The Polish Journal of the Arts and Culture
Nr 12 (4/2014) / Article

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Applying interactive sensors to the learning and memorisation process

ABSTRACT

The aim of this paper is to show one possible way to develop educational methods and tools. Its first part provides a description of research results (mostly in the field of neurobiology) which can prove the significant positive impact of physical activity on the human brain's cognitive functions. One of the tools enabling the combination of physical exercise with exercises improving our cognitive abilities is the interactive sensor, currently used as hardware in game consoles. In this paper, not only is the multidimensional positive impact of physical activity on the human brain promoted, but the necessity of implementing methods integrating intellectual tasks with physical exercises is additionally postulated.

KEY WORDS

educational methods, computer games, cognitive abilities, physical activity, interactive sensors

INTRODUCTION

The negative impact of a passive lifestyle on the human body is a relatively well-acknowledged fact. So far, however, most societies have shared the common belief that physical and intellectual abilities are not related. Stereotypes of athletes and scientists have been gradually losing their power, although they are still present in the social discourse. We no longer perceive scientists as short-sighted (from spending endless hours reading thick books or sitting in front of a computer screen), either obese or pathologically skinny (due to a certain carelessness in their daily life).

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Athletes are no longer seen only in the context of their professional achievements, but are more and more frequently appreciated for their intellect and education.

Another aspect of the modern world is the presence of technology on an unprecedented scale in people's everyday lives. Technology is becoming a ubiquitous instrument, used both at work and at play. Popular culture has absorbed, for example, technologies enabling communication among people all over the world. As a result, a number of existing standards, rules and habits are being transformed. The model of the community is also changing, for the life of an individual is influenced not only by the community he or she physically lives in, but also by people, groups or even whole cultures from thousands of kilometres away. This new mode of communication, along with a new way of human 'being in the world', is generating numerous health and development problems, both intellectual and physical.

Some of the problems emerge from excessive exposure to stimuli, which endangers every inhabitant of a big city. People are constantly bombarded with information coming from a variety of sources. They need more and more time and energy to process it. As a result, the number of people suffering from diseases of civilisation (e.g. obesity, which in fact can be fatal) is rising. Most inhabitants of developed countries are familiar with these facts; nevertheless, the problem seems to be continually proliferating.

These tendencies deeply reflect other processes related to the individual's intellectual development. Both learning and memorisation seem to partake of a different nature than they did only a few years ago.

Therefore, a revision of the educational system is becoming necessary, because the continued inadequacy of didactic methods will result in lower and lower levels of work efficiency. Moreover, the current state of knowledge regarding cognitive sciences, such as psychology, neurobiology, pedagogy or sociology, calls for the application of a whole range of effective solutions, such as mnemotechnics or mindmapping.

The aim of this paper is to prove that incorporating a tool such as an interactive sensor, commonly used in the hardware of game consoles, into the educational process is one of the best strategies for improving learning efficiency. Furthermore, the paper's main assumption is the acknowledgement of the multidimensional, positive impact of physical activity on the improvement of human intellectual abilities.

The first part of this paper introduces research assumptions regarding neuroplasticity, the incredible ability of the human brain to constantly reconfigure its neural structures. The next part shows research results confirming the positive impact of physical activity on this ability. Subsequently, various programmes

aimed at the integration of the psychic and physical levels in the process of education are presented. The final part presents the advantages of the appropriate application of interactive sensors, currently being used mainly in interactive games (such as Microsoft Kinect, Nintendo Wii, etc.) to the educational process. Eventually, the effectiveness of the presented method will be demonstrated on the basis of related research results.

'THERE ARE NO INACTIVE AREAS IN THE BRAIN'[1]

This was the conclusion arrived at by a research team from the University of California in San Diego. The husband-wife team of V. S. Ramachandran and D. Rogers-Ramachandran, in collaboration with S. Cobb,[2] focussed their analysis on changes in the brain caused by the amputation of a limb. Examining the impact amputation has on the brain area responsible for the movement of the limb, they came to amazing conclusions, proving that not only the area related to the movement of the amputated limb became less active, but also that the adjoining brain areas demonstrated higher levels of activity. As K. Rymarczyk summarises: 'In other words, the area correlated to the amputated arm has been absorbed by the surrounding areas […] With no external stimulation, the disused areas are incorporated by the areas closest to them'.[3] These findings indicate that the brain is an organ undergoing constant transformation. This incredible ability is called 'brain plasticity'. As Rymarczyk writes, 'this term originates from the Greek word *plastikós*, meaning *creating.* This concept reflects the ability of neurons to transform themselves permanently during the learning processes. It means that the synaptic connections between the neurons are being reconfigured at that time.'[4]

This term appeared for the first time in 1948 in Jerzy Konorski's sensational paper, 'Conditioned reflexes and neuron organisation', in which he refuted the common belief of that time, namely, that an adult human's brain structures do not undergo important transformations. His publication caused a stir. As Rymarczyk states:

> For over 100 years it was thought the brain of an adult human being had no ability to recover and that it remained unchanged. Naturally, it was assumed that adults still pos-

[1] K. Rymarczyk, *Plastyczność mózgu* [in:] *Neurobiologiczne podstawy integracji sensorycznej – ujęcie interdyscyplinarne*, ed. M. Wiśniewska, Kraków 2010, p. 63.

[2] V. S. Ramachandran, *Touching the phantom*, "Nature" 1995, No. 77, pp. 489–490.

[3] K. Rymarczyk, op. cit., p. 63.

[4] Ibidem, p. 59.

> sessed the ability to learn and adapt to changing external conditions. It was thought, however, that the learning process consisted mainly in changing synaptic weights inside the brain's neural network, whereas once created, cortex maps never changed.[5]

Konarski has described this term the following way: 'Another feature, which, in certain sets of neurons, helps create permanent functional transformations as a result of certain stimuli or their combination, shall be called *plasticity,* and the corresponding changes *plastic changes*'.[6]

The site where plasticity reveals itself is the synapse, as the area that modifies the mode of communication with other synapses by changing the course of neuronal impulses.

> The plasticity of the brain is the ability of synapses and neural circuits to change as a result of being active. It is a feature the continuity of our psychic life depends on […] Active nerve cells create 3 billion connections per second. An active nerve cell can have from 2 to 20,000 dendrites receiving and storing information. Each neuron can also transmit information via the axon, i.e. nerve fibre […] The speed of such transmission can reach 100 metres per second.[7]

Therefore, the synapse enables correct functioning of the brain, and a decrease in its level of activity is symptomatic of numerous serious diseases attacking the human nervous system, such as dementia or Alzheimer's disease.

As neurobiologists indicate, a certain degree of brain plasticity is necessary for every healthy human being, which means, essentially, constant transformation and reconfiguration of the network of synaptic connections.

> As such, plasticity represents an intrinsic property of the nervous system retained throughout life that enables the modification of function and structure in response to environmental demands via the strengthening, weakening, pruning, or adding of synaptic connections and by promoting neurogenesis. This means that the brain does not remain

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[5] Ibidem, p. 61.

[6] J. Konorski, *Organisation of conditioned reflexes*, after M. Kossut, *Synapsy i plastyczność mózgu*, [online], http://fundacjarozwojunauki.pl/res/Tom1/Nauka%20swiatowa%20i%20polska[1].Rozdzial%2009.pdf [13.09.2014].

[7] H. Nawrocka, *Plastyczność mózgu a kinezjologia edukacyjna*, [online], http://nawrocka.com.pl/files/kinezjologia.pdf [15.05.2014].

> static but, instead, continues to change as the obligatory consequence of each sensory input, motor act, association, reward signal, action plan, and awareness.[8]

Thus the brain remains constantly active, even in sleep, when other bodily functions slow down.

Therefore, the question should be asked: what does adequate plasticity actually mean? As neurobiologists claim: a sufficient level of brain plasticity has a significant impact on adapting brain structures and functions to changing needs, while an insufficient level makes the synaptic connections less stable. This may endanger the performance of basic cognitive and behavioural processes. With regard to the constant need to adapt behaviour and knowledge to new methods of action and thinking, another question arises: are we capable of consciously improving the thinking process on our own? Can we, despite the limitations imposed by the biochemical construction of our bodies, raise our intellectual abilities to a higher level?

PHYSICAL FITNESS AND INTELLECTUAL ABILITIES

'Iron rusts from disuse, stagnant water loses its purity,
and in cold weather becomes frozen;
even so does inaction sap the vigours of the mind'.[9]

Certainly we are able to improve our intellectual abilities; this is what we actually do in the learning process. The question posed in the previous chapter can be transformed into the question of whether, knowing the biochemical structures behind the functioning of the human organism, we can consciously use their potential to raise our level of intellectual ability.

The response to the assumption of varying intensity of intellectual capacity from person to person has been given in the form of numerous methods of

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[8] A. Pascual-Leone, *Characterizing Brain Cortical Plasticity and Network Dynamics Across the Age-Span in Health and Disease with TMS-EEG and TMS-fMR, Special Issue: Brain Imaging across the Lifespan*, [online], Springer 2011, p. 302: http://www.tmslab.org/publications/386.pdf [10.06.2013].

[9] L. da Vinci, *The Notebooks of Leonardo da Vinci*, [online], http://books.google.pl/books?id=a8nMAwAAQBAJ&pg=PT219&dq=The+Notebooks+of+Leonardo+da+Vinci,+Jean+Paul+Richter&hl=pl&sa=X&ei=bg5zVKyBA4PMygOhrILICA&ved=0CCkQ6AEwAQ#v=onepage&q=The%20Notebooks%20of%20Leonardo%20da%20Vinci%2C%20Jean%20Paul%20Richter&f=false [10.06.2013].

classifying our abilities: from disciplines which provide typically intellectual pleasure such as Sudoku or chess to IQ tests, which supposedly enable reliable evaluation.

As has already been mentioned, previous findings on the effects of physical exercise on mental performance were downplayed or rejected outright.[10] If, however, the focus was shifted to the impact of physical activity on the intellectual state of a human being, reference was made to the effects of short duration.

If one looks at the available knowledge, it is easy to determine the short-term positive effects of exercise on the work of the entire human body. The obvious advantages associated with sport include, among other things, greater oxygenation of the body (especially the brain and heart) and an increase in the production of chemicals enhancing the immune system and well-being, such as endorphins. At the same time, following physical exercise, the body's resistance to stress increases. This is because bodies accustomed to exercise, after experiencing a relatively high level of stress, release a substance called cortisol, which speeds up the process of destruction of healthy cells in the hippocampus. And, importantly, in the context of this knowledge 'it has also been shown in animal experiments that long-term hypercortisolism associated with the persistence of stress leads to a decrease in the density and sensitivity of 5-HT1 receptors along with contraction of CA3 pyramidal neuron peak dendrites in the hippocampus' [28, 29].

In neuroimaging research using human subjects, a significant reduction in the volume of the hippocampus was demonstrated in cases of depression [30, 31], along with the reduction of glucose metabolism in the brain and neuronal mass loss in the limbic system. [32, 33][11] These studies prove that the hormones secreted in a stressful situation have, in the long run, a damaging effect on the human body, most importantly on brain structures themselves.

Exercise also exerts a long-term positive impact on the brain, including, among other aspects, strengthening of the plasticity of neuronal cells and the growth of the area of the brain called the hippocampus. As the author of *Short lectures on neurobiology* writes: 'The hippocampus is the old cortex (Lat. Archaecortex), in which only three layers of neurons can be distinguished. […] The hippocampus, in turn, participates in certain types of learning'.[12] This part of the brain is also involved in

[10] The best example may be the concept of educational kinesiology, which raised a wave of criticism, cf. P. Dennison, *Kinezjologia edukacyjna dla dzieci: podstawowy podręcznik kinezjologii edukacyjnej dla rodziców i nauczycieli*, Międzynarodowy Instytut Neurokinezjologii, Warszawa 2003.

[11] M. Załuska*, Dehydroepiandrosteron (DHEA) in the mechanisms of stress and depression*, "Psychiatria Polska" 2009, Vol. XLIII, No 3, p. 266.

[12] A. Longstaff, *Krótkie wykłady. Neurobiologia*, Warszawa 2002, p. 109.

the transmission of content from so-called short-term to long-term memory. Studies of the hippocampus indicate that reorganisation of the brain resulting from plasticity may lead to changes at the level of the structure of the brain. Such changes were observed by E. Maguire, H. Spiers and K. Woollet. '[They] showed that in London the hippocampus (the brain structure responsible for spatial memory) of a taxi driver is larger than that of the average Londoner'.[13] It follows that it is possible to substantially rearrange human brain structures so that specific intellectual capacity – in this case, spatial memory – will be reinforced.

But can such changes be the consequence of performing physical exercise?

An example confirming the positive effect of physical exercise on intellectual functions is an experiment called the Water Maze Trap.[14] In its different variants, it was determined that moderate but regular exercise helps to improve memory function and facilitates learning. This is to say that movement has a positive effect precisely in the area of the hippocampus. This process is connected with increased activity of the protein BDNF (brain-derived neurotrophic factor), which is responsible for the life expectancy and activity of a nerve cell. The study consisted of forcing a group of rats into increased physical activity, while a control group performed less exercise. As a result, the group that exercised longer was able to solve tasks related to spatial memory more quickly. The experiment proves that physical exercise influences the volume of the hippocampus and enhances spatial memory.

The whole series of studies suggests that appropriately targeted sets of physical exercises develop not only general physical abilities, but also facilitate the adaptation of mental capacity to the requirements of contemporary life. However, the biggest challenge seems to be to encourage an overwhelmed man to exercise at all.

PROJECTS INTEGRATING PSYCHO-PHYSICAL STIMULATION IN TEACHING

The question, therefore, arises: how to take advantage of the trend towards a healthy lifestyle for educational purposes? To answer this question, it is worth starting with an appropriate definition of the learning process. One of the better definitions for this type of research was proposed by C. Plewka i M. Taraszkiewicz: 'learning is a result of experience, performance, or cognition that could take

[13] K. Rymarczyk, op. cit., p. 63.

[14] E.K. Morris, *Comments on Cognitive Science in the Experimental Analysis of Behaviour,* "The Behaviour Analyst", 1982 No 2 (Fall), pp. 109–25, [online], http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2742049/pdf/behavan00071–0005.pdf [12.06.2013].

place only through other activities, such as reading, speaking, writing, counting, listening, thinking, experiencing, performing, etc., provided these activities lead to some change or a change is happening as a result of these activities'.[15] This definition, first of all, addresses applicable methods of teaching. From this definition alone, it can be deduced that teaching cannot be reduced solely to the forms of lecture and display. As a result of the awareness that mere transmission of content is of limited effectiveness, a number of modern teaching methods have emerged, e.g. problem, exposing, software or practical methods.[16]

An extraordinary example of the application of modern methods of teaching can be observed in so-called 'serious games'. These have purposes other than entertainment, for they enable the player to acquire specific knowledge and skills. They have virtually unlimited applications: 'In addition to obvious advantages, such as enabling learners to experience situations impossible in the real world for reasons of safety, cost, time, etc. (Corti, 2006; Squire & Jenkins, 2003), serious games, it is argued, can have positive impacts on the players' development of a number of different skills'.[17] Serious games very cleverly use their similarity to entertainment-related activities in the learning process. The areas in which such games can be utilised seem to expand constantly:

> Serious games can be applied to a broad spectrum of areas, but, as with almost anything, they can be categorised in a number of different ways. Some categorise serious games into pedagogical, idealistic, politic, or societal games (nyteknik.se, spel.bth.se). Other examples are education, healthcare, national security, corporate management, and more (www.coventry.ac.uk), or education, health, public policy, science, government, and corporate training (usatoday.com).[18]

Currently serious games of this type are being developed at Polish universities.[19] They are designed to support a particular profession, for example, a laparoscopy game for surgeons to be used with Nintendo Wii. Examples of this kind of game are diverse. One of them is Heartville, a Dutch prototype in which points are awarded,

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[15] C. Plewka, M. Taraszkiewicz, *Uczymy się uczyć*, Szczecin 2010, p. 20.

[16] W. Okoń, *Wprowadzenie do dydaktyki ogólnej*, Warszawa 1987.

[17] T. Susi, M. Johannesson, *Serious Game – An Overview Protocol*, Technical Report HS-IKI-TR-07–001, School of Humanities and Informatics, University of Skövde, Sweden, [online], http://his.diva portal.org/smash/get/diva2:2416/FULLTEXT01.pdf [12.06.2013].

[18] Ibidem, p. 10.

[19] *Gry poważne*, Wydział Fizyki, Astronomii i Informatyki Stosowanej Uniwersytetu Jagiellońskiego, Europejska Akademia Gier, [online], http://www.fais.uj.edu.pl/wydzial/video-fotoreportaze/-/journal_content/56_INSTANCE_Df4E/41628/9423739 [12.06.2013].

for example, for a 20-minute walk in fresh air. The player can later replace these points with e-points that are used to build an interactive village. The more real-life achievements of this type, the easier it becomes to build a village in an interactive world. The game was tested by psychiatric patients at GGZ Centraal in Amersfoort. Another game of this type is Playmancer, which is being tested by the Bellvitge University Hospital in Barcelona. The player moves on a treadmill in front of the screen the state of her emotions is controlled through observation of her facial expressions. When the patient begins to exhibit negative emotions, the game becomes more difficult; when, on the other hand, she expresses positive emotions, the game becomes easier. With this mechanism, the player develops an extremely valuable awareness of her own emotional states and, what is more, learns to control them.

Another example is the Microsoft Kinect sensor, which enables the user to monitor the position of his body and control the game with his movements. Additionally, a recently produced game called EA Sports Active 2 uses a headband with sensors which, apart from monitoring the movements of the body, can also monitor the player's heart rate, using an index displayed on the screen. Currently in Poland, on the initiative of a private foundation, all children's oncology wards are to be supplied with xbox devices with the Kinect console. In this project, it is assumed that, thanks to the opportunity to operate interactive equipment, the mental state of the young patients will improve. One of the games dedicated to people with cancer is Re-Mission, in which the participants play characters located in a diseased human body. The game is meant to relax and de-stress patients, to provide them with information about the disease, and finally to enable them to gain a feeling of greater control over their bodies.[20]

One of the most interesting projects using a device detecting the flow of brainwaves is Mindflex. To play the game, the player is equipped with a small electroencephalograph that reads the flow of electricity in his brain, according to which windmills placed on a special board begin to move, which in turn activates a flow of air that lifts a small ball. The game consists in 'carrying' the ball in the right way. There is also a version for two players, where the aim is to push the ball onto the other player's field. Everything is operated solely via brain waves.

A mechanism similar to that used in Mindflex can be found in a therapeutic method called biofeedback. As the name implies, it consists, in very general terms, of providing the patient with feedback on the physical state of a particular area of her body, thus enabling her to consciously regulate these states. Can this type of research and therapy be used to improve the learning and working processes of a healthy human being?

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[20] P. Ślusarski, *Graj na zdrowie*, "Fokus" 2013, No 1/208, pp. 84–86.

THE ADVANTAGES OF APPLYING INTERACTIVE MOTION SENSORS IN THE LEARNING PROCESS

There are numerous theories according to which one can point out two levels of communication in the learning process, one based on verbal, the other on non-verbal content.

> From the point of view of the effectiveness of interactions in the teaching-learning process, the most important is content, but it is non-verbal signals which focus and maintain the attention on it […] The effectiveness of knowledge of the surrounding reality is determined by the attention processes. Psychologists agree that the condition of learning (remembering-coding) any information (knowledge and skills) is to focus and maintain attention on the stimuli which are their carriers.[21]

Maintaining listeners' attention is a major problem faced by educators and teachers. Research presented by R. H. Mills shows that students' interest during a lecture or presentation in which the audience is passive reaches its highest level in the fifth minute, whereas after fifteen minutes the value of attention falls to a very low point.[22] The fact that these studies were carried out in the 1970s suggests that the current degree of attention maintained by a potential audience is even worse. The matter is further complicated by the fact that currently one is bombarded with information and is used to giving it only cursory glances. This is suggested by (among others) Tomasz Goban-Klas and Piotr Sienkiewicz:

> Contemporary societies get not only more information, but also more junk information, and more and more people are unable to adapt well to the rapid changes in the social environment. This aspect drew the attention of Manuel Castells, who created the theory of the divided *informational city*, where, along with the global economy and the saturation of information, disadvantaged groups remain and grow – groups of social and not only informational outcasts.[23]

In a similar vein, the plight of the modern big-city inhabitant is described by G. Simmel:

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[21] *Przekaz pozawerbalny w systemie kształcenia zdalnego*, ed. J. Jędryczkowski, Uniwersytet Zielonogórski, [online], http://www.uz.zgora.pl/~jjedrycz/publikacje/027/Miedzyzdroje%202007_Przekaz%20pozawerbalny.pdf [13.09.2014].

[22] W. H. Mills, *Techniques of technical training*, Macmillan, London 1977.

[23] T. Goban-Klas, P. Sienkiewicz, *Społeczeństwo informacyjne: szanse, zagrożenia, wyzwania*, Kraków 1999, p. 57.

> The psychological background for metropolitan individuality is the intensity of nerve stimulation resulting from the rapid, continuous changes of external and internal sensations. A human is a being keenly aware of differences; his consciousness captures the differences between the present and previous sensations. Repeated experiences, differing slightly from each other, and their subsequent recurrences, to a rhythm known by heart, wear less, if I may say so, on consciousness than the congestion of rapidly changing images, the discontinuity and diversity of sensations all bombarding one's mind at the same time, and unexpected experiences.[24]

The author suggests that these psychological conditions are specific to large cities. Therefore he not only draws the specific profile of a typical inhabitant of a big city, but also correctly reads trends that shape the whole of society. This analysis of contemporaneity suggests that people spend huge amounts of energy on classifying and rejecting mostly useless information.

In the face of these considerations, it seems reasonable to apply educational tools which will follow the current state of knowledge in neurobiology, i.e. on the beneficial effects of physical activity on brain function (recent studies demonstrating that appropriate exercise can help to prevent the development of Alzheimer's disease are also important), and current teaching methods (especially the flexible learning method).

Based on CBOS (Public Opinion Research Centre) data,[25] according to which Poles spend more and more time in virtual reality or using mobile devices, it can be concluded that currently the most attractive way to acquire knowledge and develop skills is with the use of mobile devices. In a report dated June 2014, 65% of respondents confirmed that they used the Internet at least once a week; this percentage has increased since 2010 by three points. Undoubtedly, mobile devices have become an important part of the average person's life. Using them, people accomplish more and more daily tasks. Moreover, their use is related to a variety of amenities and is regarded as a specific form of entertainment.

The ideal solution to didactic problems would be a method that activates different types of human memory, both verbal and non-verbal. It must be characterised by a multifaceted approach enabling the recipient to maintain her attention, but at the same time must be a form of entertainment, education and relaxation. All of these guidelines can be fulfilled thanks to the results of studies on the positive impact physical exercise has on intellectual capabilities.

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[24] G. Simmel, *Mentalność mieszkańców wielkich miast*, [online], http://www.wh.agh.edu.pl/other/materialy/70_2009_10_09_09_10_10_Simmel.pdf [11.10.2014].

[25] CBOS No 82/2014, *Komunikat z badań a. Internauci 2014*, Warszawa 2014.

This method, which will enjoy the advantages of a game, while enabling the achievement of impressive results, can be based chiefly on the use of interactive sensors designed for virtual games in the learning process. This approach is consistent with the assumptions of flexible learning,[26] because in addition to the assigned tasks, which will require certain movements, the user can receive information not only in a explanatory form, but concurrently, through the collaborating and demonstrating methods. The possibilities appear to be almost endless. As well, this kind of knowledge transfer seems to be the most appropriate for the modern student, because it is based on rules characteristic of computer games.

During the task-game performance, both hands can be used. Their coordination will depend on both aural and visual stimuli. Thanks to this, different parts of the brain, located both in the left and in right cerebral hemispheres, will be activated. It is worth noting at this point that 90% of people appear to have a dominant left cerebral hemisphere. The remaining 7.5% have a dominant right cerebral hemisphere, while in 2.5% both hemispheres are equally active. Movement and speech are located in the left cerebral hemisphere, but these functions are separate, and in some people the motor area is situated in the right hemisphere. The left hemisphere is the home of analytical functions (sensitive to sequential analysis), while the right is holistic (dealing better with shapes and spatial relations). The right hemisphere is responsible for the perception of music; the left, for the perception of words. Therefore, the simple difficulty of matching an auditory stimulus to a specific task and motor response will foster the simultaneous stimulation of both cerebral hemispheres, which in turn will result in strengthening the connections between them. Regular exercise will most likely help to increase hippocampal volume, a conclusion suggested by the Water Maze Trap[27] test results.

At the same time, the focus on motor coordination will require the participant to achieve a certain state of concentration, which then can be used to 'smuggle' the content to be memorised. This method is obviously limited by the availability of appropriate game-exercises. Therefore, it is crucial to invest in the implementation of such projects.[28]

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[26] B. Collis, J. Moonen, *Flexible Learning in a Digital World: Experiences and Expectations*, Psychology Press, New York 2001.

[27] E.K. Morris, op. cit.

[28] When exercising with the *Microsoft Kinect* controller, the availibility of free non-commercial version of SDK software will be of great help, because it enables use of the sensor in the Windows 7 environment, without connecting the xbox console.

SUMMARY

A postulated solution to the problem of the low efficiency of traditional teaching methods is to combine these methods with those based on the application of interactive sensors (used for computer games) which require bodily movement. Various centres in the brain will be stimulated thereby. The effectiveness of this approach is confirmed by the results of research on sensory integration, which indicates the need to combine different stimuli in the process of development and learning. As suggested by V. F. Maas, sensory integration is one of the most effective ways to improve our intellectual capacity:

> […] if we want to improve our abilities we take, for example, additional music or gymnastics lessons. The role of sensory integration therapy is the basis of the basic functioning of the sensory systems. Integration improves the functioning of the higher cortical centres through removing blockages disrupting their normal operation. SI does not teach specific abilities, but only makes learning easier.[29]

The exercise-game method demonstrates its vast range of use. An educational game project using interactive game controllers can be implemented at all levels of education, because the method itself requires no restrictions on specific knowledge or skills (the game should be intuitive and user-friendly). Enhancing knowledge with simultaneous physical stimulation will enable the achievement of better results than those attained through the application of explanatory methods only. The results of serious game users seem to confirm that. The dexterity of teenage players may exceed that of practicing surgeons. Research carried out by the medical department of the University of Texas showed that within three tested groups – practicing surgeons, university students and high school students – the best results in performing surgery in a virtual game were achieved by high school students.[30]31 These studies demonstrate that games may have unusual applications and show that they certainly constitute a path leading to the acquisition of important and useful skills.

Undertaking the creation of a new game which will support human cognitive abilities and at the same time serve as an interesting entertainment will raise a point in the current discussion on the need to adapt teaching methods to research results in the fields of neuroscience and cognitive science.

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[29] V. F. Maas, *Uczenie się przez zmysły. Wprowadzenie do teorii integracji sensorycznej*, Warszawa 1998, pp. 40.

[30] *Young Gamers Offer Insight to Teaching New Physicians Robotic Surgery*, The UTMB Newsroom, published 16 December 2012, [online], http://www.utmb.edu/newsroom/article8061.aspx [12.06.2013].

REFERENCES

1. Bomba R., *Gry komputerowe w perspektywie antropologii codzienności*, Wydawnictwo Adam Marszałek, Toruń 2014.
2. Collis B., Moonen J., *Flexible Learning in a Digital World: Experiences and Expectations*, Psychology Press, New York 2001.
3. CBOS No 82/2014, *Komunikat z badań CBOS. Internauci 2014*, Warszawa 2014.
4. Dennison P., *Kinezjologia edukacyjna dla dzieci: podstawowy podręcznik kinezjologii edukacyjnej dla rodziców i nauczycieli*, Międzynarodowy Instytut Neurokinezjologii, Warszawa 2003.
5. Goban-Klas T., Sienkiewicz P., *Społeczeństwo informacyjne: szanse, zagrożenia, wyzwania*, Fundacja Postęp Telekomunikacji, Kraków 1999.
6. Jędryczkowski J., *Przekaz pozawerbalny w systemie kształcenia zdalnego*, Uniwersytet Zielonogórski, [online], http://www.uz.zgora.pl/~jjedrycz/publikacje/027/Miedzyzdroje%202007_Przekaz%20pozawerbalny.pdf [13.09.2014].
7. Konorski J., *Organization of conditioned reflexes*, after M. Kossut, *Synapsy i plastyczność mózgu*, [online], http://fundacjarozwojunauki.pl/res/Tom1/Nauka%20swiatowa%20i%20polska[1].Rozdzial%2009.pdf [13.09.2014].
8. Longstaff A., *Krótkie wykłady. Neurobiologia*, PWN, Warszawa 2002.
9. Maas V. F., *Uczenie się przez zmysły. Wprowadzenie do teorii integracji sensorycznej*, Wydawnictwo Szkolne i Pedagogiczne Spółka Akcyjna, Warszawa 1998.
10. Mills W. H., *Techniques of technical training*, Macmillan, London 1977.
11. Morris E. K., *Comments on Cognitive Science in the Experimental Analysis of Behaviour*, "The Behaviour Analyst" 1982, No 2 (Fall), pp. 109–25, [online], http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2742049/pdf/behavan00071–0005.pdf [12.06.2013].
12. Nawrocka H., *Plastyczność mózgu a konezjologia edukacyjna*, [online], http://nawrocka.com.pl/files/kinezjologia.pdf [15.05.2014].
13. Okoń W., *Wprowadzenie do dydaktyki ogólnej*, PWN, Warszawa 1987.
14. Pascual-Leone A., *Characterizing Brain Cortical Plasticity and Network Dynamics Across the Age-Span in Health and Disease with TMS-EEG and TMS-fMR*, Special Issue: *Brain Imaging across the Lifespan*, Springer 2011, p. 302, [online], http://www.tmslab.org/publications/386.pdf [10.06.2013].
15. Plewka C., Taraszkiewicz M., *Uczymy się uczyć*, Towarzystwo Wiedzy Powszechnej Oddział Regionalny w Szczecinie, Szczecin 2010.
16. Ramachandran V. S., *Touching the phantom*, "Nature" 1995.
17. Rymarczyk K., *Plastyczność mózgu*, [in:] *Neurobiologiczne podstawy integracji sensorycznej – ujęcie interdyscyplinarne*, ed. M. Wiśniewska, Impuls, Kraków 2010.
18. Simmel G., *Mentalność mieszkańców wielkich miast*, [online], http://www.wh.agh.edu.pl/other/materialy/70_2009_10_09_09_10_10_Simmel.pdf [11.10.2014].
19. Susi T., Johannesson M., *Serious Game – An Overview Protocol*, Technical Report HS-IKI-TR-07–001, School of Humanities and Informatics, University of Skövde, Sweden, [online], http://his.diva portal.org/smash/get/diva2:2416/FULLTEXT01.pdf [12.06.2013].
20. Ślusarski P., *Graj na zdrowie*, "Focus" 2013, No 1/208.

21. da Vinci L., *The Notebooks of Leonardo da Vinci*, [online], http://books.google.pl/books?id=a8nMAwAAQBAJ&pg=PT219&dq=The+Notebooks+of+Leonardo+da+Vinci,+Jean+Paul+Richter&hl=pl&sa=X&ei=bg5zVKyBA4PMygOhrILICA&ved=0CCkQ6AEwAQ#v=onepage&q=The%20Notebooks%20of%20Leonardo%20da%20Vinci%2C%20Jean%20Paul%20Richter&f=false [10.06.2013].
22. Załuska M., *Dehydroepiandrosterone (DHEA) in the mechanisms of stress and depression*, "Psychiatria Polska" 2009, Vol. XLIII, No 3.

FILM RESOURCES

23. *Young Gamers Offer Insight to Teaching New Physicians Robotic Surgery*, The UTMB Newsroom, published 16 December 2012, [online], http://www.utmb.edu/newsroom/article8061.aspx [12.06.2013].
24. *Gry poważne*, Wydział Fizyki, Astronomii i Informatyki Stosowanej Uniwersytetu Jagiellońskiego, Europejska Akademia Gier, [online], http://www.fais.uj.edu.pl/wydzial/video-fotoreportaze/-/journal_content/56_INSTANCE_Df4E/41628/9423739 [12.06.2013].