurdles is forgetting, at the moment of the victory. That the barriers were unnatural and that he ran only 100 meters" (Kotrba, 1998, p. 88).

The hero didn't become the hero because he or she made such a decision. Heroism is not an issue of the will nor of rational calculation. The individual who would concentrate on becoming the hero, the (wo) man intending to get fame would become a caricature of the hero, a record holder of assorted curiosities like in the Guinness' Book of World Records. In this case it is sufficient to flash once, to get self affirmation of his/her performance by appreciation of the public. Being the hero "means in plain terms to take one's own conscience in earnest, not to be a pure product of one's environment, contingency and volunteerism. Our existence is achievement which we have to take on" (Hogenová, 1998, p. 72). The hero doesn't care about the appreciation and aureole of the victory. The hero just realizes a chance to act.

SUMMARY

In summary we would like to make the following five points.

1. Hero and heroism are not only historical phenomena, the meaning of which is changing over time. For a long time the hero was a character wandering from home throughout the world. He/she lived in a way in order to come home and to enrich the people via his/her experience. This type of hero has physical power as only a part of their life and it is not the most important. The hero was known to be first of all as fair and honest, but also with courage, activity, and the overcoming of difficulties. This understanding of the hero has dramatically changed in the past several decades.

2. The agon motive is seen in every society and every historical period, and this is also a constitutive aspect of being human. The agon is competition and encounter which is the environment for the origin of hero, if he/she acts fairly. Everybody who has the courage to go into agon, to fight and compete, is going to find the answer to the question "Who am I?" and "Who is my competitor?". These are the questions for every potential hero who answers them by his/her perfectionism process.

3. We can distinguish two forms of competition: rivalization and perfectionism. While the rivalization is a mode of agon competition with the opponent, the goal is to conquer him/her. However, the process of perfectionism is looking for the best from anyone. Nobody can become the hero without competition and fair fight.

4. Victory and loss are fundamental parts of sport and competition. Victory should have some boundaries, and ethical values should be an essential part of sport and winning. A fair victory is a completely different phenomenon than victory at any cost. This fair victory or right competition needs both winners as well as losers. Therefore the value of victory in fair competition is not higher than the value of loss. But today's society doesn't value loss. Each person can learn through victory, but also in defeat. Defeat can aid in one's personal development to create a big heart rather than remaining a one dimensional winner.

5. Today's hero is often seen as a winner without regard to these constitutive aspects of the hero in the past. Today the hero can win by means of physical power, and the winner is seen as a hero. But the missing part of today's hero is very often courage, a "big heart", and ethical values. It is a lesson from history and a task for philosophers to argue that only the physical dimension in life is not sufficient. We must move beyond this one dimension into a holistic understanding of the human being.

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HRDINA VE VÍTĚZSTVÍ A PROHŘE

(Souhrn anglického textu)

VÝCHODISKA: Každá hra a soutěž obsahuje nejistotu z možností výhry a prohry. Většina kultur začleňuje koncept hrdiny a jeho znaků do života svých občanů.

CÍLE: Cílem tohoto příspěvku je vysvětlit důležitost pojmu hrdina. Jeho součástí je diskuse o „agón motivu", principu interpersonálního soutěžení a procesu přijímání výzev.

METODIKA: Zvolenou metodologií je historická, rétorická a filosofická perspektiva načrtávající historii pojmu hrdina. Další diskuse se soustřeďuje na důležitost konceptu soutěže, rivalizace a perfekcionismu.

VÝSLEDKY: Důraz je třeba klást na rozdíly mezi válečným a sportovním agónem a jejich možnou transformací. Zaprvé, diskutujeme rozdíl mezi snahou o dosažení vítězství prostřednictvím „rivalizace" a „perfekcionismu". Rivalizace znamená pokoření soupeře, vítězství nad člověkem, zatímco perfekcionismus implikuje otázku, kdo je nejlepší, je to soutěž s hodnotou. Zadruhé, rozlišujeme fenomén vítězství od fenoménu „vítězství za každou cenu". Taková adorace vítězství nad ostatními hodnotami (zdraví, čest apod.) není znakem hrdiny. Zatřetí, poukazujeme, jaké důsledky vplývají do soudobého obrazu jednodimenzionálního tělesného hrdiny, jehož hlavním cílem je pouze dosažení vítězství. A začtvrté, pojednáváme o tom, jak se archetyp hrdiny proměňoval z Homérova archetypu hrdiny propojujícího tělesnou sílu s intelektem a soucitem („velké srdce") v hrdinu jedné dimenze, tělesnosti.

ZÁVĚRY: Z tohoto důvodu je potřeba vyzvedávat hodnotu prohry rozšiřující cíl soutěže do kontextu smyslu života.

Klíčová slova: hrdina, vítězství, prohra, soutěž, realizace, perfekcionismus, agón motiv.

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ENROLLING 6–8 YEAR OLD CHILDREN IN ALPINE SKIING COURSES IN SLOVENIA

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BACKGROUND: Skiing is clearly a sport activity most children enjoy practising and are thus happy to enroll in various courses organised by skiing schools, societies and clubs.

OBJECTIVE: The study aimed to analyse parents' reasons for and interests in enrolling their children in an Alpine skiing course and to establish how parents' education and monthly income levels relate to the frequency of children attending a skiing course.

METHODS: We surveyed 250 parents of 6 to 8 year old children using a questionnaire with 17 variables. Frequencies and contingency tables were calculated. The statistical significance of relationships between the variables was tested by a contingency coefficient.

RESULTS: The results showed that one half of the parents had enrolled their child in an Alpine skiing course at least once. Parents with a higher level of education and higher monthly income enroll their children more frequently in an Alpine skiing course. The person proposing to enroll a child in the course is mostly the father. In more than one half of the families both parents ski; however, three quarters of the families never or rarely go skiing together. The fathers assessed their skiing skills higher than the mothers. The reason most often stated for not having yet enrolled their child in an Alpine skiing course was financial difficulties. The parents' goals for children concerning skiing are as follows: more than one half of the parents believe their child should learn to ski well and 30% of parents attribute a high level of importance to safety on ski slopes. Only 5% of the parents would like their child to engage in competitive skiing.

CONCLUSIONS: Our findings will help organisers of ski courses to better understand parents' reasons for sending children to ski courses. If a child has the opportunity to learn this sport, they are able to develop permanent healthy habits. If some of these habits are dedicated to sports, skiing will undoubtedly figure on the list of their recreational activities.

Keywords: Parents' opinions, children skiing, clubs, schools, questionnaire, analysis.

INTRODUCTION

A child starts learning the bases of different sports already in the preschool period. It is parents who facilitate their child's first engagement in sport and are largely responsible for early learning. Sport maintains and invigorates a child's health, develops their motor and other abilities and facilitates their integration into the social and natural environment and adaptation to it. It is therefore important that parents introduce their child into a regular sport activity already in the preschool and early school period (Videmšek & Pišot, 2007). Skiing is clearly a sport activity most children enjoy practising and are thus happy to enroll in various courses organised by skiing schools, societies and clubs. Of course, parents have to allow them this possibility and encourage them (Pišot, Videmšek, & Fabretto, 2008).

The results of some research projects investigating the impact of the environment on the physical activity of young children show that parents with a higher level of education and higher income devote more attention to their child's sport activity. In general, those children whose parents are physically active and spend active holidays with their children engage in sports more than others (Kropej & Videmšek, 2002). An example set by parents is undoubtedly very important and beneficial for children as most of them gradually take on their parents' (bad) habits (Cecić Erpič, 2005). In those families engaging in a sport activity, children tend to develop the following abilities: persistence, discipline, precision, self confidence, tolerance, patience, healthy competitiveness and the knowledge that one makes an effort to achieve a goal (Alfermann, Wurth, & Saborowski, 2002).

The results of an American study about the positive effect of physically active parents on their children are very interesting: children of physically active mothers who practice a sport are twice as active as children of inactive mothers. The fathers' influence is even stronger: children of physically active fathers are 3.5 times more active than children of inactive fathers. Those children

whose parents are both physically active are the most active of all – even six times more than children with physically inactive parents (Kalish, 2000).

Some comparative analyses (Strel, Kovač, & Jurak, 2004; Videmšek & Pišot, 2007) show that, in general, children exceed the energy and motor abilities of their parents at the age of seven. That age is one of the first milestones in a child's process of alienation from their family. Parents' poor motor abilities and sport knowledge pose a serious obstacle to their practicing sport together with their children, even in young families (Strel, Kovač, & Jurak, 2004). The results of a few recent studies show that some parents are already aware of these problems (Videmšek, Štihec, & Karpljuk, 2008).

Skiing is also one of those sports parents have insufficient command of to be able to instruct their children (Videmšek & Pišot, 2007). Therefore, they often enroll their children in different skiing schools, societies and clubs where children learn how to ski under expert guidance, while at the same time developing their motor and functional abilities and gradually perceiving a healthy lifestyle as an important personal and social value.

We often ask ourselves whether Alpine skiing is still the number one national sport in Slovenia. Nowadays, in times of a tough struggle to earn a crust, many consider skiing to be an expensive sport. According to the results of a study about the engagement of the Slovenian population in individual sports (Berčič & Sila, 2007), Alpine skiing ranks fourth in terms of the percentage of people practicing it (16.8%). In 2007, walking topped the ladder with 62.7%, thus confirming that people could no longer afford expensive ski equipment and ski passes (Berčič & Sila, 2007).

Our study aimed to investigate parents' general interest in their children's skiing. We aimed to establish which parents proposed that their children be enrolled in a skiing course, whether the parents can also ski, how often they ski and what their goals are for their children in terms of skiing. We were also interested in whether parents with higher education and income levels enroll their children more often in an Alpine skiing course.

METHODS

Participants

The sample consisted of 250 parents of children from five primary schools, regardless of whether they had enrolled their children in a skiing course or not. Their children were 6 to 8 years old. The study encompassed 35% of parents of children attending the first grade of a nine year primary school, 19% of the second grade and 46% of the third grade. The surveyed subjects included 135 mothers and 125 fathers, aged between 25 and 56 years. The mothers were 37 and the fathers 39 years old on average. Our sample was too small to allow use of a generalisation.

Instruments and procedure

The parents of 6 to 8 year old children completed a questionnaire consisting of 17 questions:

- parents' gender and age;
- child's age;
- parents' level of education;
- both parents' monthly income;
- number of children in the family;
- living environment (town or village);
- number of skiing courses completed;
- reasons for not participating in a course;
- person proposing that the child be enrolled in a skiing course;
- father's and mother's skiing skills;
- child's ski skills before enrollment in a course;
- frequency of skiing of the family;
- the child's ski equipment;
- parents' goals for their child in terms of skiing.

All questions in our questionnaire were closed type questions where parents could select only one answer. The parents completed the questionnaire during a parents meeting at school. Before the survey, they were informed of the basic aim of the study and instructed as to how to complete the questionnaire. Their participation in the survey was voluntary.

Methods of processing statistical data

The data acquired with the survey questionnaire were processed with the SPSS 15.0 (Statistical Package for the Social Sciences) software package. Frequencies and Crosstabs were calculated. The probability of a relationship between the variables was tested by the contingency coefficient at a 5% risk level.

RESULTS

TABLE 1 depicts that one third of the surveyed parents had a secondary school education, whereas a slightly lower percentage was accounted for by parents with a higher (31.2%) and university education (26.4%). Only three parents had a master's degree or a Ph.D. Furthermore, TABLE 1 shows a statistically significant relation between the parents' level of education and the frequency of children's participation in a skiing course. Parents with a higher level of education enroll their children in a skiing course more frequently. Of these, 17.2% of them had a higher education, followed by a university education (16.8%) and secondary school education (12.4%). All parents with a master's degree or a Ph.D. had already enrolled their child in an Alpine

skiing course, whereas only 1.6% of the parents who had enrolled their child in a course had only completed primary school.

TABLE 1
Parents' education in relationship to children's participation in a skiing course

Parents' education	Skiing course participation				Total	
	Yes		No			
	N	%	N	%	N	%
Primary school	4	3.25	15	11.81	19	7.6
Secondary school	31	25.20	53	41.73	84	33.6
College	43	34.96	35	27.56	78	31.2
University	42	34.15	24	18,9	66	26.4
Master's or Ph.D.	3	2.44	0	0	3	1.2
Total	**123**	**100**	**127**	**100**	**250**	**100**

Legend:
N = number of answers

Contingency coefficient: 0.154
Statistical significance of relation: **0.000**

TABLE 2 depicts that parents with € 1,500 to € 2,000 in monthly income (16.4%) prevail, followed by those with € 1,000 to € 1,500 (14.4%) and above € 2,000 (6%). Only a few parents who had already enrolled their child in a skiing course (9.2%) earn € 1,000 per month or less. The opposite was established for parents who had never enrolled their child in a skiing course, namely, the majority have a low monthly income.

TABLE 2
Parents' monthly income in relationship to the number of children participating in a skiing course

Monthly income per parent	Skiing course participation				Total	
	Yes		No			
	N	%	N	%	N	%
€ 1,000 or less	23	18.70	58	45.67	81	32.4
€ 1,001 to € 1,500	36	29.27	41	32.28	77	30.8
€ 1,501 to € 2,000	41	33.33	23	18.11	64	25.6
Over € 2,000	15	12.20	4	3.15	19	7.6
Didn't want to answer	8	6.50	1	0.79	9	3.6
Total	**123**	**100**	**127**	**100**	**250**	**100**

Legend:
N = number of answers

Contingency coefficient: 0.068
Statistical significance of relation: **0.027**

Despite the fact that the contingency coefficient is small, TABLE 2 shows a statistically significant relationship between the monthly income of parents and the frequency of their enrolling their children in a skiing course. Parents with a higher income enroll their children in a skiing course more often.

Of all families, 37% live in a village, 40% in a town and 23% in a suburb. Of the parents who have already enrolled their child in an Alpine skiing course those living in a town prevail (67%) as opposed to the 12% live in a village and 21% living in a suburb.

We were also interested in the number of children in the surveyed family. As many as 52% of the families have two children, 27% one child and 14% three children; 6% of the families have four children and only one parent reported having more than four children. Among parents who had already enrolled their children in a skiing course, the families with two children prevail (58%) and the share of families with one child is also high (32%). Only 7% of families with three children and 3% of families with four children had already enrolled their child in a skiing course.

About one half of the parents had never enrolled their children in a skiing course. Most often the parents enrolled their children in a skiing course once (35%), although 10% of the parents enrolled them twice and 5% three times and more. The majority of children who had not yet participated in a skiing course attend the first grade of primary school (76%), 70% the second and 56% the third grade.

There are two main reasons stated by the parents for not having yet enrolled their child in a skiing course. As expected, financial difficulties (30%) are the predominant reason, followed by inappropriate timing of the course (25%). A high percentage of parents (10%) stated they were not interested in skiing which is why they had not enrolled their child in a skiing course, whereas 10% stated their child was not interested in such a course. Furthermore, 10% of the parents believed their child was too young to take a course lasting several days, whereas 8% provided their own skiing instruction to their children. Some parents (4%) also mentioned a disease of their child, whereas 3% of them gave motion sickness and expensive ski equipment as reasons.

The results showed who in the family proposed that the child be enrolled in a skiing course. In 45% of the families that person was the father, in 31.2% the mother and in 21.3% both of them. Only rarely (3.4%) did such a proposal come from another person (friends or relatives).

In most families both parents ski (56%). In 20% of the families only the father skis, in 17% nobody skis, whereas only in 7% does the mother alone ski.

Based on the results of the study we estimated the level of the parents' skiing skills. The answers were di-

vided by gender. Excellent skiing skills were reported by 25.1% of the fathers and 8.8% of the mothers. The majority of the parents (47.5% of the fathers and 35.1% of the mothers) thought they could ski well, whereas 11.9% of the fathers and 31.6% of the mothers assessed their skiing skills as being below average. It is also interesting that 15.5% of the fathers and 24.5% of the mothers replied they could not ski.

We were interested in how often a family goes skiing together. The bulk of answers were "rarely" (41%). It is somewhat surprising that even 35% of the families never go skiing together, although 24% of the families frequently go skiing together.

No less than one half of the parents had never enrolled their children in a skiing course. Those who had enrolled their child in a skiing course stated that the child skiied poorly before the course (20%), 13% said that their child had previously had good skiing skills and 17% that their child could not ski before attending the course.

We also investigated parents' goals for their child in terms of skiing. Of all surveyed parents, only 10% stated they were not interested in skiing and therefore had no goals related to this sport. More than one half of the parents (55%) thought their child should learn how to ski well. For 30% of the parents it was important that the child could safely ski down the slope and only 5% of the parents wanted their child to engage in competitive skiing.

In our study we also asked parents about their child's ski equipment. As many as 43.1% of the children had second hand ski equipment and 35.4% had new equipment, whereas a large share (14.4%) did not own any ski equipment. It is surprising that only 7.1% of the children rented ski equipment.

DISCUSSION

The study involved parents of children aged between six and eight. This age is appropriate for the systematic engagement of a child in individual sports as the child is then relatively independent, follows the learning process more easily, their attention is focused on the instructor's information and less on environmental disturbances. At this stage of development, children are capable of learning more complex motor patterns relatively quickly and without any major strains.

One half of the parents had never enrolled their child in any skiing course. Nearly one third stated financial difficulties as the main reason for not enrolling their children in a skiing course and one quarter the inappropriate timing of a course.

A child should be encouraged and enabled to have various movement activities on a daily basis, particularly outdoors where he/she would develop his/her motor and functional skills, as well as movement conceptual framework (Taylor, 2002a).

Vrtovec (2008) analysed the reasons for children's non participation in afternoon sport activities. One of the primary reasons found in her study was "financial difficulties" (22%), and the same share was accounted for by "distance of the sports hall from home". A high percentage of the parents also stated that their child had refused to participate in an afternoon exercise session. Miklič (2008) obtained much more encouraging results. Only 3% of the parents stated that their child would not be enrolled in an afternoon exercise course in the first triad of the primary school for financial reasons. Yet it must be noted that the author surveyed parents who had already enrolled their child in an organised sport exercise activity in a kindergarten and most probably had no financial difficulties.

Our study showed a statistically significant relationship between parents' levels of education and monthly income and the frequency of enrolling children in a skiing course. Parents with a higher monthly income and a higher level of education enroll their children in an Alpine skiing course more frequently. Similar results were obtained by Videmšek, Gregorčič, Štihec and Karpljuk (2004) in a survey of parents of children aged between four and fifteen who were attending different skiing schools. The authors established that those parents who enrolled their children in an Alpine skiing school generally had a higher economic status. Kropej and Videmšek (2003) established that parents' level of education and income also influence whether they enroll their child in an organised sport exercise activity in the preschool period. The education of adults influences their children's and their own engagement in sport. The study by Sila (2007) of the sport and recreational activity of Slovenians showed that those who regularly engaged in a sport activity had a higher level of education. Videmšek, Posega, Štihec and Karpljuk (2007) believe that the relationship between parents' education and monthly income and their children's sport activity is mostly statistically significant in competitive sports, where parents spend a lot of money on their children. In their study where the parents of 10 to 14 year old Austrian Alpine skiing competitors were surveyed, Kornexl, Spanner and Hotter (2007) established that the parents spent on average € 3,156 per year on their children's skiing. The authors also stated that the parents invested up to 15 hours of their time per week to facilitate their child's engagement in competitive Alpine skiing.

Dobida and Videmšek (2005) believe that financial standing often influences the intensity of engaging in a sport. There are more and more families who can hardly make both ends meet each month and do not think about any leisure activity because they are on the

edge of subsistence. Skiing is one of those sports requiring a lot of money and therefore one should expect that families from lower social strata will not engage in it.

Parents are one of the key factors influencing a child's decision to practice a sport. They often lack knowledge and have limited opportunities to learn different sports, which is why an expertly organised and guided sport activity for children is very important (Čebokli, Videmšek, & Karpljuk, 2009).

A child in early or mid-childhood is strongly attached to their family which – by setting examples, making proposals and taking decisions – guides the child in choosing a sport activity (Tušak, Marinšek, & Tušak, 2003). The results of our study showed that the person most often proposing to enrol a child in a skiing course is the father. Videmšek, Gregorčič, Štihec and Karpljuk (2004) surveyed parents who had already enrolled their children in an Alpine skiing course and established that the parents mostly decided on a course jointly, i.e. both parents together (69%). Likewise, Videmšek, Posega, Štihec and Karpljuk (2007), Lisovskiy (2007) established that parents in most cases decided jointly about enrolling their child in a skiing school whereas, as individuals, the fathers predominate. Videmšek (2007), Ene-Voiculescu and Ene-Voiculescu (2007) believe that in the early preschool period it is the mother who engages more in sports activities with her child, while later on this role is taken on by the father. In the first year of schooling the father has a strong influence on the child's engagement in sport. Sport courses are activities intended for gaining and deepening the knowledge and skills of a certain sport, and their continuous character positively affects the acquisition of motor abilities. While at a ski course, children are in groups and they copy one another, gain new experiences about themselves and others, acquire self esteem and develop an emotional relationship towards the group and their own actions. Children cooperate, adapt their interests to the goals of the group, follow the rules of the group and above all they are highly motivated, far more than when being on their own (Taylor, 2002b).

A strong influence on child's skiing is undoubtedly exerted by parents' skiing skills and the frequency of their skiing. In our study sample, those families where both parents ski (56%) prevailed. Only 15.5% of the fathers and 24.5% of the mothers could not ski. Fathers' and mothers' assessments of their skiing skills are subjective, so some may underestimate themselves while others may tend to exaggerate. The majority of parents think their skiing skills are good, more men than women think their skiing skills are excellent, and more women than men think their skiing skills are poor. The above results show that fathers are better skiers or that they overestimate themselves. Videmšek, Gregorčič, Štihec and Karpljuk (2004) obtained similar results; in their study, most fathers assessed their skiing skills as being excellent or very good. However, Videmšek, Posega, Štihec and Karpljuk (2007) established that all parents of those children who competed in ski clubs could ski and that one half of the fathers had trained in skiing in the past.

Family skiing or a skiing holiday can be a great financial burden for many families these days. Therefore, the results of our study were as expected. As many as 35% of the families never have decided on a family skiing trip or holiday, and 41% have done so only rarely. Families can still afford a one day skiing trip, whereas skiing holidays lasting several days each year exceed their financial abilities. The results of Videmšek, Gregorčič, Štihec and Karpljuk (2004) are slightly different. No less than 27% of families took five to ten day skiing holidays, whereas 17% of families decided on a one day skiing trip and only 3% never went skiing. The share of those families whose skiing holidays last for up to five days is also high. Of course, it should be noted that this study involved only those parents who had enrolled their child in a skiing school, whereas our study involved all parents, including those not interested in skiing at all.

The financial burden for families not only consists of expensive ski passes, courses, transport and hotels but also purchases of ski equipment. Many families cannot afford to buy ski equipment for their children, which is more expensive every year. Kornexl, Spanner and Hotter (2007) surveyed the parents of 10 to 14 year old Austrian Alpine skiing competitors and established that the parents spent up to € 5,000 per year on their children's skiing, of which 56% was for ski equipment. Nevertheless, our study established that 35% of children have new equipment which is slightly cheaper than that designed for competitive skiers. The above result is surprising considering the fact that children need new equipment every season because they grow quickly and that well maintained second hand children's ski equipment can be found at many ski fairs. It was expected that more parents would buy second hand equipment. Such parents accounted for a slightly higher percentage (43%) but still below the expected level. Only 14.4% of children do not have any skiing equipment which is not much compared to the percentage of children not participating in a course (66%). Consequently, the majority of those who had not participated in a skiing course do have ski equipment but do not use it or are not interested in a course. Only 7% of the children had rented equipment.

The results of the study by Videmšek, Gregorčič, Štihec and Karpljuk (2004) are similar. The majority of parents (69%) bought new equipment for their children, 28% of children had second-hand equipment and 8% rented it. The authors ascribed these results to the changes in skiing techniques and the occurrence of new,

different equipment on the market. Parents are somewhat "forced" into buying skis with a more pronounced side curve arc or renting them as they enable a beginner to progress faster. Dobida, Rausavljević and Videmšek (2008) were of the opinion that having a broader and high quality range of equipment in ski rental shops could contribute substantively to allow better access to skiing to those who cannot afford expensive new ski equipment.

Our study also investigated parents' goals for their child in terms of skiing. Only one quarter of the parents enrolled children who were good skiers in a skiing course, whereas most children could not ski or were poor skiers. More than one half of the parents stated that the most important thing for them was that their child would learn to ski well, whereas the rest claimed it was important for them that their child could safely move down the ski slope. Only 5% of the parents wanted their child to engage in competitive skiing. The study by Videmšek, Gregorčič, Štihec and Karpljuk (2004) yielded similar results. As much as 91% of parents participating in the study wished their child could ski well, whereas 9% of the parents considered it most important that their child could ski safely. None of the parents stated they wanted their child to engage in competitive skiing. In terms of this variable, parallels can be drawn between the two studies. The results of a study involving a population of children skiing in ski clubs (Videmšek, Posega, Štihec, & Karpljuk, 2007) showed that particularly those fathers who had trained in skiing in the past had high goals (Taylor, 2002c) for their children – most wished their children to become elite competitors.

Parents often expect that, during a skiing course, their child will learn in the optimum way in the shortest time possible. They are insufficiently aware of the fact that certain elements of skiing require time, like in other sports. For younger children Alpine skiing, the same as other sports, should contain elements of play as the latter is the basis of human creativity. When instructing children how to ski, one has to consider that the learning process should be part of a stress free childhood and not according to the classical education system. To teach a child how to ski is a goal set by parents and instructors, certainly not by a child. The child has other reasons which are far more important for it to join the activity if it is organised appropriately. The child is interested in the path to the goal, the diversity and quality of the process and the experience thus gained, not in the goal as the final product (Pišot & Videmšek, 2004).

If learning how to ski is adapted to a child's abilities, characteristics and traits, then a child certainly skis with contentment. A content little skier often makes their parents enthusiastic about skiing, too, so even if they had not skiied (much) in the past they now engage more often in this sport or some other similar sport activity (Pust, Lešnik, & Pori, 2004).

If a child has the opportunity to learn this sport, they are able to develop permanently habits associated with it. If some of these habits are dedicated to sports, skiing will undoubtedly figure on the list of their recreational activities. Last but not least, by learning to ski, a child also learns about an indispensable element of our Slovenian tradition. Let us hope that, in spite of the many problems described above, skiing will remain one of the most important sport and recreational activities for children, adolescents and adults.

CONCLUSIONS

Despite the fact that our sample was too small to allow us to make a generalisation, we can conclude that:

- One half of the parents had enrolled their child in an Alpine skiing course at least once.
- Parents with a higher level of education and higher monthly income enroll their children more frequently in an Alpine skiing course.
- The person proposing to enroll a child in the course is mostly the father.
- The fathers assessed their own skiing skills higher than the mothers.
- The reason most often stated for not having yet enrolled their child in an Alpine skiing course was financial difficulties.
- The parents' goals for children concerning skiing are as follows: more than one half of the parents believe their child should learn to ski well and 30% of parents attribute a high level of importance to safety on ski slopes. Only 5% of the parents would like their child to engage in competitive skiing.

Skiing nowadays is unquestionably one of the more important sport and recreation activities in winter time. Our findings will help organisers of ski courses to better understand parent's reasons for including children in their courses. We hope this research has been enlightening regarding some questions about actively introducing children to skiing. It would be better if a bigger sample would be chosen next time so we could generalize our findings for the whole country of Slovenia.

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ZÁPIS ŠESTI AŽ OSMILETÝCH DĚTÍ DO KURZŮ SJEZDOVÉHO LYŽOVÁNÍ VE SLOVINSKU

(Souhrn anglického textu)

VÝCHODISKA: Lyžování je sportovní aktivitou, kterou většina dětí ráda praktikuje, a proto se rády zapisují do různých kurzů organizovaných lyžařskými školami, společnostmi a kluby.

CÍL: Studie měla za cíl analyzovat důvody rodičů a zájmy spojené se zápisem jejich dětí do kurzů sjezdového lyžování a stanovit, jak vzdělání rodičů a jejich měsíční příjem ovlivňují četnost, s jakou jejich děti navštěvují lyžařské kurzy.

METODY: Provedli jsme průzkum mezi 250 rodiči dětí ve věku 6–8 let, a to za použití dotazníku se 17 proměnnými. Byly vypočítány frekvenční a kontingentační tabulky. Statistická váha vztahů mezi proměnnými byla ověřena kontingentačním koeficientem.

VÝSLEDKY: Výsledky ukázaly, že polovina rodičů alespoň jednou zapsala své dítě do kurzu sjezdového lyžování. Rodiče s vyšším vzděláním a vyšším měsíčním příjmem zapisují své děti do kurzů sjezdového lyžování častěji. Osoba, která v rámci rodiny navrhuje, aby se dítě zapsalo do takového kurzu, je většinou otec. Ve více než polovině rodin oba rodiče lyžují; ovšem tři čtvrtiny rodin spolu nikdy nechodí lyžovat nebo toto praktiku-

jí jen zřídka. Otcové hodnotí své lyžařské dovednosti lépe než matky. Důvod nejčastěji uváděný v souvislosti s tím, proč dané dítě nebylo zapsáno do kurzu sjezdového lyžování, byly finanční obtíže. Důvody rodičů pro to, aby se jejich děti naučily lyžovat, byly tyto: více než polovina rodičů si myslí, že by se jejich děti měly naučit dobře lyžovat, a 30 % rodičů přisuzuje velkou důležitost bezpečnosti na lyžařských svazích. Pouze 5 % rodičů by chtělo, aby se jejich dítě účastnilo lyžařských závodů.

ZÁVĚRY: Naše zjištění pomohou organizátorům lyžařských kurzů lépe pochopit, jaké důvody vedou rodiče, aby zapisovali své děti do lyžařských kurzů. Když má dítě možnost učit se tomuto sportu, pak lépe rozvíjí své zdravé návyky. Pokud jsou některé z těchto návyků zaměřeny na sport, bude lyžování bezpochyby figurovat na seznamu rekreačních aktivit tohoto dítěte.

Klíčová slova: názory rodičů, lyžování dětí, kluby, školy, dotazník, analýza.

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CONCENTRATION OF ATTENTION AS A PREDISPOSITION OF PERFORMANCE IN JUNIOR CATEGORIES IN ENDURANCE SPORTS

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BACKGROUND: From the chosen studies done in endurance multithlon athletes and endurance athletes generally (Nideffer, 1995; Nideffer & Bond, 1989; Nideffer & Bond, 1998; Nideffer, 2000; Hátlová, 2000 and others) it follows that one of the most important psychological predispositions for maximal performance is the ability to concentrate one's attention.

OBJECTIVE: The aim was to find out differences in concentration of attention in extremely endurance-loaded adolescents. The research involved 57 triathletes of age 15–22 years, members of youth sport centers in the Czech Republic, divided into groups according to particular competition categories (15–17 and 18–22). We supposed that there is statistical and subject matter significance in differences in the values measured in tests of concentration of attention between the youth category (15–17 years) and the junior category and K23 (18–22 years).

METHODS: We used standardized psychodiagnostic tests (Jirásek's numeric square, Numeric rectangle, the Bourdon test and Disjunctive reaction time II). To compare differences in results of both groups of triathlon athletes we used, on the basis of F-test results, the t-test for independent samples with equal variance. Factor validity was verified by means of confirmative factor analysis. To develop standards of performance in particular tests for both categories we converted results into standardized values (T-points) which points out intra and inter individual differences more precisely concerning the defined model – a norm.

RESULTS: The results indicate that the group of older triathletes shows a significantly higher level of concentration of attention. Differences were, in all examined diagnostics, statistically significant (Jirásek's test before physical load $t = 2.127$, $p = 0.037$, $\omega^2 = 0.062$; Jirásek's test after physical load $t = 2.970$, $p = 0.004$, $\omega^2 = 0.123$; Numeric rectangle $t = -3.307$, $p = 0.002$, $\omega^2 = 0.150$; the Bourdon test = -3.331, $p = 0.002$, $\omega^2 = 0.150$; Disjunctive test $t = 4.95$, $p = 6.79*10^{-6}$, $\omega^2 = 0.296$). On the basis of the verified validity of the test battery (Goodness of Fit Index [GFI] = 0.960, [RMR] = = 0.042) we present standards for both age categories in all verified tests.

CONCLUSIONS: We found out that the ability to concentrate attention increases with age in junior categories. The data were statistically more significant in the group of older triathlon athletes (18–22 years) than in the group of younger triathletes (15–17 years). Differences were, in all examined diagnostics, statistically significant.

Keywords: Psychodiagnostics, sport psychology, youth sports centers, triathlon.

INTRODUCTION

Summaries of sports results prove that differences in top athletes' performances in measurable sports branches and disciplines (locomotive activities) lessen. A detailed view over factors influencing sports performance and indicators of the physical preparedness of the best racers reveals that it is difficult to identify differences. The question is how much significant difference may be found in the area of mental preparedness. The triathlon consists of the three most common endurance sports: swimming, cycling and running. The training of all the three together involves placing enormous demands on both the physical and mental preparedness of the athlete. Hence it is a group of extremely loaded athletes, whose number of training units range between 10–18 and whose total weekly load time is 12–30 hours depending upon the preparation period and the athlete's quality (Zemanová, 2008). A comparable quantity of training units and total load time is presented also by youth sports centers of particular sports. In races with such extreme loads, the ability to preserve athletes' concentration of attention at a high level for the whole race with the aim not to do any tactical nor technical mistake, is considered an important factor deciding about the athlete's success or failure, especially because of the current equability of the physical parameters of the world's or European top athletes.

In the youth and junior categories of endurance sports there are standards for the evaluation of particular performance indicators and therefore it is possible to compare the actual fitness capacity of an individual with these recommendations for concrete age categories. But in the field of diagnostics of psychological

predispositions, or let us say their level in endurance athletes, it has not been so yet. From the point of view of ontogenetic development, the period of 15–20 years is generally characterized as being homogenous. But when considering taking part in sport preparation, mental development becomes more intensive and such a "long" period cannot be, for the diagnostics of sports talents, considered unified. We suppose that apart from the growth of the physical parameters of fitness capacity, mental parameters will change as well, so that the level of ability to focus attention will rise, too. Therefore we want to create standards for evaluation of the level of concentration skills by means of T-points separately for the categories of 15–17 years and 18–22 years, not only for the whole group aged 15–22 years. Age categories were chosen intentionally, in order to be in agreement with the competition categories of our chosen example of endurance sport – the triathlon (youth and juniors K23).

Sports and clinical psychologists have dealt with the analysis of psychological predispositions for endurance sports for a few decades. From the chosen studies done in endurance multithlon athletes and endurance athletes generally (Nideffer, 1995; Nideffer & Bond, 1989; Nideffer & Bond, 1998; Nideffer, 2000; Hátlová, 2000 and others) it follows that one of the most important psychological predispositions for the maximal performance is the ability to concentrate one's attention. This mental predisposition is considered to be essential because of lowering the risk of injury during the training or the race (Morgan & Pollock, 1977; Jackson, Long, & Skinner, 1991; Nideffer, 1993). Attention may be characterized as a precondition of any effective action and as an attribute of cognitive processes. Objects of attention may be external stimuli or our own somatic and mental conditions. It depends on inborn predispositions and our qualities, habits and experiences. It involves all information which an individual manipulates with while, on the other hand, consciousness involves only a smaller range of information which we realize that we work with (focused attention). Attention allows us to rationally use our limited cognitive sources (Koukolík, 2002; Kulišťák, 2003).

Niderfer and Sagal (2001) state that concentration of attention changes in two dimensions – in both its width and direction. The dimension of width may be further divided according to angle of view into broadened and narrowed. According to how large is the image we want to record, we zoom in and out of our focus on the image while the size of an area is at the expense of a detail and vice versa. Extended attention allows us to perceive more events at once; and it is essential, especially in sports where situations are changing very fast (heuristic sports). On the other hand, narrowed attention occurs in reactions to one or two stimuli (concentration – mobilization sports). The second dimension is a function of direction which concentration follows. It may be internal, that means directed to one's own thoughts, feelings and experiences, or external, which is focused on events happening around us. These already mentioned dimensions interact and finally create four major types of concentration of attention.

The research on marathoners done by Morgan and Pollock (1977) was focused on ways of mental coping with long-term load. During top performance, elite runners concentrated on associative attention strategies (they observed how their body functions and reacts and how they perceive their own feelings, they focused on their breathing, muscle tension, depth and speed of breath). Runners of a lower level tended to use disassociative attention strategies; it means elements of distraction and amusement during the race. Similar conclusions are confirmed by other studies, as well (e.g. Couture, Jerome, & Tihanyi, 1999; Scott, Scott, Bedic, & Dowd, 1999) which results in the fact that associative strategies (an internal view) are used in higher run intensities, especially during races. They facilitate the surmounting of physical discomfort and the enlargement of the time spent in high race intensity despite cumulating fatigue. In spite of this, during training performed at a lower intensity (long term monotonous load) disassociative strategies are more popular (an external view, e.g. listening to music). The redoubtable higher risk of injury has not been confirmed in this strategy; by contrast it has appeared to be an important means of reducing total fatigue from monotonous training or regeneration running. These strategies are recommended for use as a training method in individual endurance sports for easier coping with long monotonous training without a higher risk of injury.

Interesting conclusions were found by Nideffer (1998) in a complex psychological study of top athletes in the Australian Institute of Sport in Canberra. The research was done on athletes who agreed to undertake test examinations in the interval of about one year. The study showed that on the basis of training it is possible to develop self confidence, leadership and concentration skills. Significant differences were found with regard to age. In the period of 16–24 years there are possibilities for developing the mentioned abilities, but they decrease with higher age. As a psychodiagnostic means they decided to choose psychology test TAIS (The Attentional and Interpersonal Style), the author of which is an American psychologist named Nideffer, who projected the first version of the test for focused attention in 1976. The test includes three scales measuring the level of concentration of attention (extended – wide external, extended – wide internal and limited – narrowed attention) and three scales of ineffective concentration (external overload, internal overload and reduced – lowered

attention). The test has been used with modifications in many centers of elite top sport in the whole world for 15 years and serves both racers and coaches. The repeated test involved 502 athletes. TABLE 1 shows particular psychological measurements and their percentage differences changing during the interval of one year.

TABLE 1
Scale measuring the level of concentration of attention and its processual changes during the interval of one year (Nideffer, 1998)

Scale TAIS	Juniors	Seniors
BET	**2.9%**	–0.8%
BIT	**3.7%**	0.0%
NAR	**3.5%**	1.0%
OET	**3.1%**	0.8%
OIT	**4.2%**	1.8%
RED	**3.5%**	0.6%

Legend:
BET – ability to read and react quickly and instinctively to the environment
BIT – ability to analyze, plan, and strategize
NAR – ability to focus concentration, pay attention to details, and follow through
OET – external distractibility
OIT – internal distractibility
RED – inability to make appropriate shifts from an internal to an external focus

The first group (juniors) consisted of young athletes aged 16–24 years; the second group (seniors) was composed of athletes with an average age of 43 years. The results of the study confirmed that concentration skills may be developed in youth by means of regular training, while in older athletes, tendencies to have weaker abilities to perceive one's surroundings after a former training session were seen.

We were interested in the question of whether there are differences in the ability to concentrate attention depending on an athlete's age and whether parameters referring to attentional skills change with age (in time) or they remain at more or less the same level. In our study we focused on the identification of the level of ability to concentrate attention depending on an athlete's age based on the example of the triathlon, the most widespread endurance multithlon which is a part of the program of the summer Olympic Games. The aim was to find out differences in concentration of attention in extremely endurance loaded adolescents (younger and older triathlon athletes of junior categories). We supposed that there is statistical and subject matter significance in differences in the values measured in tests of concentration of attention between the youth category (group 1) and junior category and K23 (group 2).

METHODS

Research group

The research sample presented all male and female triathlon athletes (n = 57) aged 15–22 years at youth sports centers in the Czech Republic (SCM). The tested sample was divided into two groups according to age, or the categories in which athletes race.

With respect to the fact that no statistically significant difference between men and women was proven (Jirásek's test before physical load t = 0.041, p = 0.684; Jirásek's test after physical load t = 0.125, p = 0.226; Numeric rectangle t = –0.177 p = 0.860; The Bourdon test t = 0.098, p = 0.920; Disjunctive test t = 0.426, p = = 0.671), the groups were not divided according to sex.

TABLE 2
Division of groups according to sports categories

Group	Number of tested	age (years)
1	31	15–17
2	26	18–22

The tests were performed by the team of the Laboratory of Sport Motor Activities, Faculty of Physical Education and Sport, Charles University in Prague, within the complex diagnostics of SCM of the Czech Triathlon Federation and junior representatives. The examination was carried out in training camps of particular SCM. All participants were tested under equal conditions, examination was done always on the identical day of the training camp (the third day), always between lunch and afternoon training; after a similar morning training program. The interval of relaxation after the last training session took two hours. Participants were examined in a quiet room with tables and chairs without any possibility of cheating. Instructions were given by the same person with a precise and invariable schedule.

The tests used

For our research the following standardized psychodiagnostic tests were used:

- Jirásek's numeric square (before and after physical load): This test is used in examination of the quality of concentration of attention. The test is performed twice. First in quiet surroundings, when the participant is initially acquainted with the testing process, and then immediately after bearing a maximal physical load. The time gap between these tests took four hours. A square divided into 25 cells is laid down in front of the participant. In every cell there is one number from 1 to 25. The numbers are located randomly. Each participant's task is to find all numbers in order from one to twenty-five in as short a time interval as possible (Jirásek, 1975).

- Numeric rectangle: It is a test of attention, or a test of optical response. It tests qualities of attention, especially its selectivity and distribution. It expresses and measures readiness, attention, imagination, brightness, comprehension and memory. The chart, which consists of numbers from 1 to 100 ordered randomly with no regard to size, position or location, was laid down in front of the participant. The participant looks for dictated numbers always in a series of three attempts, for a total of eight series. The goal is to find as many dictated numbers as possible in the defined time interval (Doležal, Kuruc, & Senka, 1992).
- The Bourdon test: The principle of the Bourdon test embodies in differentiation (to strike out or underline) stimuli very similar in shape during a longer, exactly defined period of time. The test examines concentration of attention; it may serve as a tool for the diagnostics of work qualities from a work curve or as a method for examining work characteristics during a period of long term load of attention. On the basis of performance indicators we may evaluate the performance capacity of an individual and his/her fatigability. The test takes 30 minutes. The participant is given a sheet of paper with a large quantity of squares. In a total of 30 lines there are altogether 2,550 squares. In every square there is either a black quarter circle in one of the four corners or a black half circle on one of the four sides inside the square. The participant's task is to underline some of them and strike out the others, according to the instructions. The aim is to mark without mistakes as many submitted squares as possible in the given time interval (Kuruc, Senka, & Čečer, 1992).
- Disjunctive reaction time II: The test serves for the diagnostics of individual differences in reactions and fast and correct decision making. It is directly used for the evaluation of predispositions and the level of fitness capacity in extremely loaded persons. The test is adequately used when examining reaction time and individual differences in performance productivity, which means in tests of cognitive abilities. The sheet of paper consists of cells; every cell contains two points – a black one and a white one. The participant's task is to correctly fix the previously defined position of a black point in a direction towards the white point in the sheet. The aim is to correctly mark as many squares as possible (Vonkomer, 1992).

The statistics methods used

To compare differences in the results of both groups of triathlon athletes on the basis of F-test results, we used the t-test for independent samples with equal variances.

Factor validity was verified by means of confirmative factor analysis (TABLE 5, 6, Fig. 1).

To develop standards of performance in particular tests for both categories we converted results into standardized values (T-points) which points out intra and inter individual differences more precisely concerning the defined model or norm. We used the transformation of norm quantity (McCall's criteria) where the norm, in other words the mean of the whole group, matches with 50 T-points and the zone of one standard deviation matches with 10 T-points. The standard zone is therefore defined by the range of 45–55 T-points; the value of 70 T-points represents an excellent level, while the value of 30 T-points meansan insufficient level (TABLE 7). Every result, in particular tests, is always assigned to the zone of T-points independently for both age categories.

RESULTS

First we present means and standard deviations of results in tests of both examined groups (TABLE 3). Consequently (TABLE 4) results of comparison of performance means in groups 1 and 2 by means of the t-test for independent samples with equal variances and subject matter significance (ω^2) are presented.

TABLE 3
Means and standard deviations of results in both examined groups in particular tests

	Units of measurement	Group	Mean	Std. Deviation	Std. Error Mean
Jirásek's numeric square before physical load	s	1	33.96	8.78	1.58
	s	2	29.86	7.47	1.18
Jirásek's numeric square after physical load	s	1	31.47	7.83	1.41
	s	2	26.38	6.60	1.04
Numeric rectangle	points	1	17.68	3.15	0.56
	points	2	20.19	2.54	0.49
The Bourdon test	points	1	1417.27	303.12	55.34
	points	2	1718.04	377.70	72.69
Disjunctive test	points	1	30.45	7.96	1.45
	points	2	24.36	6.55	1.24

Our suppositions were proven in each test, it means that results of the group of older athletes were statistically better than those of the group of younger athletes at the level of significance $p < 0.01$ (only in Jirásek's test before physical load the level of significance was 0.05).

TABLE 4
Results of t-test for independent samples with equal variances

	t-test for Equality of Means						
	t	Sig.(p) (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		
					Upper	Lower	ω^2
Jirásek's NS before load	2.127	0.037	4.106	1.931	0.254	7.958	0.062
Jirásek's NS after load	2.970	0.004	5.088	1.713	1.670	8.505	0.123
Numeric rectangle	–3.307	0.002	–2.508	0.758	–4.027	–0.988	0.150
The Bourdon test	–3.331	0.002	–300.770	90.305	–481.745	–119.796	0.150
Disjunctive test	4.951	0.000	9.845	1.988	5.862	13.829	0.296

Results of Jirásek's test showed a significant difference in a test performed after physical load ($p = 0.004$, $\omega^2 = 0.123$) and a test performed before physical load ($p = 0.037$, $\omega^2 = 0.062$). But in both cases the group of older triathlon athletes needed a shorter time interval for correct task performance.

The test Numeric rectangle (TABLE 4) revealed significant difference between the tests of both groups ($p = 0.002$, $\omega^2 = 0.150$). The test is done in silence; but with regard to the fact that its results are very similar to the results of Jirásek's numeric square, we suppose that it is possible to substitute it by using Jirásek's test. The advantage is its lower administrative and organizational demands.

The Bourdon test showed again significantly higher values of the concentration of attention in older triathlon athletes (TABLE 4) focused on long term activity, the ability to shift one's attention, searching for impulses and the speed of these operations when compared to the group of younger athletes ($p < 0.01$, $\omega^2 = 0.150$). Differences were found in the quality of performance (quantity of mistakes), as well. We present only the value of clear performance, that means without any difference of the total performance and number of mistakes. This test is believed to be very important because it is focused on testing long term concentration of attention (the length of the test is 30 minutes). The maintenance of concentration of attention is one of the key predispositions for quality performance in endurance sports.

The disjunctive reaction time II is used for the diagnostics of individual differences in reactions and fast and correct decision making. It was intentionally performed after the Bourdon test, which means after long term monotonous mental load when athletes tend to lose their concentration of attention.

The group of older triathlon athletes marked a larger amount of squares and simultaneously they made fewer mistakes ($p < 0.01$, $\omega^2 = 0.29$). This test indicated the highest significance ($p = 6.79*10^{-6}$, $\omega^2 = 0.296$). The question is whether this difference is attributed only to this test or to its placement at the end of the whole examination when it increases along with cumulating fatigue differences in concentration skills.

Factor validity was verified by confirmative factor analysis (Goodness of Fit Index [GFI] = 0.960, [RMR] = = 0.042) (TABLE 5). Jirásek's test after physical load showed the highest value of factor validity and simultaneously the lowest uniqueness (TABLE 6, Fig. 1). For better orientation we add a path diagram of this one factor model of concentration of attention (Fig. 1).

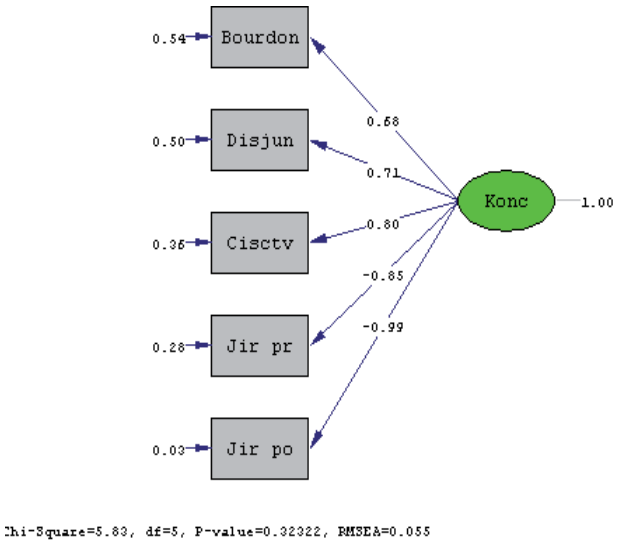
TABLE 5
Goodness of Fit Statistics

Goodness of Fit Index (GFI)	0.960
Normed Fit Index (NFI)	0.970
Root Mean Square Residual (RMR)	0.042
Standardized RMR	0.042

TABLE 6
Absolute values of factor validity and uniqueness of tests

Jirásek's test before physical load	0.85	0.28
Jirásek's test after physical load	0.99	0.03
Numeric rectangle	0.80	0.36
The Bourdon test	0.68	0.54
Disjunctive test	0.71	0.50

Fig. 1
Path diagram of one factor model of concentration of attention



Legend:
Bourdon – The Bourdon test
Disjun – Disjunctive test
Cisctv – Numeric rectangle
Jir pr – Jirásek's test before physical load
Jir po – Jirásek's test after physical load
Konc – Concentration of attention

TABLE 7
Standards for evaluation of level of the chosen parameters

Level of parameter	T-points
Insufficient	30
Deeply below standard	35
Below standard	40
Moderately below standard	45
Standard	50
Moderately above standard	55
Above standard	60
Highly above standard	65
Excellent	70

TABLE 8
Standards – Jirásek's numeric square (before physical load)

Jirásek's square – before physical load		
15–17 years	**T-points**	**18–23 years**
(s)		**(s)**
51.2	30	44.6
46.9	35	40.9
42.6	40	37.2
38.3	45	33.5
34.0	50	29.9
29.6	55	26.2
25.3	60	22.5
21.0	65	18.8
16.7	70	15.1

TABLE 9
Standards – Jirásek's numeric square (after physical load)

Jirásek's square – after physical load		
15–17 years	**T-points**	**18–23 years**
(s)		**(s)**
46.9	30	39.4
43.0	35	36.2
39.2	40	33.0
35.3	45	29.6
31.5	50	26.4
27.6	55	23.1
23.8	60	19.9
19.9	65	16.6
16.1	70	13.4

TABLE 10
Standards – Disjunctive test

Disjunctive test		
15–17 years	**T-points**	**18–23 years**
(points)		**(points)**
28	30	39
32	35	42
37	40	46
41	45	50
45	50	53
50	55	57
54	60	60
58	65	64
62	70	65

TABLE 11
Standards – Numeric rectangle

Numeric rectangle		
15–17 years	**T-points**	**18–23 years**
(points)		**(points)**
11	30	15
13	35	16
15	40	18
16	45	19
18	50	20
19	55	21
21	60	22
22	65	23
24	70	24

TABLE 12
Standards – The Bourdon test

The Bourdon test		
15–17 years	**T-points**	**18–23 years**
(points)		**(points)**
821	30	977
970	35	1162
1119	40	1347
1268	45	1533
1417	50	1718
1566	55	1903
1715	60	2089
1864	65	2274
2013	70	2459

DISCUSSION

The study proved that the group of older athletes had statistically higher results on the tests. Therefore they are supposed to have a higher level of perception and regulation of load so that they should be able, even during the bearing of a maximal physical load, to put forth quality sport performance. It is not possible to definitely state whether there is any difference in contentration abilities caused only by ontogenetic development, or whether the key factor is the effect of training and the contribution of sport preparation to its cultivation or skills gained by the usage of along term endurance load.

To validate or refuse such a statement we would have to do a longitudinal study and a detailed examination of the casuistics involved.

It is equally important to realize that the "common factor" of long termed concentration performance in endurance multithlon are the motivation and volition processes; thus the abilities of self-control and self regulation during the bearing of a long-term load, which may vary while growing older.

Issues of volition and motivation in performance have been studied for many years (e.g. Brichcín, 1999; Hošek & Hátlová, 2006). Motivation is here (along with abilities) considered to be a function of performance. Volition enters into action as a certain regulator and energizer. The theory of achievement motivation was developed in the nineteensixties in the USA (Hošek, 2006) and later it was elaborated on by Heckhausen in Europe. These psychologists used the method TAT of Svoboda (1999) for the verification of their results.

In sport psychology, the need for great achievement is measured mainly in a projective way; apart from this, inquiring techniques (questionnaires, tests of risks, assessment) are used. A hypothesis that the need for great achievement is higher in athletes than in the common population, was proven. It is possible to assume that the need for great achievement as a hidden independent variable affects the results of much experimental research dealing with physical fitness and performance. The question is how large a proportion of the results is attributed to different motivation and different approaches of the tested persons to the examination. Therefore it would be interesting to use tests of this type and find out how much the results in concentration tests are affected.

The training of the development of the concentration of attention may have a single shot effect, but for stable improvement, systematic long-term intervention is essential. Influence on and improvement of the ability to concentrate one's attention may be successfully achieved by particular relaxation and suggestive techniques. Further means for affecting an individual's psyche and increasing his/her physical performance are to be found in the form of supplementary pharmacological preparations. A great future is predicted for neurotransmitters. It is necessary to add that in some sports their usage during a race is forbidden.

Many athletes use AVS (audio-visual stimulating) devices which quickly and effectively affect their bioelectrical brain activity. Another successful method includes exercises for the increase of one's concentration of one's attention, especially in the form of exercises connected with physical load intended for the elimination of problems in a race, for the shifting of the concentration of attention in individual dimensions (Weinberg & Gould, 2003) and exercises used before the race for the increase of one's concentration, for anxiety inhibition and the elimination of external disturbing influences (Seiler & Stock, 1996).

The methods are well-known and are constantly being developed. In the Czech Republic, the methods mentioned above are only randomly included in the sport preparation of a few endurance athletes, rather than systematically used. Now we have constructed the means for monitoring their changes depending on age, which shows us the current state of an athlete's preparation and standards which compare the athlete's result with a similar population. It may be the next source of support for coaches in psychological preparation.

We recommend inserting psychological preparation into a year long training cycle immediately after a race period, which means in the post-race recovery period. This should be framed individually on the basis of an analysis of the concrete race and those found weaknesses which could have been evoked by mental causes.

CONCLUSIONS

Based on the test battery which is composed of four tests focused on the evaluation of the concentration of attention (Jirásek's numeric square before and after a physical load, Numeric rectangle, The Bourdon test

and Disjunctive reaction time II) we found out that the ability to concentrate attention increases with age in junior categories. The data were statistically more significant in the group of older triathlon athletes (18–22 years) than in the group of younger triathletes (15–17 years). Differences were, in all examined diagnostics, statistically significant (Jirásek's test before a physical load $t = 2.127$, $p = 0.037$, $\omega^2 = 0.062$; Jirásek's test after a physical load $t = 2.970$, $p = 0.004$, $\omega^2 = 0.123$; Numeric rectangle $t = -3.307$, $p = 0.002$, $\omega^2 = 0.150$; The Bourdon test $t = -3.331$, $p = 0.002$, $\omega^2 = 0.150$; Disjunctive test $t = 4.95$, $p = 6.79*10^{-6}$, $\omega^2 = 0.296$).

On the basis of the verified validity of the test battery (Goodness of Fit Index [GFI] = 0.960 [RMR] = = 0.042) we present standards for both age categories in all verified tests.

Consequently we worked out standards for the evaluation of the level of concentration skills according to age categories – youth (15–17 years) and juniors together with category K23 (18–22 years) used in endurance sports (concretely in the triathlon) by means of standardized values (T-points) which more accurately point out intra and inter individual differences with regard to the defined model or norm.

The established test battery becomes a permanent part of testing triathlon youth and the final mean value of T-points (the mean result of all four tests) will be included in the complex evaluation of triathlon athletes and will complete the values of physiological and motor tests.

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KONCENTRACE POZORNOSTI JAKO PŘEDPOKLAD VÝKONU U SPORTOVCŮ V JUNIORSKÝCH KATEGORIÍCH VE VYTRVALOSTNÍCH SPORTECH

(Souhrn anglického textu)

VÝCHODISKA: Analýzou psychologických předpokladů pro vytrvalostní sporty se zabývají sportovní i klinič tí psychologové již několik desítek let. Z vybraných studií provedených u vytrvalostních vícebojařů a vytrvalců obecně (Nideffer, 1995; Nideffer & Bond, 1989; Nideffer & Bond, 1998; Nideffer, 2000; Hátlová, 2000 a další) vyplývá, že jedním z nejdůležitějších psychologických předpokladů pro maximální výkon je schopnost koncentrace pozornosti.

CÍLE: Cílem bylo zjištění rozdílů v koncentraci pozornosti extrémně vytrvalostně zatěžovaných adolescentů. Výzkum byl realizován na 57 triatlonistech ve věku 15–22 let zařazených do sportovních center mládeže ČR, rozdělených do skupin dle jednotlivých závodních kategorií (15–17 a 18–22). Předpokládali jsme tedy, že je statistický a věcně významný rozdíl v hodnotách naměřených v testech koncentrace pozornosti mezi dorostenci (15–17 let) a juniory a K23 (18–22 let).

METODIKA: Použili jsme standardizované psychodiagnostické testy (Jiráskův číselný čtverec, Číselný obdélník, Bourdonův test a Disjunkční reakční čas II). Pro porovnání rozdílů výsledků dvou skupin triatlonistů jsme na základě výsledků F-testu použili t-test pro nezávislé výběry s rovností rozptylů. Ověření faktorové validity jsme provedli pomocí konfirmativní faktorové analýzy. Pro vypracování standardů výkonů v jednotlivých testech pro obě věkové kategorie jsme výsledky převedli na standardizované hodnoty (T-body), které názorněji ukazují intra a interindividuální rozdíly vzhledem k určenému modelu – normě.

VÝSLEDKY: Výsledky testování ukázaly, že skupina starších triatlonistů vykazuje významně vyšší schopnost koncentrace pozornosti. Rozdíly byly u všech zjišťovaných diagnostik statisticky významné (Jiráskův test před výkonem $t = 2{,}127$, $p = 0{,}037$, $\omega^2 = 0{,}062$; Jiráskův test po výkonu $t = 2{,}970$, $p = 0{,}004$, $\omega^2 = 0{,}123$; Číselný obdélník $t = -3{,}307$, $p = 0{,}002$, $\omega^2 = 0{,}150$; Bourdonův test $t = -3{,}331$, $p = 0{,}002$, $\omega^2 = 0{,}150$; Disjunkční test $t = 4{,}95$, $p = 6{,}79 \cdot 10^{-6}$, $\omega^2 = 0{,}296$). Na základě ověření validity testové baterie (Goodness of Fit Index [GFI] = 0.960, [RMR] = 0.042) uvádíme standardy pro obě věkové kategorie u všech ověřovaných testů.

ZÁVĚRY: Zjistili jsme, že schopnost koncentrace pozornosti se v juniorských kategoriích s věkem zvyšuje. Zjištěné údaje byly statisticky významně vyšší u skupiny starších triatlonistů (18–22 let) oproti skupině mladších triatlonistů (15–17 let). Rozdíly byly u všech zjišťovaných diagnostik statisticky významné.

Klíčová slova: psychodiagnostika, psychologie sportu, sportovní centra mládeže, triatlon.

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THE ASSESSMENT OF THE EXTENT OF THE RECOVERY OF HAND SENSORIMOTOR FUNCTIONS IN THE GROUP OF REHABILITATED PATIENTS AFTER STROKE IN THE POST-ACUTE STAGE

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BACKGROUND: Although the deficit of hand sensomotory functions is very common in patients after stroke, the algorithm of their renewal is relatively little known. It is not clear whether the extent or type of somatosensory dysfunction correlates with an impeded process of motorics renewal.

OBJECTIVE: This study was focused on observation of hand sensorimotor functions in a group of patients in post-acute phase after ischemic stroke, localized in artery cerebri media. The aim was to find out the extent of improvement of somatosensory and motor hand functions. This is the first stage of a research project which will be followed by the observation of an experimental group with therapy targeted to somatosensory functions.

METHODS: The observed group of patients was treated at an inpatient department of a rehabilitation clinic and underwent standard therapy lasting 3–4 weeks. To assess hand sensorimotor functions two sensation tests were used: the FMT – the Fabric Matching Test and the RASP – The Rivermead Assessment of Somatosensory Performance. Two tests of fine motor function were also used: the NHPT – The Nine Hole Peg Test and the TMF – The Test of Manipulation Functions by means of a special constructional set Ministav. These tests were performed at the beginning and at the end of therapy.

RESULTS: In the observed group of patients, we found impairments of somatosensory functions and fine motor function even on the unimpaired upper limb. Nevertheless, fine motor function is impaired more seriously than the somatosensory functions. The biggest deficits of motor functions were found in tasks which had required a precise grip. The most obvious changes in the assessment of patients were found in ADL assessed by the Barthel Index – the return of functions towards the standard was observed in one third of the subjects.

CONCLUSION: After the application of standard therapy, improvement of hand sensorimotor functions was observed in a group of patients, but the results are not consistent. Some of the patients got worse and sometimes there was only a slight change. The results of an experimental group of patients must be proven by a therapy specifically targeted to influence the somatosensory functions.

Keywords: Stroke, hand with hemiparesis, somatosensory functions, fine motor functions, hand functions tests.

INTRODUCTION

With regards to patients after stroke, the impairment of sensorimotor functions is shown in more than 65% of patients in their set of symptoms. The most characteristic symptom is the loss of discriminative sensation. The tresholds of the primary sensory quality (e.g. touch) are often unidentifiable and some qualitative changes, variability in responses and dissociated loss of sensation, are observed. The important role of sensation in motor function is particularly evident in their control of pinch grip, their ability to sustain and adapt appropriate force without vision, object manipulation, combining component parts of movement such as transport and grasp, discrimination of surfaces at the end of handheld objects, and adjustment to sensory conflict conditions such as a rough surface (Selzer et al., 2006).

Furthermore, the sensory impairments have detrimental effects on the spontaneous use of hands and influence the reacquisition of skilled movements. It has been suggested that a learned non use phenomenon, occuring with sensory loss, leads to further deterioration of motor abilities (Dannenbaum & Dykes, 1988). Despite this fact, these impairments and their recovery when performing diagnostics are often omitted. The present time studies mostly focus only on the evaluation of the recovery of impaired motor functions.

Some authors suggest that it is not necessary to follow somatosensory functions to predict the recovery of impaired functions, and that it is problematic to evaluate them objectively. Nevertheless there exists an opinion that, despite the importance of sensation, there is no standardized assessment procedure or consistent method of recording findings (Lincoln et al., 1991). Other

authors are opposed and, contrary to this opinion, suggest that it is necessary to follow these functions and register their changes (Campbell et al., 1996; Carey et al., 2002; Blennerhassett et al., 2006).

The importance of the sensory system as an early indicator of motor recovery after stroke has been suggested in neuroimaging and clinical studies (Kusoffsky et al., 1982). It has been suggested that sensory reorganization may precede motor reorganization and may, in fact, trigger the latter (Weiller, 1998).

At present, relatively little is known about the time or pattern of recovery for somatosensory loss after stroke or whether the extent or type of somatosensory loss by itself is associated with poor motor or functional recovery (Winward, 2007).

This study is aimed at the extent of the recovery of somatosensoric and motoric functions of the hand in patients after stroke using four tests and the results received are compared with the results of a one Activity of Daily Living test.

METHODS

The study was comprised of 15 patients (7 men, 8 women) who suffered from ischemic middle cerebral artery stroke in the postacute phase. All were right handed. They were observed at the age of 45–75 years (mean 59.6 years), 11 with left and 4 with right hemiparesis. Reasons for excluding patients included: unable to cooperate, severe speech disorders, neglect syndrome and peripheral neuropathy.

A limit of the study is the interrelationship between the trunk posture and the limbs. A possible limitation is also the influence of diagnostics and therapy in the case of other clinical signs. Therefore other output variables, such as changed muscle tone, muscle length and occurence of spasticity, which will not be included in the study, will have to be considered when evaluating its outcome. This study was approved by the Faculty Hospital Ethics Committee.

The study participants were investigated for somatosensory and motor recovery in the post-acute phase after their stroke at the Clinic of Rehabilitation, Faculty Hospital Ostrava. They were assessed twice,, right from the start (check up) and also at the end (e.g. examination) of their rehabilitation. During their stay at the Clinic of Rehabilitation, standard rehabilitation was performed, including physical therapy and neurorehabilitation techniques within the framework of physiotherapy and occupational therapy. Rehabilitation was performed on average five times a week, twice a day (approximately 7. 5 hours per week), for four weeks.

In all subjects, to assess their sensorimotor functions, four tests were used. Two of these tests were somatosensory tests: FMT – The Fabric Matching Test (Carey et al., 1997) and RASP – The Rivermead Assessment of Somatosensory Performance (Winward et al., 2000), and two tests were motor function tests: NPHT – The Nine Peg Hole Test (Wade, 1994; Mathiowetz et al., 1985) and TMF – The Test of Manipulation Functions (Vyskotová et al., 2003; Vyskotová, 2007). Further, one ADL test – Barthel Index (Mahoney, 1965) – was performed – TABLE 1.

TABLE 1
Used tests

Title of the test	**Test characteristics**
FMT (The Fabric Matching Test)	Test for assessing sense discrimination focused on fabric surface. It consists of a set of ten standardized fabric surfaces, which range on a scale from the softest to the roughest. The goal is to distinguish the variety and to assign the same surfaces matching each other. The achieved score served as the test criterion.
RASP (The Rivermead Assessment of Somatosensory Performance)	Test for assessing somatosensory functions in neurological diseases. It contains seven subtests: sharp/dull discrimination, surface pressure touch, surface localization, bilateral touch discrimination, two point discrimination, temperature discrimination, proprioception movement discrimination, proprioception direction discrimination. The achieved score served as the test criterion.
NHPT (The Nine Hole Peg Test)	Test for assessing fine motor function. The patient's task is to place, as quickly as possible, nine pegs into holes in a testing board and then to pick them up with one hand, one peg after another, and to put them into a bowl. Unimanual dexterity of the fingers is tested. The achieved time is used as the test criterion.
TMF (The Test of Manipulation Functions)	The test assesses handling skills, unimanual and bimanual, by means of five objects of the special constructional set Ministav, which are called *The needle*, *The cube*, *The house*, *The pyramid* and *The mummy*. As a whole, it comprises 17 subtests, in which tasks such as assembling and dismantling of objects, assembling of an object according to the example, upholding with the palmar and pinch grasp or putting the needle through holes into the object are performed. The achieved time is used as the test criterion.
Barthel Index	Standard, well validated assessment that measures functional outcome, including independence in mobility and self care. The Barthel Index consists of 10 items (feeding, bathing, grooming, dressing, bowels, bladder, toilet use, transfers, mobility and stairs). The achieved score served as the test criterion.

Statistics were not done due to the limited number of patients. For better plasticity, the outcome is demonstrated in a summarized form of the column graph in order to differentiate the changes in particular items and their trends clearly and in order to manifest the abnormal findings in "unimpaired" limbs in patients after stroke in a better way.

RESULTS

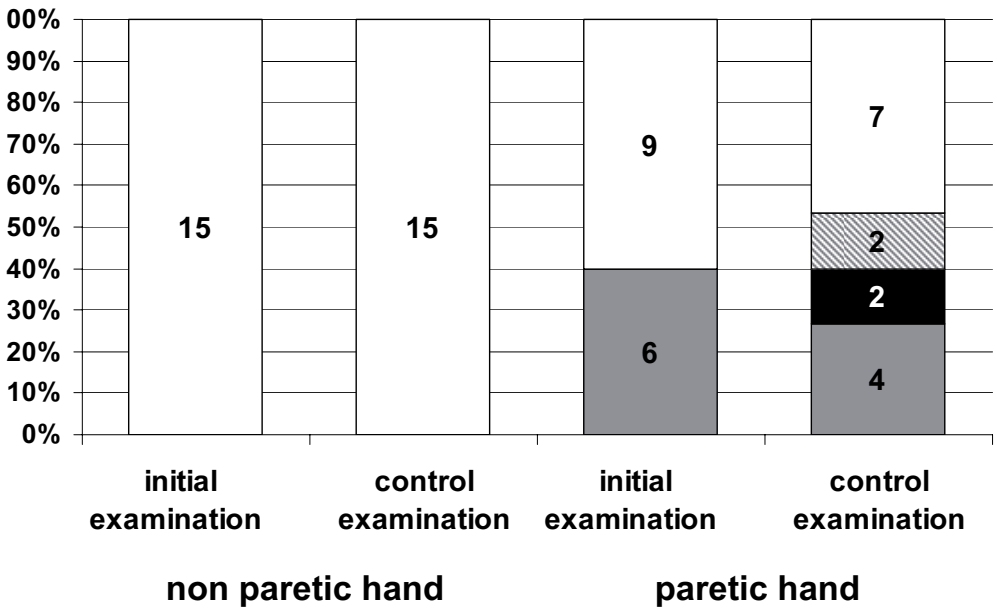
In all subjects the results of the initial check-up and final examination have been given. We have assessed how many subjects, according to the given standards for single tests, were within the standard or did not reach the standard during testing. Furthermore, some improvements and deteriorations in performance were observed during the final examination. The results are shown in the graphic form by means of the bar graphs. In these graphs the following categories are shown:

- **standard** (number of subjects having no deficit);
- **improvement** (number of subjects showing improvement after therapy);
- **deterioration** (number of subjects whose states were observed to be worse at the final examination);
- **off the standard** (a number of subjects who were not up to the standard of the given tests and were not influenced by therapy).

The results of somatosensory tests are different in single tested modalities. The test for the evaluation of a discrimination sensation – **FMT** – testing the surface texture (Fig. 1) showed in all subjects a zero deficit in both initial and the final examination in the **unimpaired extremity**. Nine subjects corresponded to the standard in the **paretic extremity** in the initial examination. In two subjects deterioration from the standard into the off the standard state in the final examination was observed. In two subjects a mild improvement was seen and four subjects remained off the standard.

The **RASP** showed deficit on both sides before and after therapy. The modalities evaluated by means of RASP (Fig. 2a, b) on the **unimpaired side** were, in most subjects, within the standard in the **initial examination**. Some deficit was found in the modalities: "*sharp/dull discrimination*" (4 subjects), "*surface pressure touch discrimination*" (1 subject), "*surface localization*" (4 subjects). The standard was found in two modalities in all subjects: "*two point discrimination*" and "*temperature discrimination*". On the **paretic side** in the initial examination, a certain degree

Fig. 1
The Fabric Matching Test



Legend (holds for all following graphs):

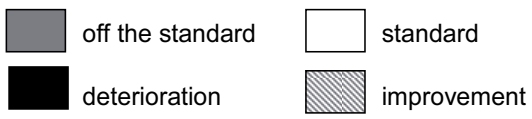
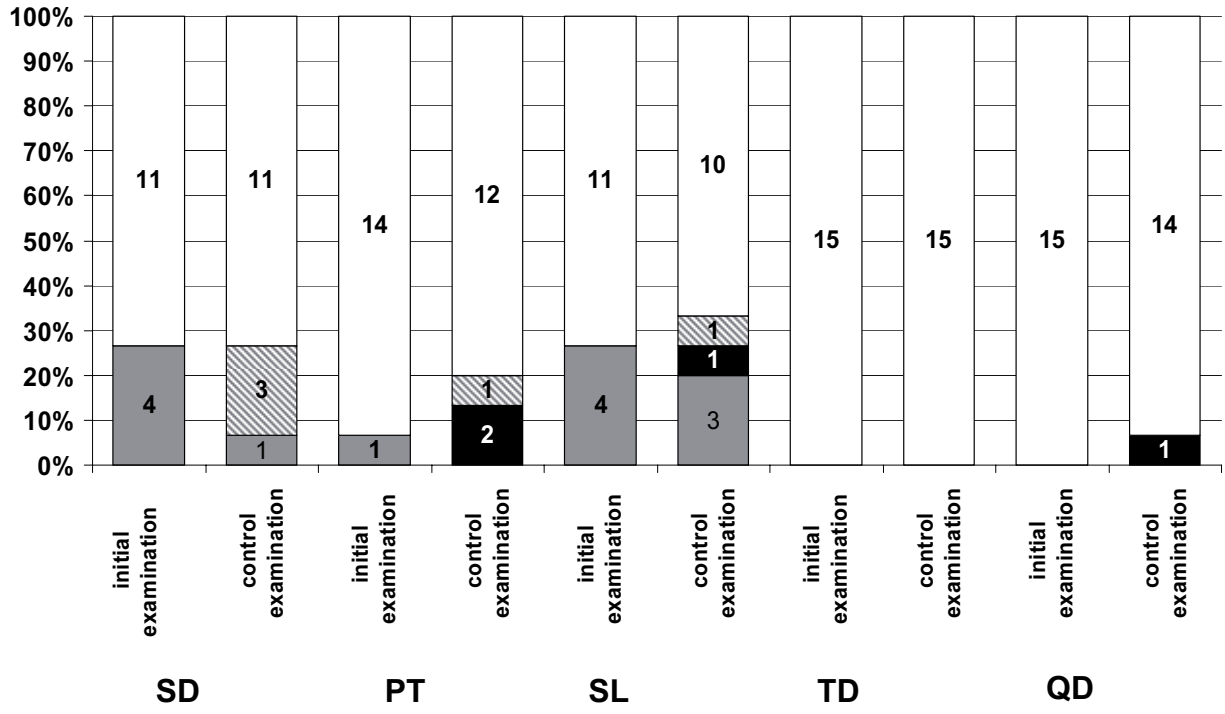


Fig. 2a
The RASP – unimpaired side



Legend:
SD – sharp/dull discrimination
PT – surface pressure touch
SL – surface localization
TD – two point discrimination
QD – temperature discrimination

Fig. 2b
The RASP – impaired side

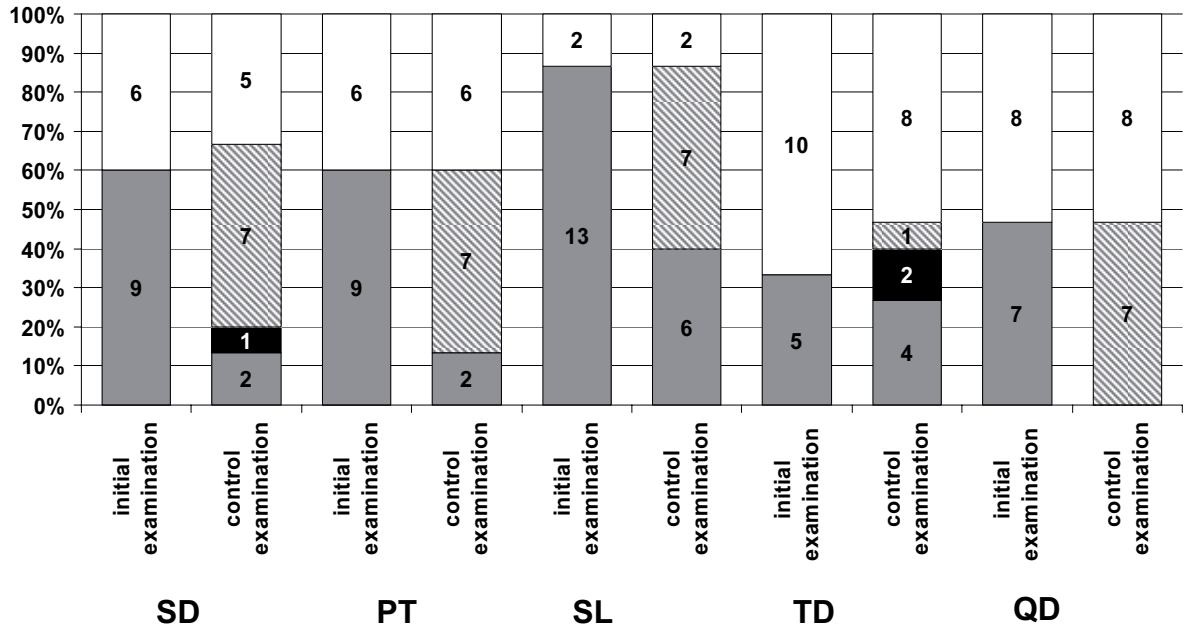


Fig. 3
The NHPT

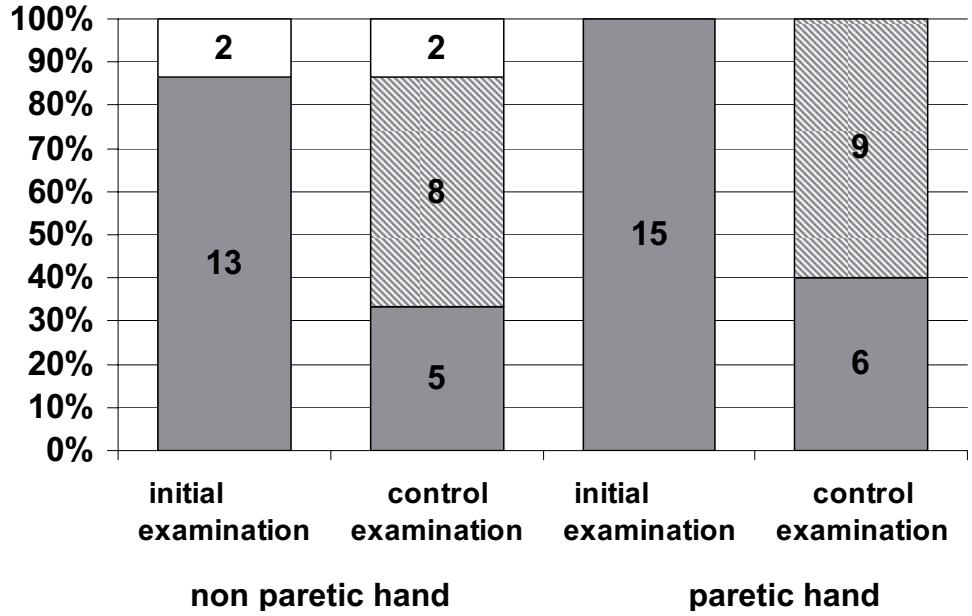


Fig. 4 a
The TMF – subtest Pyramid – unimpaired extremity

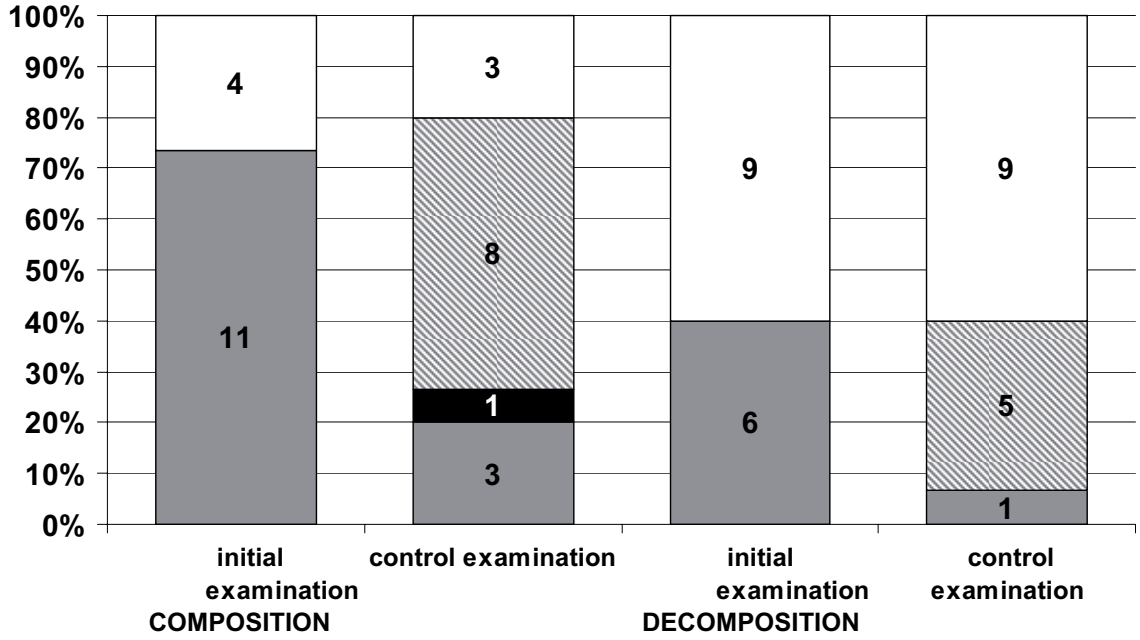


Fig. 4b
The TMF – subtest Pyramid – paretic extremity

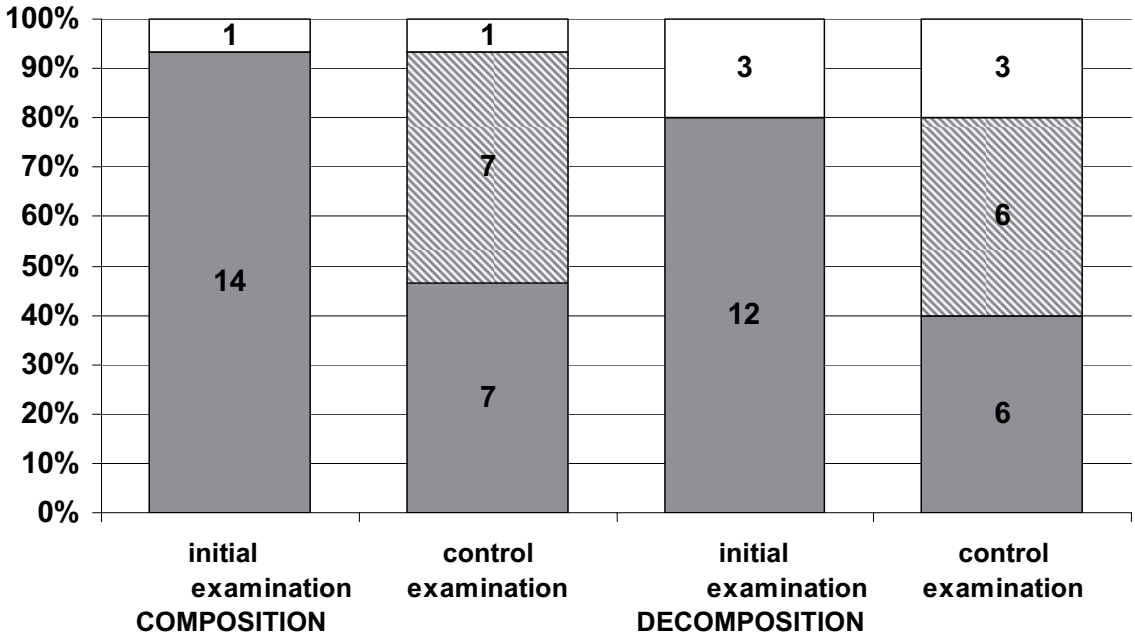


Fig. 5a
The TMF – subtests Mummy – unimpaired extremity

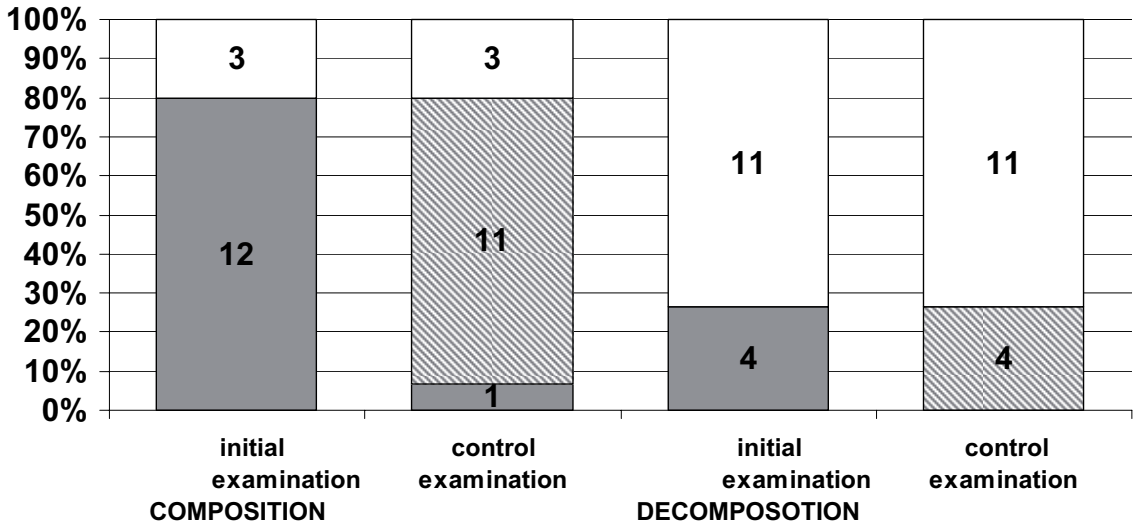


Fig. 5b
The TMF – subtests Mummy – paretic extremity

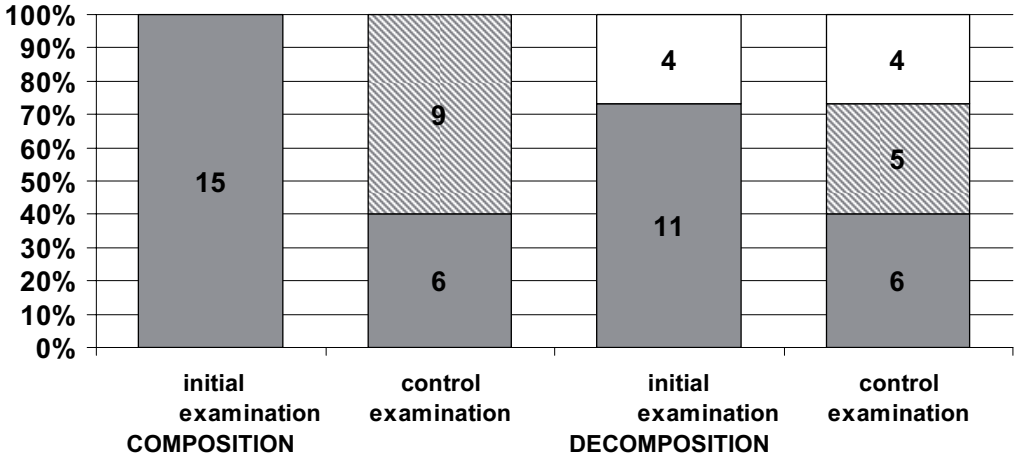


Fig. 6a
The TMF – subtests Cube – unimpaired extremity

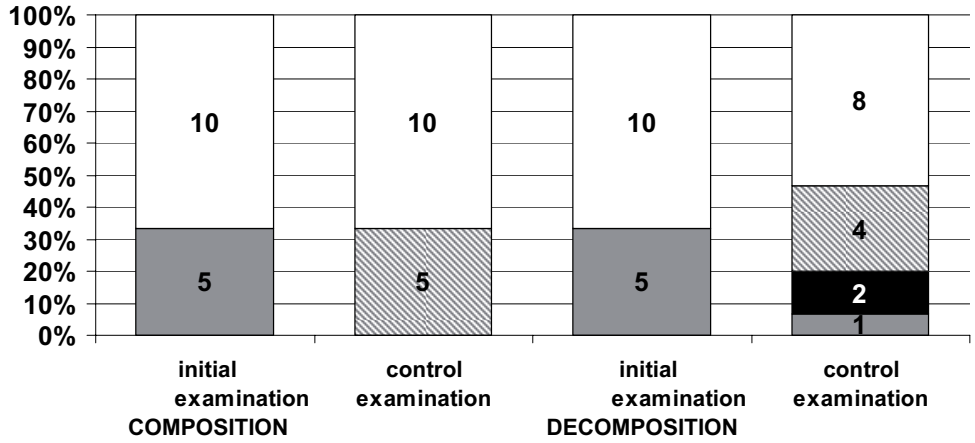


Fig. 6b
The TMF – subtests Cube – paretic extremity

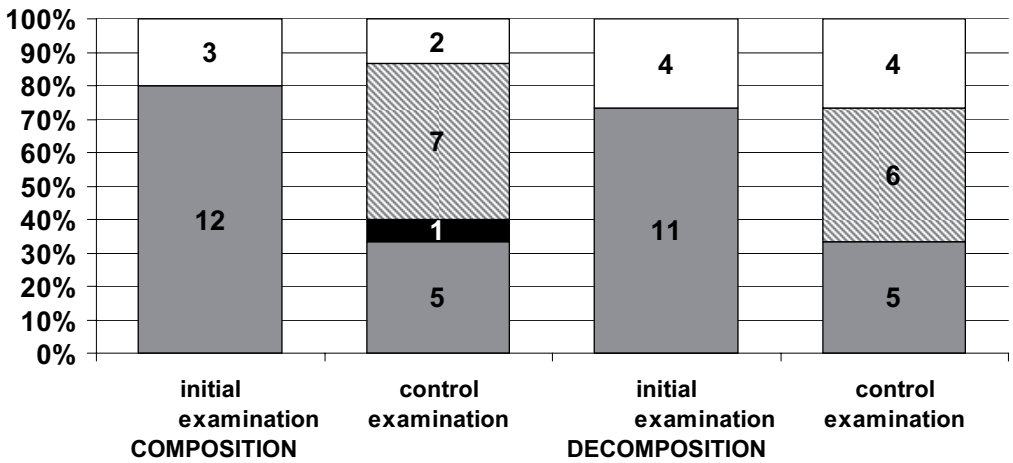
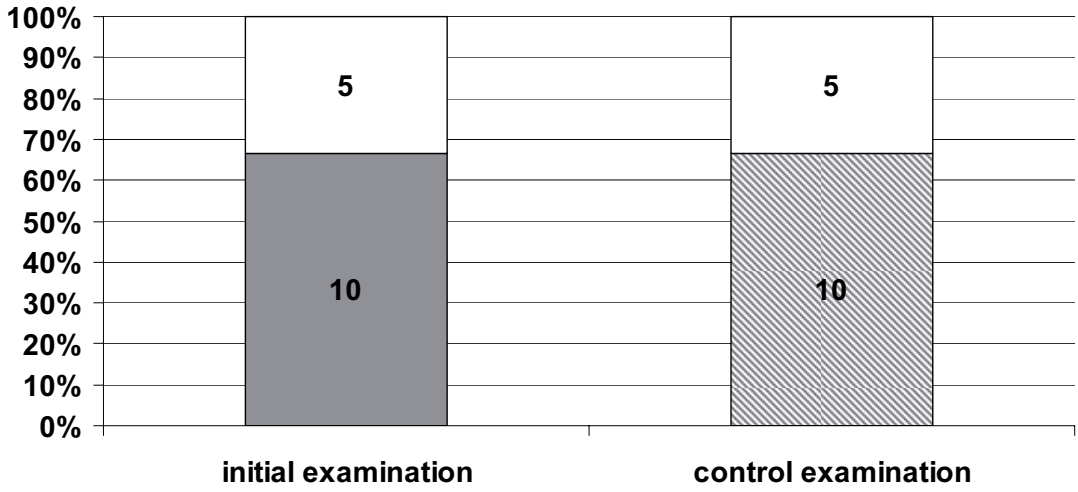


Fig. 7
The Barthel Index



of deficit in all the modalities was found. The largest number of subjects having a deficit were found in the modality "*surface localization*" (13 subjects), "*sharp/dull discrimination*" and "*surface pressure touch discrimination*" (9 subjects). The deficit observed in the smaller number of subjects was in the modality "*temperature discrimination*" (7 subjects) and "*two point discrimination*" (5 subjects).

After therapy the biggest improvement in the modality "*sharp/dull discrimination*" (3 subjects) on the **unimpaired side** was seen. In the modalities "*surface pressure touch discrimination*" (2 subjects), "*surface localization*" (1 subject) and "*temperature discrimination*" (1 subject), on the other hand, some deterioration of their state was observed.

As for the **paretic side**, most subjects (7 in each case) showed improvement in the modalities "*sharp/dull discrimination*", "*surface pressure touch discrimination*", "*surface localization*" and "*temperature discrimination*". In two modalities ("*sharp/dull discrimination*" and "*two point discrimination*") some deterioration in the results was seen.

The NHPT was performed on the unimpaired and paretic extremity (Fig. 3). As for the **unimpaired extremity**, 2 subjects were within the standard in the **initial examination**. The 13 subjects left were off the standard. Eight subjects improved their performance **after therapy** and 5 remained off the standard. In the **paretic extremity** some deficit was found in both the **initial and control examination** in all 15 subjects, but **after therapy** some improvement in 9 subjects was observed. No subject showed any deterioration of performance.

The TMF (Fig. 4a, 6b) was performed on the unimpaired and paretic extremity. In the **initial examination** of the **unimpaired extremity**, the largest number of subjects had a deficit of manipulation functions in the subtests "*Assembling the mummy*" (12 subjects) and "*Assembling the pyramid*" (11 subjects). During the **final examination** a great improvement of the deficit in both subtests was observed. In the subtest "*Assembling the mummy*" 11 subjects showed improvement and in the subtest "*Assembling the pyramid*"; 8 subjects indicated improved performance. Some deterioration was observed in the subtests "*Dismantling the cube*" (2 subjects) and "*Assembling the pyramid*" (1 subject). Three subjects were found off the standard in the subtest "*Assembling the pyramid*" and 1 subject in the subtests "*Dismantling the pyramid*", "*Assembling the mummy*" and "*Dismantling the cube*", respectively.

In the **initial examination** of the **paretic extremity**, the largest number of subjects with the deficit of manipulation functions in the subtests "*Assembling the mummy*" (15 subjects), "*Assembling the pyramid*" (14 subjects), "*Dismantling the pyramid*" and "*Assembling the cube*" (12 subjects) was found.

In the **final examination** a certain deficit improvement in all the subtests was seen at least in 50% subjects. In the subtest "*Assembling the mummy*" 9 subjects indicated improvement, 7 subjects in the subtests "*Assembling the cube*" and "*Assembling the pyramid*", 6 subjects in the subtests "*Dismantling the cube*" and "*Dismantling the pyramid*" and in the subtest "*Dismantling the mummy*", 5 subjects improved their deficit. Only in one subject deterioration was seen in the subtest "*Assembling the cube*".

The results of the **ADL test** (Barthel Index) are showed in Fig. 7. Ten subjects were observed to be off the standard in the **initial examination**. In the **final examination** a certain deficit improvement in all these subjects was seen. Nobody got worse.

DISCUSSION

Using the above described tests, we studied whether there is a deficit of somatosensory and motor functions and if it changes during the post-acute phase after stroke in the localization of the hand. No deficit in any subject was found on the so called **"unimpaired" side** in the **initial examination** only in the modalities "*surface pressure touch discrimination*", "*two point discrimination*" and "*temperature discrimination*" (although the state of one subject got worse during the final examination of temperature discrimination). In other studied items a number of subjects with a deficit always were seen in the observed group. Four subjects in the group manifested a conforming deficit that was evaluated as "off the standard" in the modalities "*sharp/dull discrimination*" and "*surface localization*". In one subject the deficit showed in the modality "*surface pressure touch discrimination*".

In the tests of fine motor function, a high degree of deficit (NHPT: 13 subjects; TMF: mostly in the subtest "*Assembling the mummy*" – 12 subjects, in the subtest "*Assembling the pyramid*" – 11 subjects) was found in the "unimpaired extremity".

During the **final examination** the biggest improvement was observed in the modality "*sharp/dull discrimination*" (3 subjects), in the test of fine motor function NHPT (8 subjects) and in subtests of TMF "*Assembling the pyramid*" (8 subjects) and "*Assembling the mummy*" (11 subjects). However, a certain deterioration of the performance in the modalities such as "*surface pressure touch discrimination*" (2 subjects), "*surface localization*" (1 subject), "*temperature discrimination*" (1 subject), in the subtest "*Assembling the pyramid*" (1 subject) and "*Dismantling the cube*" (2 subjects) occurred. It may be concluded that the condition of the unimpaired extremity, except for the above mentioned deterioration, was in course improvement. Despite this, 5 subjects (one third) remained without changes in the category "out of standard" in the test NHPT. A mild improvement in their performance was seen in all the subtests in TMF.

In the **paretic extremity** during the **initial examination** a deficit occurred much more frequently in each tested modality when compared with the unimpaired side. From the view point of somatosensoric functions, the largest number of subjects with a deficit was observed in the modalities: "*surface localization*" (13 subjects), "*sharp/dull discrimination*" (9 subjects), "*surface pressure touch discrimination*" (9 subjects) and in the tests of fine motorics (NHPT – 13 subjects; TMF – subtest "*Assembling the pyramid*" – 11 subjects and subtest "*Assembling the mummy*" – 12 subjects).

According to the results of the **final examination**, the deterioration of discrimination sensation (discrimination of the surface texture) in the **paretic extremity** was observed after therapy and in 40% of subjects the deficit continued. In conformity with the results of the RASP test, a conspicuous improvement was found in the modalities "*sharp/dull discrimination*", "*surface localization*" and "*surface pressure touch discrimination*". Winward et al. (2007), who also used the RASP test in their study to evaluate somatosensory deficit, suggest that no patient within the studied group achieved full recovery on all somatosensory subtests four weeks after they had a stroke, however, the general trend was one of gradual incremental recovery in most modalities. As the most important finding, they mention an evident oscillation in the performance of somatosensory functions in an individual patient and between patients as opposed to the relatively stable finding in the motor functions and activities of daily living.

According to the NHPT a deficit of the fine motor function in the paretic extremity was found in all the subjects, but 9 out of them showed a mild improvement of their performance. The results correspond to those found by Blennerhassett et al. (2006) who suggest that stroke performance on the pinch grip lift and hold task is likely to differ from typical grip force patterns employed by healthy adults. Delayed grip formulation and variable grip force application are key characteristics of grip dysfunction after stroke.

In conformity with the results of the TMF the deficit was seen in the paretic extremity in the initial examination in all subtests in more than 70% of the subjects and, after therapy, in the final examination the deficit was found in more than 60% of the cases. Contrary to the NHPT, which tests only one type of a precise (pinch) grip, the TMF tests a broader scale of grips so that in each subtest a mild improvement in several subjects may be observed. The largest number of improvements was seen in the subtest "*Assembling the mummy*" (9 subjects). In the subtest "*Assembling the cube*", a certain deterioration was found in one person. In the paretic extremity more than 30% subjects were off the standard in all subtests.

From these study results it is obvious that the sensory and motor deficit in one sided lesions in the post-acute phase after stroke may be seen even in the upper extremity on the unimpaired side. In this case fine motor function is impaired more than somatosensory functions. After 4 week rehabilitation some subtests showed even a certain deterioration.

Interestingly, it may be considered that the unimpaired "two point discrimination" and "surface discrimination" in the unimpaired extremity was found when compared with the modalities "sharp/dull stimuli discrimination", "surface pression touch", "localization of touch" and "temperature stimuli discrimination". The most impaired modalities: "sharp/dull stimuli discrimination", "surface pression touch", and "localization of

touch" are identical in both the paretic and the unimpaired extremity.

The greatest decrease in deficit after therapy was shown in the Barthel Index aimed at current daily activities. It is obvious that current therapy focuses particularly on these activities. Moreover, it is here allowed to compensate for the function using a substitute mechanism. The clear improvement of ADL (evaluated by Barthel Index) corresponds to our results. It is disputable whether the therapy aimed at the above mentioned modalities will bring better results. This hypothesis should be verified with future subjects.

CONCLUSIONS

In the post-acute phase after stroke in unilateral lesions, the impairment of sensation and motor functions occur even on the upper limb of the unimpaired side. The fine motor function is thus affected more than somatosensory functions. The extent of the impairment of somatosensory functions does not correspond to the extent of the impairment of motor functions in the upper limbs.

In tests of fine motor function some deficit was seen even in the unimpaired extremity. The tasks demanding precise grip showed the highest deficit.

Motor and functional recovery demonstrated continuous improvement over time; somatosensory recovery showed marked variation in subtests, within, between and among patients.

The most conspicuous changes during the evaluation of subjects were registered in ADL as assessed by the Barthel Index – the return of functions towards the standard was observed in one third of the subjects.

It is necessary to administer more tests to answer the question whether the therapy specifically targeted to influence the degree of the given modalities could be improved.

If the results of the second stage of the research project that has been carried out at present show the therapeutic effect, we suggest including the testing and the targeted therapy as a standard part of rehabilitation in patients after stroke.

ACKNOWLEDGMENT

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HODNOCENÍ MÍRY REKONVALESCENCE SENZOMOTORICKÝCH FUNKCÍ RUKY VE SKUPINĚ REHABILITOVANÝCH PACIENTŮ PO MRTVICI V POSTAKUTNÍM STÁDIU

(Souhrn anglického textu)

VÝCHODISKA: Deficit senzomotorických funkcí ruky u pacientů po CMP je velmi častý. Přesto je algoritmus jejich obnovy relativně málo známý. Není jasné, zda rozsah či typ poruchy somatosenzorických funkcí koreluje s horší obnovou motoriky.

CÍLE: Tato studie byla zaměřena na sledování senzomotorických funkcí ruky u skupiny pacientů v postakutním stádiu po ischemické CMP, lokalizované v povodí arteria cerebri media. Cílem bylo zjistit míru úpravy somatosenzorických a motorických funkcí ruky u sledované skupiny. Jedná se o první etapu výzkumu, na kterou bude navazovat sledování experimentální skupiny s terapií cílenou na somatosenzorické funkce.

METODIKA: Sledovaná skupina pacientů byla léčena na oddělení kliniky lůžkové rehabilitace a prošla standardní terapií po dobu 3–4 týdnů. K hodnocení senzomotorických funkcí ruky byly použity 2 testy čití: FMT – Test srovnávání textury látek a RASP – Rivermeadské hodnocení somatosenzorických funkcí a 2 testy motoriky: NHPT – Devítikolíkový test a TMF – Test manipulačních funkcí ruky pomocí stavebnice Ministav. Testy byly provedeny na začátku a na konci terapie.

VÝSLEDKY: U sledované skupiny pacientů jsme zjistili poruchy somatosenzorických funkcí a motoriky i na horní končetině nepostižené strany. Jemná motorika je přitom postižena více než somatosenzorické funkce. Největší deficit u motorických funkcí vykazovaly úkoly vyžadující precizní úchop. Nejvýraznější změny při hodnocení pacientů byly registrovány v ADL, hodnocených indexem Barthelové – k úpravě funkcí do normy došlo u 1/3 pacientů.

ZÁVĚRY: Po aplikaci standardní terapie došlo u sledované skupiny pacientů ke zlepšování senzomotorických funkcí ruky, ale výsledky nejsou konsistentní, někteří pacienti se zhoršili a někdy došlo jen k mírné úpravě. Je nutno otestovat, jaké budou výsledky experimentální skupiny pacientů, s terapií specificky cílenou na ovlivnění somatosenzorických funkcí.

Klíčová slova: cévní mozková příhoda, hemiparetická ruka, somatosenzorické funkce, jemná motorika, testy ruky.

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MUSCLE ACTIVATION IN HEALTHY SUBJECTS DURING SINGLE STEP UP

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Submitted in January, 2009

BACKGROUND: The single step up is an integral movement performance for functional mobility and activities of daily living. During this activity the body has to be able to keep its balance and maintain a stable upright posture for performing voluntary movement. For this purpose the central nervous system creates different motor programs specific to the task. A motor programme is believed to contain the pre-programmed sequence of muscle activity prior to the initiation of the task, and includes both the muscle activity for the task, as well as postural muscle activity.

OBJECTIVE: The aim of this paper was to examine the sequence of muscular activation, and to determine the timing of the involvement of selected trunk and leg muscles whilst stepping up. The further aim was to find out the most common muscle patterns in this model of motor activity in healthy subjects.

METHODS: The bilateral electromyographic (EMG) signal from the gluteus maximus, biceps femoris and erectores spinae muscles were recorded using surface electromyography. The visual record of the step up performance was registered simultaneously with surface electromyography. The tested group consisted of 16 healthy (5 men with an average age of 23.6, 11 women with an average age of 23.2). They were monitored during the motor task – the step up task, that is which was performed by the dominant leg. The subject stood facing the step (height of the step = 20 cm). Upon request he/she stepped up with the right leg at a spontaneous speed. The motor task was completed by bringing the left leg up onto the step.

RESULTS: During this task, we registered the activation of the right erector spinae muscle, right biceps femoris muscle, left erector spinae muscle and left biceps femoris muscle before the beginning of the visually recognizable movement. The most frequently registered pattern of activation on the side that carried out the step was: right biceps femoris muscle → right erector spinae muscle → right gluteus maximus muscle. Greater differences in the sequence of the muscle involvement were found on the side of the supporting leg.

CONCLUSIONS: In conclusion, the findings have indicated that there exists variability in patterns of muscle activation during the step up task.

Keywords: Stepping, surface electromyography, muscular activity, timing.

INTRODUCTION

The single step up is an integral movement performance for functional mobility and activities of daily living. During this activity the body has to be able to keep its balance and maintain a stable upright posture for performing voluntary movement. Imbalance in the performance of this functional task may cause falls with various undesired consequences (Mercer et al., 1999; Shumway-Cook & Woollacott, 2007). The point in time at which subjects fall has not yet been identified, but investigating the anticipatory period prior to the initiation of the stepping is valuable. This is because it can lead to insight concerning the priority of the organization of the task by the central nervous system, particularly with regard to motor programmes. A motor programme is believed to contain the pre-programmed sequence of muscle activity prior to the initiation of the task, and includes both the muscle activity for the task as well as postural muscle activity.

According to Gélat and Brenière (2000) the performance of a single step can be divided into four phases. The first phase, which is called the anticipatory phase, starts at the onset of the dynamic phenomena and it finishes at the moment when the heel breaks contact with the support surface (heel off). The second phase is the performance of the movement itself. It starts with the heel off, and finishes at the moment when the leading limb again makes contact with the ground. The third phase is the stage of double stance, which starts with the contact of the leading limb with the ground and finishes at the moment the backward limb leaves the ground (toe off). The fourth phase of the movement starts with the toe off from the support surface and finishes by putting it down next to the other limb.

The aim of this paper was to examine the sequence of muscular activation, and to determine the timing of the involvement of selected trunk and leg muscles whilst stepping up. The further aim was to find out the most

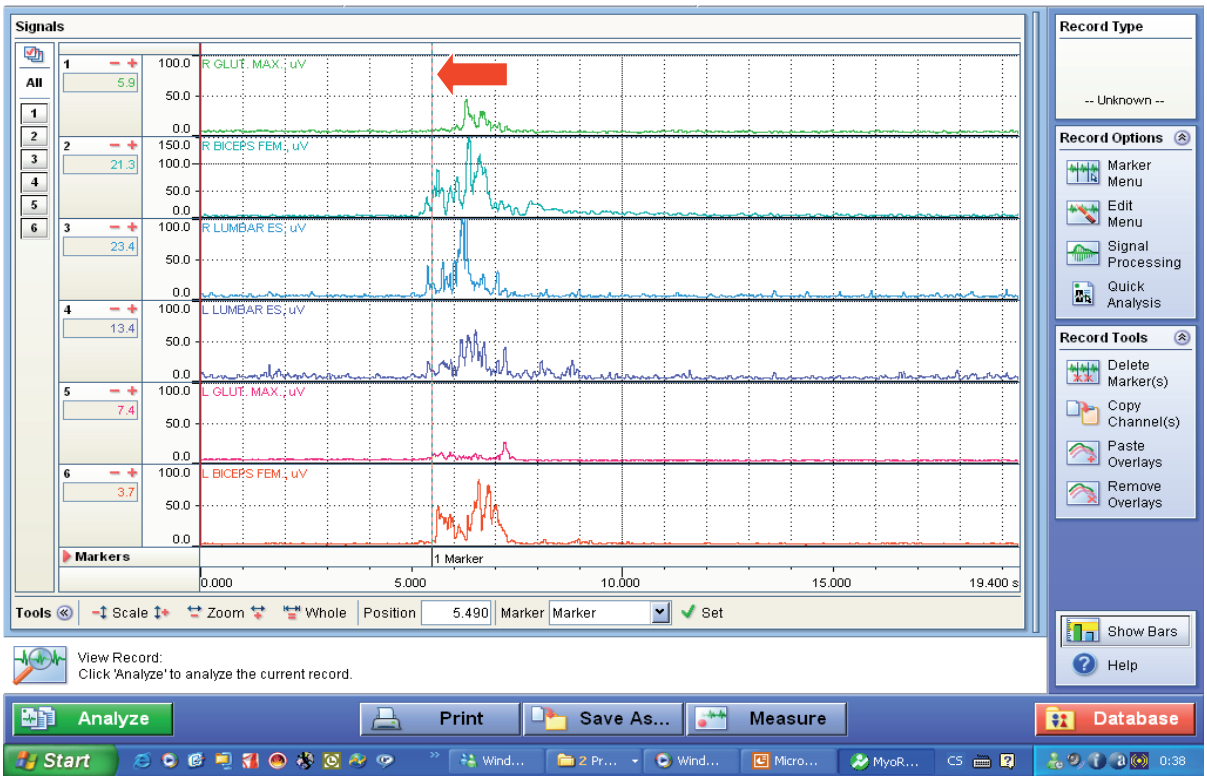
common patterns for the involvement of muscles in this model of motor activity in healthy subjects.

MATERIAL AND METHODS

The tested group consisted of 16 healthy subjects (5 men with an average age of 23.6, 11 women with an average age of 23.2), who were examined by an experienced physiotherapist. No important muscular imbalances were found. They were monitored during the motor task – in this case the step up task which was performed by the dominant leg. All subjects were right footed persons. A Czech translation of the Footedness Questionnaire was used to determine limb dominance (Wai-Hang, 2004).

The surface EMG Myosystem 1400A was used for the presented study. The surface EMG involved using 6 EMG channels, with a frequency bandwidth of 10 Hz – 500 Hz, an input impedance of 10 MΩ and a CMMR (Common Mode Rejection Ratio) of 130 dB. For scanning we used the surface electrodes Kendall ARBO silver-silver chloride with fixed hydrogel, with an electrode size of 10 mm and oval in shape. The inter electrode distance was 20 mm. The surface electrodes were put onto pre-cleaned skin and positioned parallel to the muscle fibres: over the right and left gluteus maximus muscles at the line between the os sacrum and trochanter major, at the point of the muscle's greatest prominence; on the right and left biceps femoris muscles at the line between the tuber ischiadicum and condylus lateralis tibie, and finally, on the right and left erectores spinae muscles, placed at a two finger widths distance laterally from the processus spinosus of L2 (Hermens, 2000). The reference electrode was placed over the spina iliaca posterior superior. The visual record of the step up performance was registered together with the surface electromyography. A SONY – DCR-TR V900E digital camera was used to scan the picture.

Fig. 1
Surface electromyographic record of muscular activity during the step up task



Legend:
R GLUT MAX – right gluteus maximus muscle
R BICEPS FEM – right biceps femoris muscle
R LUMBAR ES – right erector spinae muscle
L GLUT MAX – left gluteus maximus muscle
L BICEPS FEM – left biceps femoris muscle
L LUMBAR ES – left erector spinae muscle
uV – mikrovolt
Arrow indicate the beginning of the step up motor task.

The subject stood facing the step (height of the step = 20 cm). Upon request he/she stepped up with the right leg at spontaneous speed. The motor task was completed by bringing the left leg on up onto the step.

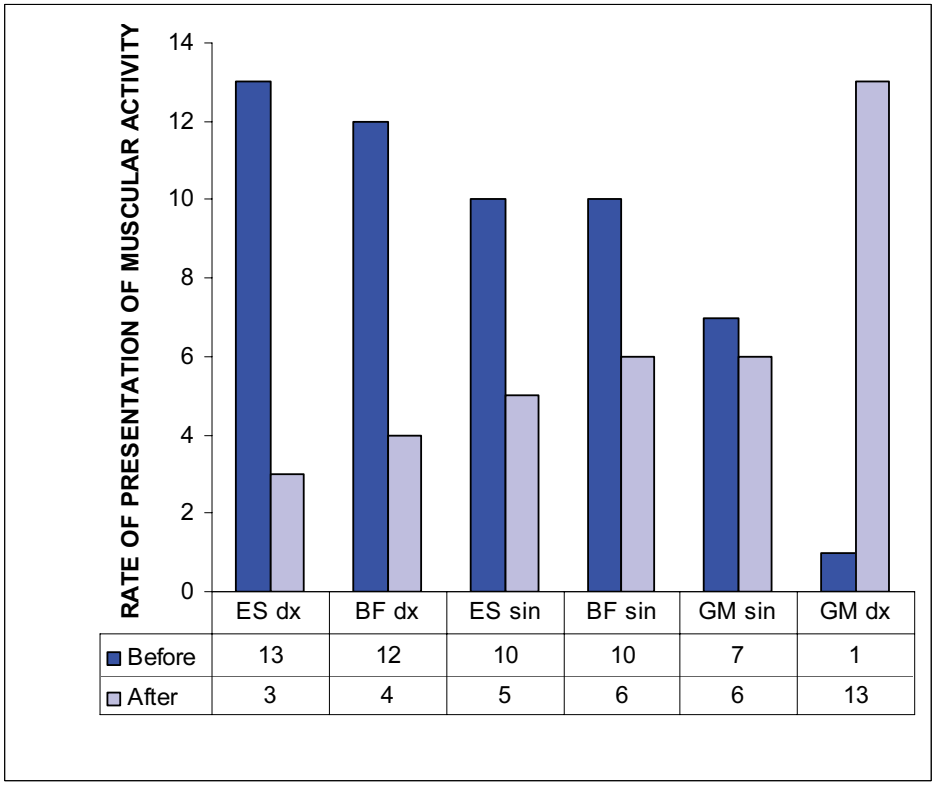
Full wave rectification and smoothing were used for processing the EMG signal. The root mean square (RMS) parameter was evaluated. The part of the EMG record from the verbal command for the performance of the motor task, until the right leg made contact with the contact sensor on the step, was evaluated. This section was divided into two parts. The first one started with the command request and ended with the beginning of the movement. The first observed movement (heel off) of the right leg on the video was indicated as the beginning of the movement (t = 0). The second part lasted from this movement (t = 0) until the first contact of the foot with the step. To detect the onset of muscle activity in individual muscles, we stated a moment, when the amplitude of the EMG signal went above the defined threshold. The threshold for each muscle was determined by calculating the sum of the mean voltage value plus 3 standard deviations from the relative baseline activity (threshold = mean + 3 SD above baseline activity) (Chung & Giuliani, 1996; Soderderg & Knutson, 2000). The onset times of all the muscles were compared to each other. The value of 10 ms was chosen for distinguishing the intervals in different muscle connections. If the time calculations were to differ by more than 10 ms, then a different sequence of muscle time activation would be registered. In the case that the beginning of the activity was equal to or less than 10 ms, then the same sequence of muscle time activation would be registered (De Luca, 1997; Rodová, 2002).

RESULTS

The activation of selected muscles in relation to visually initiated movement was evaluated in a single step up task from the beginning of the movement (t = 0). Registration of the multi-channel EMG signal provided the sequence of an activation of the selected trunk and leg muscles whilst stepping up (Fig. 1).

The findings are presented according to the frequency of the activity of single muscles before and after the beginning of the visually registered movement of the

Fig. 2
Frequency of the registered manifestation of the muscular activity of the studied muscles before and after the visually recognizable beginning of the step up task

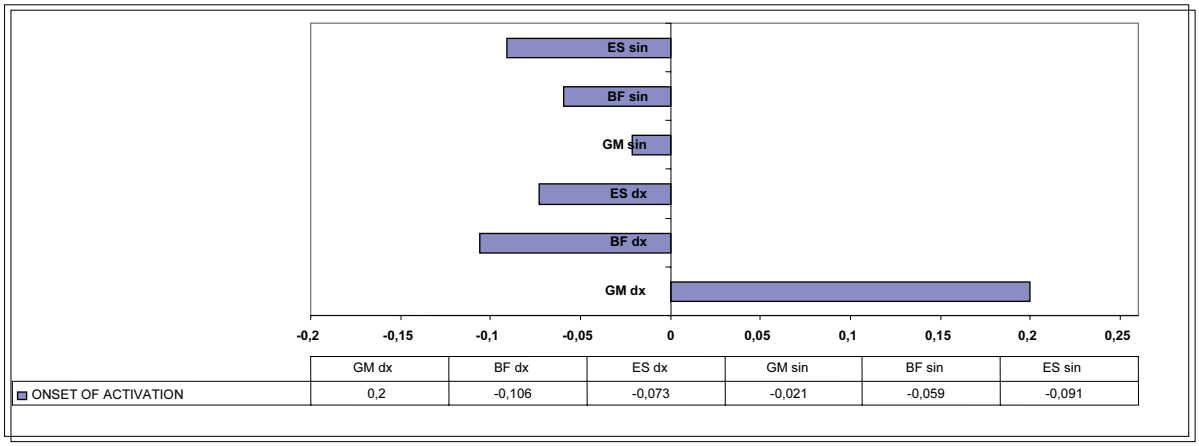


	ES dx	BF dx	ES sin	BF sin	GM sin	GM dx
Before	13	12	10	10	7	1
After	3	4	5	6	6	13

Legend:
ES dx – right erector spinae muscle
BF dx – right biceps femoris muscle
ES sin – left erector spinae muscle
BF sin – left biceps femoris muscle
GM sin – left gluteus maximus muscle
GM dx – right gluteus maximus muscle
Total number of persons – 16

step up task. The results of the muscular activation of particular muscles during the step up task were as follows: the right erector spinae muscle was activated in all examined persons (i.e. 100% – exactly 13 times before and 3 times after the beginning of the movement). The right and left biceps femoris muscles were activated in all persons (i.e. 100%) – exactly the right biceps femoris muscle 12 times before and 4 times after the beginning of the movement and the left biceps femoris muscle 10 times before and 6 times after the beginning of the movement. Activity of the left erector spinae muscle was recognised in 15 persons of 16 (i.e. 93.75%) – exactly 10 times before and 5 times after the beginning of the movement. The right gluteus maximus muscle (on the side which performs the step up movement) was activated in 14 persons of 16 (i.e. 87.5%) – exactly once before and 13 times after the beginning of the movement. The left gluteus maximus muscle (on the supporting side) was activated in 13 persons of 16 (i.e. 81.25%) – exactly 7 times before and 6 times after the beginning of the movement. There was no muscular activity recorded during this task in 3 persons (Fig. 2).

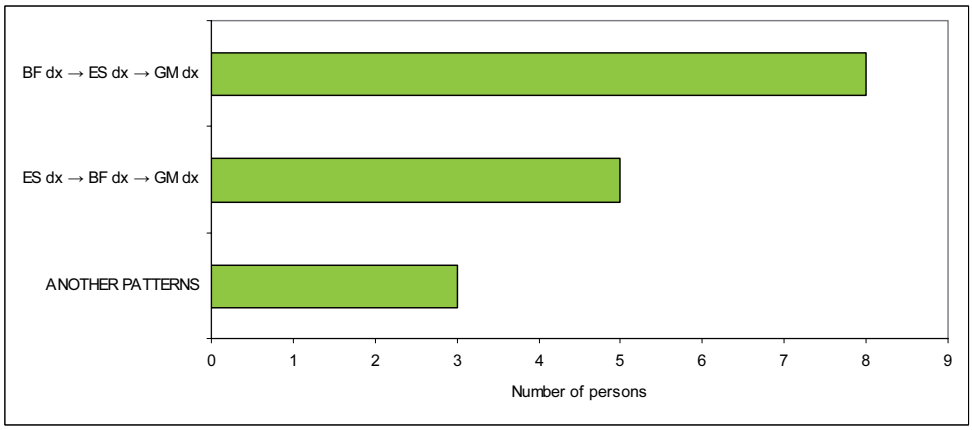
Fig. 3
The onset of the activation of single muscles in relationship to the visually registered beginning of the step up (mean values expressed in seconds)



	GM dx	BF dx	ES dx	GM sin	BF sin	ES sin
ONSET OF ACTIVATION	0,2	-0,106	-0,073	-0,021	-0,059	-0,091

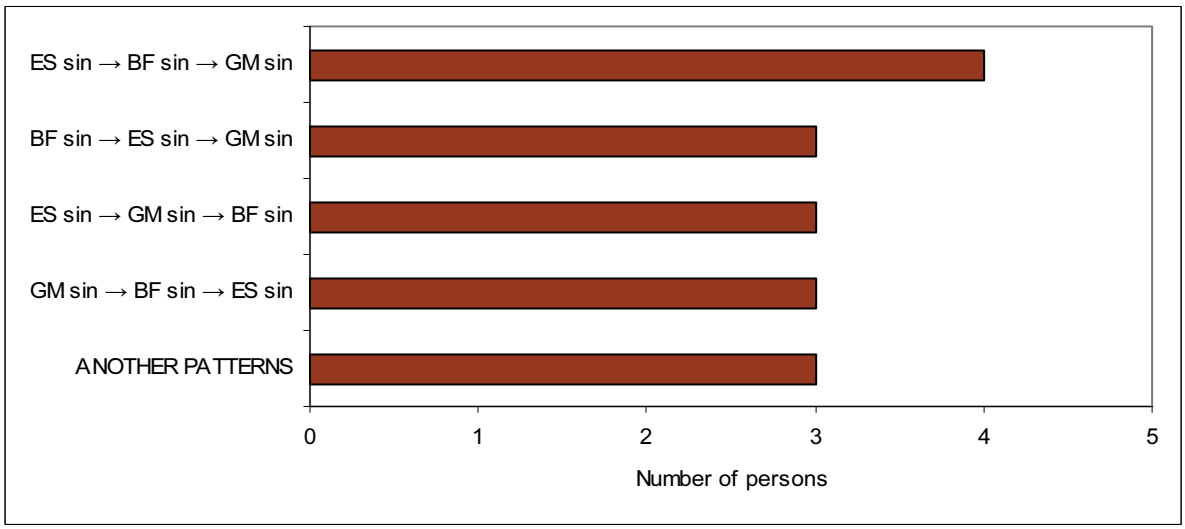
Legend:
ES dx – right erector spinae muscle
BF dx – right biceps femoris muscle
ES sin – left erector spinae muscle
BF sin – left biceps femoris muscle
GM sin – left gluteus maximus muscle
GM dx – right gluteus maximus muscle
0 – the beginning of the movement visually registered from the video record

Fig. 4
The most common patterns in the sequence of muscle activation on the right leg during the step up task



Legend:
BF dx – right biceps femoris muscle
ES dx – right erector spinae muscle
GM dx – right gluteus maximus muscle
Total number of persons – 16

Fig. 5
The most common patterns in the sequence of muscle activation on the support (left) leg during the step up task



Legend:
BF dx – left biceps femoris muscle
ES dx – left erector spinae muscle
GM dx – left gluteus maximus muscle
Total number of persons – 16

Figures 3, 4 and 5 show the mean activation time of the studied muscles and their sequence of involvement during the step up movement.

DISCUSSION

The aim of this paper was to examine the sequence of the muscle activation in the lumbopelvis area during the step up movement. During this task, we registered the activation of the right erector spinae muscle, right biceps femoris muscle, left erector spinae muscle and left biceps femoris muscle before the beginning of the visually recognizable movement. We presume that this early muscle activation may be associated with the anticipatory activity of the muscular system for stabilizing and postural functions. In accordance with Satoru et al. (2008), it is known that the muscles involved in the stabilizing action become anticipatorily active prior to the muscular activity of the prime mover. They found anticipatory activity in the left gluteus medius muscle, left obliquus internus abdominis muscle and left multifidus muscle when subjects performed three right hip flexions to 90 degrees of flexion whilst standing. Perturbations to upright posture can be counteracted by postural adjustments that occur simultaneously with, or just before, the initiation of voluntary movement. The general mechanism of postural regulations involves anticipating the effect of the movement on posture and coordinating the activation of postural adjustments with the intended movement to minimize the postural disturbance (Frank & Earl, 1990). According to Gélat and Brenière (2000), the anticipatory postural preparation during initiation of gait in healthy adults enables the movement of the centre of mass of the body forward and towards the standing foot. Muscular activity starts at the beginning of this anticipatory phase.

The next aim of this study was to find out the most frequently registered patterns of muscle activation in the model motor activity of healthy people. The most frequently registered pattern of activation on the side that carried out the step was: the right biceps femoris muscle → right erector spinae muscle → right gluteus maximus muscle. Greater differences in the sequence of the muscle involvement were found on the side of the supporting leg, not only during the whole task, but also before the beginning of the movement.

Mercer and Sahrmann (1999) studied whether consistent sequences of postural muscle activation exist when lifting the right foot onto a step from a standing position. The muscles selected were the tibialis anterior muscle, gluteus medius muscle, hamstrings, the gastrocnemius-soleus muscles of the supporting limb and the rectus femoris muscle of the moving limb. The authors found that the first muscle to activate in 93% of total trials was the tibialis anterior muscle. The sequence of muscles activated subsequent to the tibialis anterior muscle, but before the onset of lifting the right foot onto the step, was more variable. The most common muscular pattern was the tibialis anterior muscle followed by the gluteus medius muscle, without activi-

tation of any other postural muscles before movement onset. Another relatively common sequence was: tibialis anterior muscle → hamstrings → gastrocnemius-soleus muscles.

CONCLUSION

We found that during the step up task, the activation of the right erector spinae muscle, right biceps femoris muscle, left erector spinae muscle and the left biceps femoris muscle occurred before the beginning of the movement. The most frequently registered pattern of muscle activation on the side that carried out the step was: right biceps femoris muscle → right erector spinae muscle → right gluteus maximus muscle. Greater differences in muscle activation patterns were found on the side of the supporting leg. In conclusion, the findings have indicated that variability in patterns of muscle activation during the step up task does exist. It may be a reflection of the ability of the central nervous system to prepare different motor programs (in the meaning of the varying involvement of different muscles) for any given motor task. This situation requires further study for an explanation of registered differences among individual subjects and furthermore, to compare the results obtained between healthy subjects with ones obtained from subjects with diseases or disturbances of the locomotor system.

ACKNOWLEDGEMENT

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AKTIVACE SVALŮ U ZDRAVÝCH OSOB PŘI NÁKROKU NA SCHOD

(Souhrn anglického textu)

VÝCHODISKA: Nákrok na schod je součástí běžných denních motorických aktivit. Při jeho provádění musí být tělo schopno udržovat rovnováhu a stabilní vzpřímenou posturu za současného průběhu volního pohybu. K tomuto účelu vytváří centrální nervová soustava různé motorické programy, specifické pro daný úkol a obsahující předem programované sekvence zapojování svalů k zajištění provedení vlastního pohybu a k udržení postury během vykonávaného pohybu.

CÍLE: Cílem práce bylo určení časové posloupnosti zapojení vybraných svalů trupu a dolních končetin při nákroku na schod. Dalším cílem bylo zjištění nejběžnějšího vzoru zapojování svalů v této modelové pohybové aktivitě u zdravých osob.

METODIKA: U této práce byla snímána bilaterálně elektromyografická aktivita m. gluteus maximus, m. biceps femoris a m. erector spinae (v jeho lumbální části). Spolu s elektromyografickým signálem snímaným povrchovými elektrodami byl zaznamenáván i vizuální záznam provedení nákroku na schod. Soubor tvořilo 16

zdravých mladých probandů, všichni praváci (5 mužů, průměrný věk 23,6 let a 11 žen, průměrný věk 23,2 let), u kterých byly anamnesticky vyloučeny úrazy dolních končetin a páteře. Na povel nakročili probandi spontánní rychlostí na schod (výška schodu = 20 cm) pravou dolní končetinou. Pohybový úkol končil došlápnutím levou dolní končetinou na schod. Elektromyografické záznamy jednotlivých svalů byly hodnoceny z hlediska časového nástupu aktivace svalů ve vztahu k začátku pohybu pravé dolní končetiny, který byl určen podle videozáznamu. Časy nástupu aktivace jednotlivých svalů byly mezi sebou porovnány k určení časové posloupnosti zapojení svalů a k určení nejběžnějšího vzoru svalového zapojení při tomto úkolu.

VÝSLEDKY: Při úkolu nákroku na schod jsme zaregistrovali aktivaci pravého m. erector spinae, pravého m. biceps femoris, levého m. erector spinae a levého m. erector spinae již před začátkem pohybu pravé dolní končetiny. Dále jsme pozorovali jako nejčastější svalovou sekvenci na nákročné (pravé) straně: pravý m. biceps femoris → pravý m. erector spinae → pravý gluteus maximus. Větší rozdíly v sekvenci zapojování svalů jsme zachytili na stojné (levé) dolní končetině.

ZÁVĚRY: Výsledky naší studie prokazují variabilitu vzorů zapojování svalů při studovaném úkolu nákroku na schod u zdravých jedinců.

Klíčová slova: nakročení, povrchová elektromyografie, svalová aktivace, timing svalů.

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FUNCTIONAL ASYMMETRY OF THE SPINE IN STANDING AND SITTING POSITIONS

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Submitted in October, 2009

BACKGROUND: A sedentary lifestyle, together with functional asymmetry of the body, are potentially dysfunctional factors.

OBJECTIVE: In this project, the authors are trying to identify the connections between a sedentary lifestyle and the amount of functional asymmetry of the spine.

METHODS: Sixteen male volunteers aged 19–25 participated in the experiment. All of them were students of the University of Physical Education in Katowice. To measure trunk movement, the BTS Smart system was used. The quantity of functional asymmetry was described as a Functional Asymmetry Ratio (FAR), calculated using the trunk range of motion on the frontal and horizontal planes.

RESULTS: Larger FARs values were registered in a sitting position ($p < 0.01$). Frontal plane functional asymmetry was greater than the asymmetry on the horizontal plane ($p < 0.05$) and the asymmetry of the lumbar spine exceeded that recorded for the thoracic section ($p < 0.05$).

CONCLUSIONS: The association between a sedentary lifestyle and the functional asymmetry of the body is possible. Together with the increased use of sitting positions in daily life, the asymmetric load exerted on the spine may increase as well.

Keywords: Range of motion, rotation, lateral flextion, thoracic, lumbar.

INTRODUCTION

Symmetry is one of the basic features of the human body and of most animals. It is understood as regularity in spatial structure and is characterized by the possibility of the presence of at least one axis or plane of symmetry in the given organism. The most common type of symmetry is bilateral symmetry, which means that the organism can be divided into two parts: right and left; which are their mirror reflections.

Minor asymmetry of the body is treated as normal, but we must consider to what degree this structural and functional asymmetry could be interpreted in light of physiological categories.

The functional asymmetry of the human body is frequently presented in a negative light. For example Cibulka et al. (2002) points out that asymmetry of the pelvic bones introduces changes in soft tissue tightness and accompanies dysfunctions of the motor system. Bernard et al. (1987) demonstrated that a disrupted pelvic symmetry may promote development of overstrain changes in the lower back at an elderly age. The evidence of an association existing between asymmetry and low back pain have also been shown (Al-Eisa et al., 2006; Gomez, 1994; Mellin et al., 1995)

However, some degree of asymmetry is typical for healthy populations as well. For example, in a group of children and teenagers aged 7–15 years the frequency of pelvic asymmetry was estimated as 41% in boys and 40% in girls (Saulicz, 2003). Other good examples are disproportions in the hip joints' range of motion (Ellison et al., 1990) and leg length discrepancies recorded in healthy subjects (Bluestein & D'Amico, 1985; Okun et al., 1982). Inequality of the leg length of 2.33 cm is rarely a cause for gait asymmetry (Liu X-C et al., 1998).

According to McGill (2002) the risk of sustaining tissue damage increases in situations when the load exerted on a given tissue exceeds its tolerance. It's clear that a greater chance for this exists when the organism is asymmetrically loaded, e.g. during heavy lifting activity.

One should also take into account that, together with civilization development, the sitting position has become the dominant position of the modern human. This results in a considerable reduction of gravity loading and provokes plastic adaptation of the muscular and nervous systems (Richardson et al., 2004; White & Davies, 1984; Appell, 1990; McComas, 1996). In this process one of the crucial factors is tissue crawling while assuming flexed positions which is likely to disrupt the passive prevention of spinal segments. A sitting position was also presented as being disadvantageous in William's opinion (2000), who stated that maintaining the lumbar spine in flexion causes meaningful changes in multifidus muscle control occurring in the form of losing the protective tonic function.

All the facts mentioned above suggested two types of risk factors linked to the dysfunction of the motor system common at this time. These are: the structural and functional asymmetry of the human body as well as a sedentary lifestyle. This led the authors to a hypothesis that potentially these two factors may be interrelated.

OBJECTIVES

The objective of the experiment was to verify the hypothesis that among young, healthy, active people without any pain within the motor system, the degree of functional asymmetry of the spine is dependent on body position.

The following research questions are proposed:

- Is the degree of the functional asymmetry of the spine dependent on the position of the body (standing vs. sitting)?
- Are there any differences in the degree of functional asymmetry between the frontal and transverse planes? Is this difference more distinct in sitting or in a standing position? Is this difference more distinct in the thoracic or in the lumbar section of the spine?
- Are there any differences in the degree of functional asymmetry between the lumbar and thoracic section of the spine? Is this difference more distinct in sitting or in a standing position?

MATERIAL AND METHODS

Design of the experiment

Repeated experimental measures were used. The degrees of the functional asymmetry of the lumbar and thoracic section of the spine were measured in transverse (rotation) and frontal (lateral flexion) planes and served as dependent variables. The position of the subject (standing *vs.* sitting) was repeatedly measured and taken into consideration as a factor. Sections of the spine and planes of movement were considered independent factors. Repeated measurements enabled the minimization of the influence of between subject variance. The sequence of testing positions (first standing then sitting) and the plane of movement (first rotation then lateral flexion) were administered in a constant order. The direction of the movement to start the procedure with (left *vs.* right) was randomized.

Material

Forty male volunteers aged 19–25, students of the University of Physical Education, expressed their will to participate in the experiment. They must have met the following inclusion criteria:

- Lack of major injuries of the spine and lower limbs requiring any medical intervention.
- Lack of any surgery performed on the spine and lower limbs.
- Lack of any pain in the region of the lower back or lower limbs lasting more than two weeks, or pain requiring medical intervention (e.g. by a GP, nurse, or physiotherapist) at least during the three months before recruitment.
- Lack of any (even minor) injuries in the mentioned areas during the period of two weeks before the examination.

Out of the group of 40 volunteers, 16 subjects aged (mean ± SD) 21.87 ± 1.5 years, with a height of 179.09 ± 4.55 cm, and abody mass of 73.16 ± 8.19 kg were qualified. All of them signed the Informed Consent Form. The study was approved by the Institutional Ethical Committee.

Equipment

To measure the trunk range of motion, the BTS Smart (three dimensional biomechanical movement analyzer) was used (BTS Bioengineering S.p.a, Milan, Italy). The BTS Smart unit emits infrared beams that are reflected by the markers mounted on the surface of the body back to the capturing cameras.

The accuracy of linear and angular measurements was verified using mechanical models (micrometric screw, Saunders inclinometer). Using six cameras and the frequency of 60 Hz, a precision of 0.1 mm and 0.5^0 was achieved.

The measuring tool (basic software) contains three integrated computer programs: Smart Capture, Smart Tracker and Smart Analyzer.

The markers used were a custom made version of standard semi-spherical markers of 1 cm in diameter. Each of them consisted of a plastic base with a small nut inside and a head with a small screw.

Procedure

During the preparation stage it was important to position the cameras so that each marker was visible for at least two of them at every point of the movement trajectory. Then the tool was calibrated. A square was also drawn on the floor to mark the desired position of the subject's feet.

Before the commencement of the procedure, each of the participants received information concerning the flow of the examination. Everyone was told that all movements should be performed at a comfortable speed and with a maximal, but not forced range; and that all unpleasant sensation should immediately be reported to the researcher.

On the back of the subject, points were marked, on which semi spherical markers were mounted. Researchers measured the distance from the C7 spinous process to the line joining the two posterior superior iliac spines (PSIS). This distance was divided into three equal sections giving rise to 4 points in effect. The three lowest of them were used to attach central markers: upper thoracic, lower thoracic and lumbar. The sacral central point was located 5 cm below the lumbar central point. Horizontal distances of 10 cm to the right and to the left were taken both from the central upper thoracic and central lower thoracic points. At their ends, the thoracic left and right markers and the lumbar left and right markers were assembled, respectively. The left and right PSIS served as attachment points for the "so called" left and right sacral markers. This way the three triangles were created: lower thoracic, lumbar and sacral (Fig. 1).

The operation of mounting the markers was an important element of the process. First the points were marked on the skin and pieces of double sided sticky tape were stuck onto them. Then the base of each marker was attached and secured with a layer of Kinesiology Tape (K-Active Tape, Japan). The semi spherical head of the marker was screwed onto the base. This construction prevented markers from any undesired displacement on the surface of the skin.

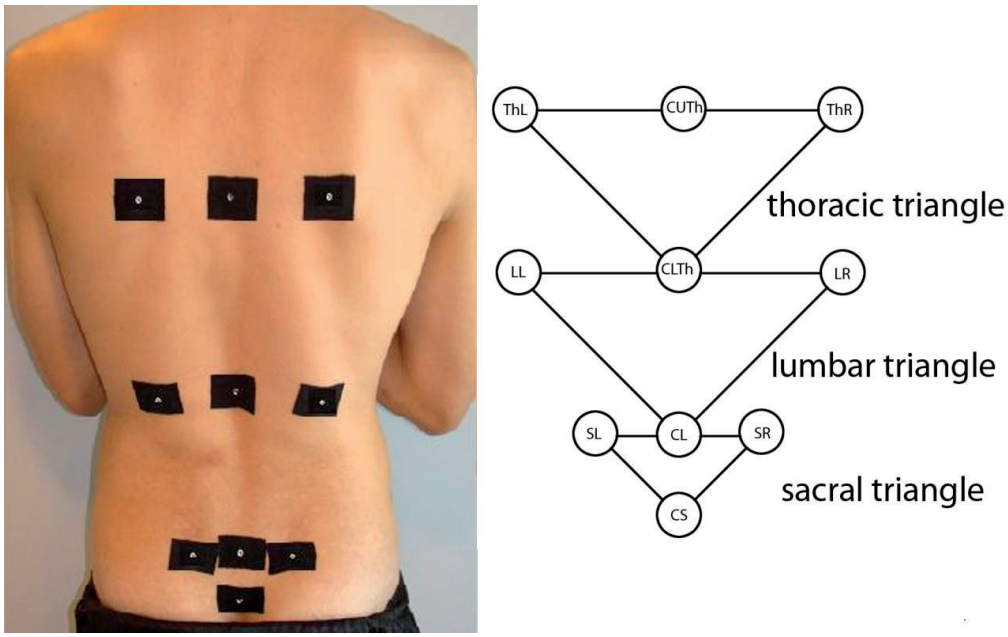
Each subject assumed a standing position on the marked square and a test series of movement sequence was carried out. Each movement proceeded as far as possible and at a comfortable, self administered pace. The order of performing individual movements was constant – rotation was always executed first. Each subject crossed his arms on the chest and the movement was started from the cervical spine then spread to the thoracic and lumbar spine, and finally involved pelvic rotation. From this end position each subject rotated his body maximally towards the opposite side (with no stopping at zero) and after reaching his end range went back to zero position. This sequence was repeated six times. After completing three trials the side to start the movement with was changed (e.g. the first three trials starting to the left, the three others – to the right). Particular attention was focused on maintaining the clear transverse plane of this motion, bending the knees, taking their feet off the floor and standing "as erectly as possible". Using the same position each subject performed the sequence for lateral flexion. The test trial was done first – initiating movement from the cervical spine going down to the thoracic and finishing with the lumbar – and the six experimental sequences were performed later.

The same movement sequences were administered in a sitting position. The only difference was that while performing rotation, the subject was not allowed to move the pelvis and during lateral flexion he might lift his buttocks from the couch. Thanks to this, a full range of lumbar motion was available.

Functional asymmetry of the spine

To describe the degree of the functional asymmetry of the thoracic and lumbar spine, mean ranges recorded

Fig. 1
The three triangles created by the markers on the subject's back (markers: CUTh – central upper thoracic; ThL – left thoracic; ThR – right thoracic; CLTh – central lower thoracic; LL – left lumbar; LR – right lumbar; CL – central lumbar; SL – left sacral; SR – right sacral; CS – central sacral)



during 6 trials were used. Both for rotation and lateral flexion the Functional Asymmetry Ratio (FAR) was used in the following form: FAR = [|R – L|/(R + L)]*100 where R – range of right rotation/lateral flexion (mean of 6 records), L – range of left rotation/lateral flexion (mean of 6 records).

This way FARs for rotation and lateral flexion in the thoracic and lumbar spine in both sitting and standing positions were calculated.

Statistical analysis

A database was created using Statistica software (Version 6.0, StatSoft, Inc.) which automatically calculated the mean values of the desired ranges of motion and FARs. Differences between standing compared to a sitting position were investigated using variance analysis (ANOVA) with three explanatory variables. Independent factors were: the spinal section (L vs. Th) and the plane of the movement (frontal vs. transverse). The repeated measurements factor was the position of the body (standing vs. sitting). A post hoc investigation using Tukey's test was also performed. For all calculations a critical α level was set at 0.05.

RESULTS

To demonstrate differences in individual components of our FAR formula between standing and sitting positions we performed ANOVA for both the absolute difference of the right and left ranges of motion (|R – L|) as well as the sum of the right and left ranges of motion (R + L). This should explain whether eventual differences in FAR were introduced by increasing/decreasing absolute differences between the sides or increasing/decreasing the total range of motion. Below (TABLE 1)

TABLE 1
Results of ANOVA for interaction: spinal section × plane of movement × body position; the absolute difference between the right and left ranges of motion (|R – L|) as well as the sum of the right and left ranges of motion (R + L). Presented are mean values [degrees] of the two parameters together with 95% confidence intervals (CI) and p levels of the Tukey test.

Plane of movement	Spinal section	Parameter	Standing mean (95% CI)	Sitting mean (±95% CI)	p level
		|R – L|	2.32 (1.68–2.96)	2.16 (1.56–2.77)	NS
	TH	R + L	36.16 (32.82–39.50)	39.38 (36.25–42.52)	NS
		|R – L|	1.16 (0.52–1.80)	1.23 (0.62–1.83)	NS
Transverse	L	R + L	25.52 (22.18–28.86)	28.90 (25.76–32.04)	NS
		|R – L|	1.13 (0.49–1.77)	1.74 (1.14–2.35)	NS
	TH	R + L	41.46 (38.12–44.80)	41.16 (38.02–44.29)	NS
		|R – L|	1.60 (0.97–2.24)	1.49 (0.88–2.09)	NS
Frontal	L	R + L	23.61 (20.27–26.95)	12.83 (9.69–15.97)	< 0.001

TABLE 2
Detailed results of variance analysis

Effect	SS	Df	MS	F	p
Plane	189.167	1	189.167	4.2581	0.043396*
Spinal section	275.971	1	275.971	6.2121	0.015467*
Plane × spinal section	436.335	1	436.335	9.8219	0.002668*
Error	2665.479	60	44.425		
Position	167.431	1	167.431	9.6348	0.002912*
Position × plane	206.172	1	206.172	11.8642	0.001050*
Position × spinal section	35.908	1	35.908	2.0663	0.155779*
Position × plane × spinal section	106.850	1	106.850	6.1487	0.015977*
Error	1042.663	60	17.378		

Legend:
SS – *sum of squares*
Df – *degree of freedom*
MS – *mean square*
F – *F statistic results*
* – *statistically significant*

we demonstrate the results for interaction: spinal section × plane of movement × body position; which seems most important for the further analysis of the FARs. Presented are the mean values of the two parameters together with 95% confidence intervals and p levels of the Tukey test for this interaction.

In this study the most important parameter was FAR. Below presented are all the main effects of variance analysis for this dependent variable and their interactions: plane of movement × spinal section, body position × plane of movement. Interaction: body position × spinal section did not occur in a statistically significant manner, whereas the interaction: spinal section × plane of movement × body position did not give any additional information and thus the authors decided to skip that. Detailed results of the analysis are shown in TABLE 2.

Main effect – body position

Functional asymmetry of the spine increased significantly in a sitting position ($p < 0.01$). In standing, FAR was about 5.06 (95% confidence interval (CI) 3.80–6.31), however in sitting it reached the level of 7.34 (95% CI 5.83–8.86).

Main effect – plane of movement

Variance analysis demonstrated significant differences between FARs in both the frontal and transverse planes ($p < 0.05$). For rotation the mean FAR was about 4.98 (95% CI 3.32–6.65), whereas for lateral flexion it was 7.41 (95% CI 5.75–9.08).

The main effect – the spinal section

The lumbar and thoracic sections FAR were significantly different ($p < 0.05$). The mean of FAR in the lumbar spine was equal to 7.66 (95% CI 6.00–9.33) and was lower than that of the thoracic section FAR – 4.73 (95% CI 3.06–6.40).

Interaction – body position × plane of movement

For this interaction ANOVA demonstrated a significant outcome ($p < 0.01$). Post hoc Tukey's test revealed a lack of significant differences in FAR between the transverse ($X = 5.11$; 95% CI 3.34–6.88) and frontal planes ($X = 5.00$; 95% CI 3.23–6.77) in standing ($p > 0.05$). In sitting this difference was, however, of significant relevance (respectively: $X = 4.86$; 95% CI 2.72–7.00; $X = 9.83$; 95% CI 7.69–11.97; $p < 0.05$) (Fig. 2).

Interaction: plane of movement × spinal section

In this case we can demonstrate a significant outcome of ANOVA as well ($p < 0.01$). The post hoc Tukey's test revealed a lack of significant differences of FAR between the thoracic ($X = 5.36$; 95% CI 3.00–7.72) and lumbar sections ($X = 4.61$; 95% CI 2.25–6.96) in the transverse plane but proved them to be significant in the frontal plane (respectively: $X = 4.10$; 95% CI 1.17–6.46; $X = 10.73$; 95% CI 8.37–13.09; $p < 0.01$) (Fig. 3).

Fig. 2
Mean values of the Functional Asymmetry Ratio (FAR) for ANOVA interaction: body position × plane of movement (whiskers indicate 95% confidence interval)

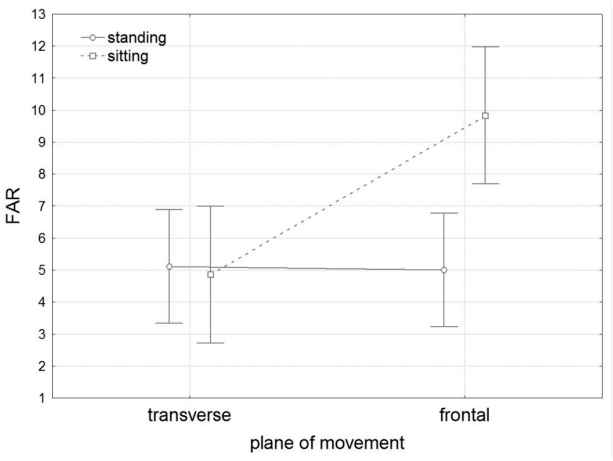
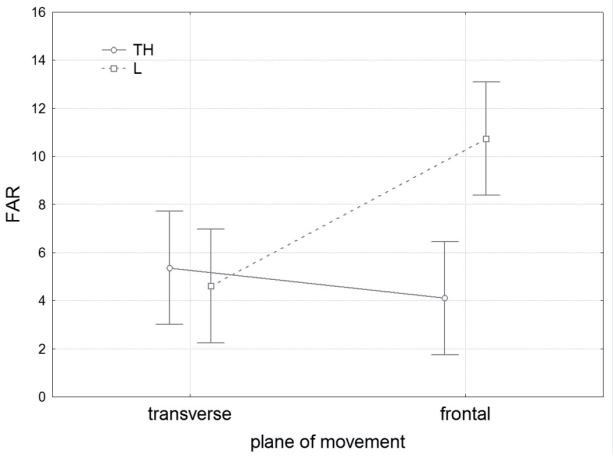


Fig. 3
Mean values of the Functional Asymmetry Ratio (FAR) for ANOVA interaction: movement plane of movement × spinal section (whiskers indicate 95% confidence interval)



DISCUSSION

The results obtained seem to prove the hypothesis that two potential negative factors – sitting position and the functional asymmetry of the human body – have something in common. Asymmetry in a sitting position is significantly larger than in a standing position. Besides this we discovered that the asymmetry of the lumbar section outnumbers the asymmetry recorded in

the thoracic spine and asymmetry on the frontal plane exceeds transverse plane asymmetry. It is possible, however, to develop the idea that these differences could be associated with a significant decrease in the total range of lumbar spine motion on the frontal plane (TABLE 1) which would influence the denominator of our formula in cases of almost all individual comparisons following ANOVA. Our evidence concerning the association between functional asymmetry and a sitting position must be therefore treated as speculative and this issue needs further investigation. Asymmetry ratios increase, but this seems more likely to be associated with a decreasing range of motion rather than an increase in the absolute difference between mobility towards the right and left sides. In several cases we were able to observe an increase in the absolute difference between sides, but this was always lacking statistical significance.

Nevertheless we will try to speculate slightly on our results which may provide valuable input for the reader struggling with similar problems.

It seems also that actions taken to reduce the influence of personal variability in the positioning of the spine and trunk during the procedure requiring subjects to perform movement in an erect position (spine elongation) might have played an important role. This position was unnatural and it is not really used in everyday life. The next standardizing procedure was that subjects were forced to perform movement as parallel as possible to the given plane reference. Here, we must consider the fact that everyday motor performance consists of complicated three dimensional spinal trajectories, not "right-angle" movements. These two factors could exert some impact on the results.

In the introduction two opposing points of view on the human body asymmetry were presented. One of them suggests that asymmetry constitutes a common and physiological phenomenon, the other claims that asymmetry is associated with pathology. Taking into account all these contradictory arguments, the authors' will is to maintain a neutral attitude. After a critical look at the recorded results (possibly a larger functional asymmetry in a sitting position) we also offer the opposite thesis: if the spine of young, healthy and active persons starts to function in more asymmetric patterns in sitting than in standing positions, maybe we should consider this phenomenon within the category of usefulness?

We can presume that increased functional asymmetry in a sitting position is used as a means for energetic cost optimization while sitting for a long time. Over the time period of billions of years, organisms on Earth were adapting to their changeable environment gaining in this way their right to survive. This is why the form and function of an organism are constantly changing in pursuit of using the energetic potential in the most rational way. Every human being from birth to death is also constantly utilizing this law, either consciously or not. Maybe the greater functional asymmetry observed in the lumbar spine section in a sitting position constitutes a manifestation of the above mentioned mechanism.

In a standing position, our nervous system has greater freedom in motion control due to the possibility of engaging hip and ankle joints. A greater degree of freedom may cause reduced differences between the dominating and non dominating sides of the body as a result. We may speculate that more symmetrical ranges of motion in a standing position are an outcome of this fact. In a more restricted sitting position the nervous system has fewer possibilities of completing any motor task and thus it chooses those patterns which it can control more easily.

The presented speculations can be considered to be an interesting source of further research problems. Investigating the phenomenon of functional asymmetry in connection with body lateralization seems to be a significant issue. Experiments exploring this field would make it possible to verify the hypotheses mentioned above and contribute to the knowledge of the functional asymmetry of the human body.

CONCLUSIONS

- Functional asymmetry of the spine in a sitting position seems to be greater than in standing.
- This may be, however, associated with a decreasing range of motion rather than increasing the absolute difference between mobility towards the right and left side.
- In a sitting position, a significant decrease in the lumbar spine range of motion was recorded in the frontal plane.
- The recorded frontal plane functional asymmetry of the spine was greater than the transverse plane asymmetry and the functional asymmetry of the lumbar section of the spine was larger than the asymmetry of the thoracic section. Again, these differences may have occurred due to a decrease in the total range of the frontal plane motion of the lumbar spine.
- Results suggest that a sedentary lifestyle may add to the functional asymmetry of the spine increasing the risk of excessive load and making tissue prone to injury. This issue may be addressed in prophylactic and therapeutic protocols.

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FUNKČNÍ ASYMETRIE PÁTEŘE VSTOJE A VSEDĚ

(Souhrn anglického textu)

VÝCHODISKA: Sedavý styl života a funkční asymetrie těla představují potenciálně dysfunkční faktory.

CÍL: V tomto projektu se autoři snaží zjistit vztah mezi sedavým stylem života a mírou funkční asymetrie páteře.

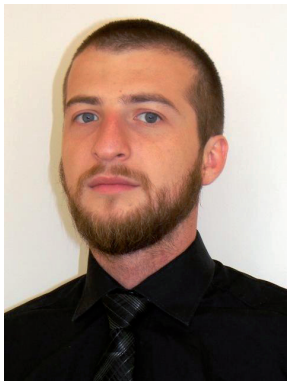
METODY: Experimentu se zúčastnilo šestnáct mužů – dobrovolníků ve věku 19–25 let. Šlo o studenty Akademie tělesné výchovy v Katovicích. K měření pohybů trupu byl použit system BTS Smart. Míra funkční asymetrie byla popsána jako koeficient funkční asymetrie (Functional Asymmetry Ratio, FAR), vypočtený z rozsahu pohybů trupu ve frontální a horizontální rovině.

VÝSLEDKY: Vyšší hodnoty FAR byly zjištěny v poloze vsedě ($p < 0,01$). Funkční asymetrie ve frontální rovině byla vyšší než asymetrie v horizontální rovině ($p < 0,05$) a asymetrie bederní páteře převýšila hodnotu zaznamenanou u hrudní části ($p < 0,05$).

ZÁVĚRY: Spojení mezi sedavým stylem života a funkční asymetrií těla je možné. Společně se zvýšeným užíváním sedavých poloh v každodenním životě se může také zvyšovat asymetrické namáhání páteře.

Klíčová slova: rozsah pohybu, rotace, laterální flexe, hrudní, bederní.

Maciej Biały, PT



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A COMPARISON OF TIME CHARACTERISTICS IN BALL CATCHING BETWEEN CHILDREN WITH AND WITHOUT DOWN'S SYNDROME

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Submitted in April, 2009

BACKGROUND: The one handed catching of a ball is a complex coordination ability. It requires the spatial and time adjustment of the hand according to the speed of the approaching ball.

OBJECTIVE: Two main objectives were exposed in the course of the present research; namely whether and why children with Down's syndrome (DS) have problems with one handed ball catching compared to the children with no impairment in motor task such as the one handed catching of a ball.

METHODS: Eleven children with DS, aged 8, and 16 with no impairment, also aged 8, were required to catch 45 balls (small, medium, and large). No spatial uncertainty regarding the trajectory of the ball was present and therefore only time judgements were required to catch the ball.

RESULTS: The results of the present research showed that children with DS missed more balls than the children from the control group; the children with DS missed 30% of the balls vs. the children from the control group, who missed 7% of the balls. In addition, children with DS missed more small balls. The kinematic analysis of the time characteristics of one handed catching revealed that the difference in timing occurs at the time of grasping the ball. When examining the time of the catch in relationship to the time window, it can be seen that most children with DS tended to finish their catch too late.

CONCLUSIONS: Since differences were not found for the time of initiation and the time of maximal aperture, the present experiment suggests that it is not so much the anticipatory control but a slowness of movement that causes the higher percentage of catching failures in the children with DS.

Keywords: Children with Down's syndrome, one handed catching, kinematic analysis.

INTRODUCTION

Down's syndrome (DS) presents a unique etiology that affects many areas of development. Of specific concern are the motor delays and deviations that can affect the development of such areas as fundamental motor patterns, physical fitness and the learning of complex motor skills. The effects of DS on motor development have been widely reported over the years (Block, 1991; Thombs & Sugden, 1991; O'Brien & Hayes, 1995; Selikowitz, 1997; Schwartzman, 1999; Savelsbergh, Van der Kamp, Ledebt, & Planinsek, 2000). The goal of early work was largely descriptive and documentational in terms of what and when the differences between subjects with DS and individuals with no impairment occur. Recently, the more theoretical question of why and how the children with DS differ from individuals with no impairment has received at least as much attention.

Catching a ball is quite a complex coordination ability. It requires the spatial and time adjustment of the hand according to the speed of the approaching ball. To catch a ball successfully the hand has to be positioned at the interception point, followed by a spatial adjustment of the hand such that the ball makes contact with the hand in the metacarpal region, and the grasp has to be initiated and completed within a defined time window depending on the speed of the approaching ball. Failure to fulfil both gross and fine orientation results in spatial and time errors. The only report known to us in the literature with respect to catching performance in DS is the report by O'Brien and Hayes (1995). They found that the children with Down's syndrome did not perform as well as compared to other children with intellectual disabilities and children with no impairments in their intellectual development. One of the possible reasons might be that skills such as ball catching, where failure is so obvious, are considered to be unsuitable for children with intellectual difficulties and children with DS as well (Henderson, Morris, & Frith, 1981). Children with Down's syndrome also have problems with interceptive action (O'Brien & Hayes, 1995). Their study does not precisely specify whether this problem is due to spatial or time errors or both. Moreover, it also remains unclear whether this problem is due to perceptual (Do they perceive time to contact and what kind of information do they use?) or motor problems (Are they clumsier, slower?). Henderson, Morris and Frith (1981) have found that children with DS

have timing problems. It is worth mentioning that they were following lines on a paper being drawn by a pencil. So the performed task was quite different as compared to catching a ball. The DS afflicted individuals needed more time for their reactions than their coevals without DS or than those having other types of disorder of their mental development (Kerr & Blais, 1985; Weeks, Chua, & Elliott, 2000). Each movement appearing to be a response to some external stimulus comes with a slight delay. It gives the impression of acting in slow motion. The results obtained by Blais and Kerr (1985) show that individuals with DS reacted to a certain stimulus in 600 ms, while the control group needed only 300 ms, Cunningham (1999) stipulates that children with DS undergo considerable difficulties in the correct passing of objects. The ones that they get into their hands are far less "explored" – tasted, touched, observed, moved, etc. These children are also less skilled in placing their hands with regard to the shape and size of an object. In several articles concerning children with Down's syndrome (Henderson, 1985; Block, 1991; Latash, Kang, & Patterson, 2002) it has been reported that their motor performance is slower in comparison with children who have no impairment in their intellectual development or than those having intellectual problems.

Not many findings have been provided with respect to an environmentally valid task such as one-handed ball catching. It is this limitation, which justifies the present research. Therefore, the main goal of this research has been to examine whether and why children with DS do not perform as well compared to children with no impairment in a motor task such as one handed catching. More specifically, it is examined whether their worse performance in catching, as found in O'Brien and Hayes (1995), is due to different or worse time judgements (timing) or whether slowness of movement causes the higher percentage of catching failures in the DS impaired children.

METHOD

SUBJECTS

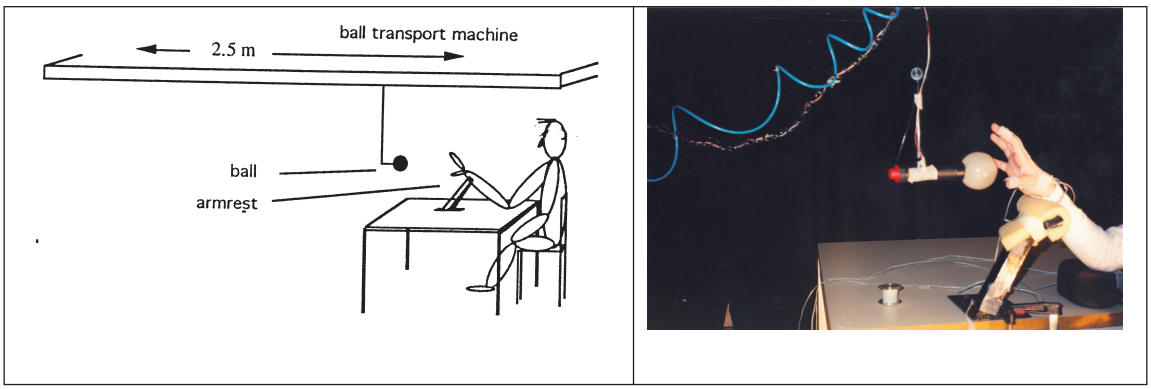
The sample consisted of 27 children aged 8 (+/–6 months). Among those were 11 children with DS (3 girls, 8 boys) and 16 with no impairment (3 girls, 13 boys). Children with no impairments are also referred as the control group. All of the children participated with their own and their parents' consent, and had no visual impairments.

PROCEDURE

Each child was assessed individually in an experimental room by the same researcher according to the Declaration of Helsinki. Subjects were required to catch 45 balls measuring 3 cm (small), 5 cm (medium) and 6 cm (large) in diameter. The balls were provided by the Ball Transport Apparatus (BallTrAP). The subjects were seated in the chair, next to the table and below the wooden box, at the end of the 200 cm straight path (Fig. 1a). The right wrist of the subject was fixed in the armrest, positioned on the table, so that only the movement of fingers was possible. Positioning of the hand ensured the hand to be in the path of the ball, so that the ball on the rod always swung into the hand of the subject. No spatial uncertainty regarding the trajectory of the ball was present and therefore only time judgements were required to catch the ball. Subjects were required to catch the ball between the thumb and the other fingers. The subject started each trial with the thumb and the index finger contacting each other. Each subject spent approximately 30 minutes to complete the experiment.

The kinematic characteristics of the catch were measured with the Selspot system. The camera was placed at a 110 cm distance, laterally from the subject,

Fig.1
Design of the apparatus and position of four LEDs



at the height of 110 cm. The Selspot system recorded four light emitting diodes (LEDs) positioned (Fig. 1b) on the end of the rod ("ball-LED"), on the wrist at the anatomical snuffbox ("wrist-LED"), as well as on the tips of the thumb and the index finger. Four reference LEDs with known distance were positioned in the same plane as the experimental LEDs on the hand and were used to calculate the distance between the experimental LEDs. The position signals of LEDs were sampled with a frequency of 156.4 Hz, and filtered by a second order Butterworth filter with a cut off frequency of 10 Hz.

The catching failures (i.e. the number of misses) and four variables, all of them being important to the timing of each catch, were analysed. The moment of ball hand contact was defined as the moment in which the distance between the ball-LED and the wrist-LED was minimal. Each catching trial produced the following kinematic variables:

- *The time of the initiation of the catch* (i.e. the distance between the thumb and the index finger starts to increase).
- *The time of maximal aperture* (i.e. the moment when the distance between the thumb and the index finger was maximal).
- *Peak closing velocity* (i.e. the maximal closing velocity).
- *The time of the catch* (i.e. the moment when the distance between the thumb and the forefinger was at minimum, depending on the ball size).

METHODS OF DATA ANALYSIS

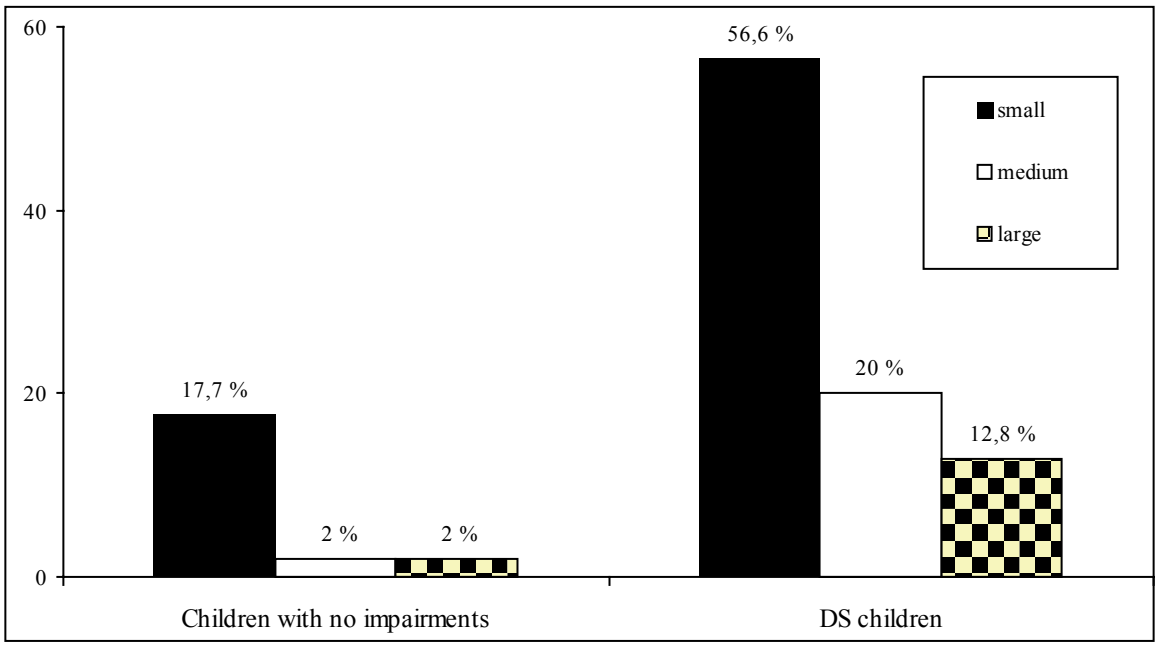
Descriptive statistics, the K–S normal distribution test and the analysis of variance (ANOVA) were carried out to compare the effect of the design of repeated measures on the last two factors. To identify differences between means, Newman-Keuls post-hoc comparisons were carried out (with $p < .05$). Data were processed with the statistical programming package SPSS for Windows (release 13.0).

RESULTS

Percentage of catching failures – misses

In the *percentage of misses* the significant main effect of a group was observed ($F [1.20] = 20.30$, $p < .001$). The DS children missed more balls than the children from the control group, ie. the DS children missed 30% of the balls vs. the children from the control group, who missed 7% of the balls. An interaction effect of ball size by group was found ($F [2.40] = 9.907$, $p < .001$) (Fig. 4). Post-hoc comparisons indicated that both groups missed more often with the small balls as compared to misses of balls of the other two sizes. In addition, the DS group missed the small balls more often as compared to the control group. The percentage of misses of different

Fig. 2
Percentage of misses of different sized balls among children with DS and children with no impairments



sized balls among children with no impairments and children with DS are presented in Fig. 2.

Kinematic analysis of the important time characteristics of catching

In analysing the time characteristics of catching, the results of the *time initiation of the catch,* the *time of the maximal aperture, peak closing velocity* and the *time of the catch* will be discussed. These values are also presented in TABLE 1.

TABLE 1
ANOVA for five kinematics' variables for DS and Control Group

Variable	GROUP	MEAN	SD	F	P
Time of the initiation of the catch	DS Control	–702 –789	166 152	2.0	.34
Time of the maximal aperture	DS Control	–241 –270	96 83	0.95	.49
Time of the catch	DS Control	57 21	19 7	2.65	.11
Peak closing velocity	DS Control	–395 –281	156 110	8.544	**.00**

Legend:
Time of the initiation of the catch, time of the maximal aperture and time of the catch are given in milliseconds (ms), while time of the peak closing velocity is given in mm/s. The minus sign indicates that the time is *before* the catch.

In analysing the time variables – the *time of the initiation* ($F[1.17] = 2.0$), the *time of the maximal aperture* ($F[1.19] = .95$) and the *time of the catch* ($F[1.19] = 2.65$) no significant main effects for a group were found, although the *time of the catch* approached significance ($p = .11$). TABLE 1 shows that the DS group tended to complete their catch later than the control group. Since the variance is also higher for the DS group, a t-test for the time of the catch was conducted. This (unrelated) t-test showed that the difference was almost significant, $t(19) = 1.63$, $p = .06$. Fig. 5 illustrates that the DS group tended to complete their catch later as compared to the control group. This was confirmed by the Mann-Whitney rank order test, which was proven to be significant, $U(19) = 78$, $p < .05$. This significant effect indicates that the DS children were catching balls later than did the children from the control group. When means of all trials together were plotted in the time window (Fig. 3), and two standard deviations were added (Fig. 4), it is clear that this tendency in the DS children, to catch the ball later, might result in more misses. It is evident from Fig. 3 that the DS subjects closed their hands later (the ball almost fell from their hands, about 100 ms after contact) compared to the control group subjects. Only one DS subject closed his hand too early. Three results of the subjects from the DS group and from the control group are presented in Fig. 4. It is seen that all three DS subjects were too late. This has also been confirmed by two standard deviations (SD) compared to the control group's subjects.

Fig. 3
Means of the time of the catch (7 DS and 14 control group subjects) in the time window

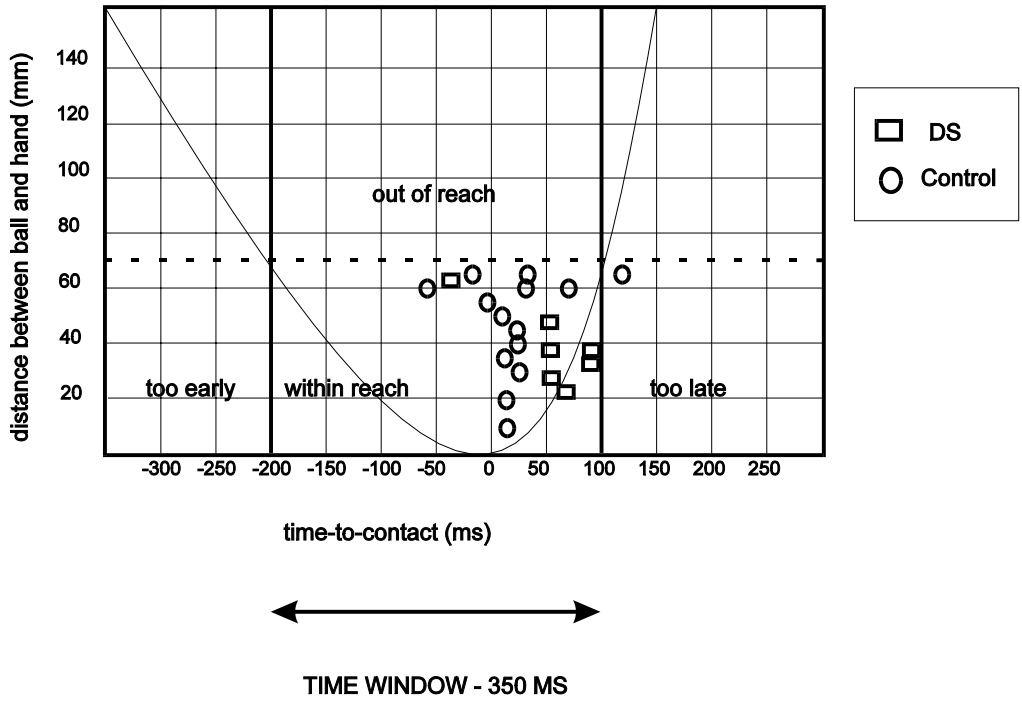
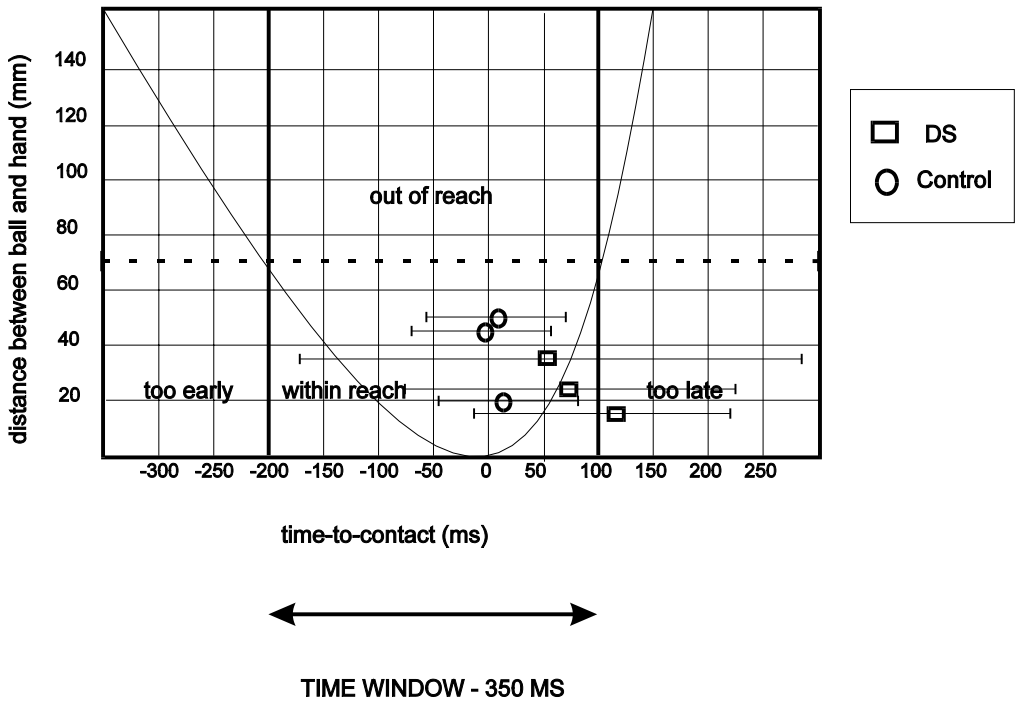


Fig. 4
Means and two standard deviations of the time of the catch (3 DS and 3 control group subjects) in the time window



A significant main effect of the group was found for the *peak closing velocity*, F (1.18) = 8.544, p < .01. The DS children closed their hands significantly faster compared to the children with no impairment (TABLE 1).

DISCUSSION

The general purpose of this study was to give an answer to the question whether and why children with DS aged 8 differ from children with no impairment aged 8 in a motor task such as one-handed ball catching where time predictions have to be made.

The results revealed that children with DS missed more often than did children with no impairment. It may be concluded that they are less successful in motor tasks with time constraints compared to their peers with no impairments. It should be stressed at this point that these findings are not surprising and are in line with the suggestions of other researchers (Henderson, 1985; Block, 1991; Thombs & Sugden, 1991; O'Brien & Hayes, 1995; Schwartzman, 1999; Polastri & Barela, 2005), who have pointed out that children with Down's syndrome perform less well than their peers, who with no impairment in intellectual development. More specifically, with respect to the time nature of the task examined, the findings are in agreement with Frith and Frith (1974), Henderson, Morris and Frith (1981) and Kerr and Blais (1985), who indicated that children with Down's syndrome have deficiencies in controlling the timing of their movement. Namely, Henderson et al. (1981) found the task of the catching of a ball too difficult for the DS children, and were not able to discover information about time characteristics in this specific motor behaviour task among the DS children. Therefore, they used a different kind of task that is a continuous tracking task. With respect to timing and information about timing in motor behaviour, tracking and catching tasks differ for the present study, as compared to a previous study. Together they offer only an opportunity for the comparison of results in two different tasks: tracking (Henderson, 1985) and catching a ball. Basically, the interest of both research projects is in the same domain. Unfortunately, there are no other studies reported with respect to catching a ball, but the data reported by Henderson et al. (1981) support our conclusions, namely problems associated with anticipatory movement tasks are due to time errors.

In order to find an answer to the question of why the DS children differed in catching performance, the kinematic analysis of the catch was carried out. It is seen that the DS children started opening and closing their hands almost at the same time as the children with no impairments, but they caught all balls of different sizes later. Especially the 3 cm balls were caught with a considerable delay. This is probably the reason why the DS children missed more balls than the control group did. This finding is consistent with the existing literature and clinical observations. Namely, the DS individuals perform slower than do their peers with no im-

pairments with respect to reaction and movement time (Henderson, 1985). The Henderson et al. study (1981) concluded that the DS children are impaired in using predictability in timing in order to control their movements by pre-programmed sequences. With the respect to the late catch found in the DS group, the question arises whether this is indeed a case of worse anticipatory control or a problem of slowness of movement. When examining the time of the catch in relationship to the time window (Fig. 3 and 4), it can be seen that most DS children, in contrast to the children with no impairments, tended to finish their catch too late. Since differences in timing were not found for the time of initiation and the time of maximal aperture, the present experiment suggests that it is not so much the anticipatory and timing control, but a slowness of movement, that causes the higher percentage of catching failures in the DS children.

CONCLUSION

The results of our research revealed that children with DS, aged 8 years, missed more often than did children with no impairments and, therefore, it can be stated that they are less successful in motor tasks such as one handed catching as compared to their peers. The kinematic analysis of the catch showed that children with DS started opening and closing their hands almost at the same time as the children with no impairments, but they caught all balls of different sizes later. Since differences in timing were not found for the time of initiation and the time of maximal aperture, the present experiment suggests that it is a slowness of movement which causes the higher percentage of catching failures in the DS children. Further research will continue in the field of the comparison of one handed catching performance among children with DS and with different intellectual disabilities, ages and gender.

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SROVNÁNÍ ČASOVÝCH CHARAKTERISTIK PŘI CHYTÁNÍ MÍČE U DĚTÍ S DOWNOVÝM SYNDROMEM A BEZ DOWNOVA SYNDROMU

(Souhrn anglického textu)

VÝCHODISKA: Chytání míče jednou rukou je dovednost s obtížnou koordinací. Vyžaduje prostorové a časové přizpůsobení pohybu ruky vzhledem k rychlosti přilétajícího míče.

CÍL: Tento výzkum měl dva hlavní cíle; totiž zjistit, zda a proč mají děti s Downovým syndromem (DS) problémy s chytáním míče jednou rukou ve srovnání s dětmi, jež nemají oslabené motorické dovednosti, například chytání míče jednou rukou.

METODY: Jedenáct dětí s DS, ve věku 8 let, a šestnáct bez poruchy motoriky, také ve věku 8 let, mělo

za úkol chytit 45 míčů (malých, středních a velkých). Hody byly stabilní, pokud jde o trajektorii míče, a proto k chycení míče byl potřeba pouze časový odhad.

VÝSLEDKY: Výsledky tohoto výzkumu ukazují, že děti s DS chytily méně míčů než děti z kontrolní skupiny; děti s DS nechytily 30 % míčů, zatímco děti z kontrolní skupiny nechytily 7 % míčů. Navíc děti s DS nechytily více malých míčů. Kinematická analýza časových charakteristik chytání jednou rukou odhalila, že rozdíl v načasování se vyskytuje v době sevření míče. Při posuzování doby chycení ve vztahu k časovému odhadu lze pozorovat, že většina dětí s DS měla sklon k příliš pozdnímu chytání.

ZÁVĚRY: Vzhledem k tomu, že nebyly nalezeny rozdíly u doby zahájení a doby maximální apertury, tento experiment naznačuje, že vyšší procento nechycených míčů u dětí s DS nemá na svědomí ani tak anticipativní kontrola, jako spíše pomalost pohybu.

Klíčová slova: děti s Downovým syndromem, chytání jednou rukou, kinematická analýza.

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The journal "Acta Universitatis Palackianae Olomucensis. Gymnica" focuses on presenting results of research studies and theoretical studies from the field of kinanthropology. The scope of the journal covers topics related to biomechanics, exercise physiology, physiotherapy, somatometry, sports psychology, sports training, physical education, public health, etc. The journal also welcomes submissions that present results of interdisciplinary research.

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We look forward to our further cooperation!

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