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Problems and perspectives of social interaction in information society

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Abstract

The development of information-based society and extensive introduction of information technologies into the processes of education and socialization pose questions of the possibility of cognitive and social development of a human being in the information environment, as well as under the conditions of interaction with intelligent information technologies. We explore these aspects in the light of the latest research in social cognitive neuroscience and developmental psychology, which underscore the role of social interaction and human precisely in normal cognitive development of children. Apart from the positive aspects, the latest advances of computer-based education and raising children possess in general a number of negative consequences for the development of infants. In this respect we also point out some peculiar behavioral strategies characteristic of autism as the most pertinent in the information society and necessitating no social environment for their development. On the other hand, the progress in contemporary robotics aimed at creating social robots allows for hope that some principles of social communication and social learning will be retained in information society. We regard this progress as a possibility of effective interaction of humans and artificial intelligence agents where the emphasis should be made on the relations "human – social robot" rather than on "human - computer".

Keywords: Social learning, human development, autism, social robotics.

Information society and human adaptive potential.

The phenomenon of information-based society is traditionally viewed as a stage in the socio-cultural evolution, characterized primarily by the development of information technology and introducing them into the sphere of social relations and communication. Positive and negative consequences of such social type for humans and their traditional social relations may be analyzed by applying the evolutionist approach and regarding information society as a stage of social-cultural evolution. As it is shown below, the major negative consequences will be the incompatibility of human adaptation potential with the information environment in which he will be almost totally plunged as early as in the nearest future.

A significant distinction of the society of a new type is a gradual minimization of disparage in the access to information resources. This is propelled by large-scale introduction of new information technologies both into everyday life and into the realms of education and professional activity, which would allow us to easily find any information of interest in the World Wide Web, as well as transmit our information to a large number of people. The prevailing mechanism of cultural transmission under such conditions turns to be exactly diffusion, which constitutes the basis of successful globalization.

At the same time the traditional interpersonal social interaction, be it communication within one's family, social group or learning, is gradually brought to a new means of social communication mediated by new technologies, where the interaction "human – computer" is prioritized. Family is being progressively stripped of its foreground role in the upbringing of children and upholding vertical transmission. The latter is substituted for horizontal transmission, when the children exceedingly communicate with each other and are doing it via Internet.

Early 1990s were characterized by the computer webbing boom, the most extensive of which is the global web – Internet. Internet would be non-existent were there no intelligent programs capable of not only creating huge databases, but also of performing search for information. The peculiarity of a computer web is such that every computer is in theory capable of accessing all the information available on the web. The capabilities of processing information by one single computer by far exceed those of humans, though up to now this good has been utilized for human benefit and with his help. Internet substitutes the means of social interaction and social communication, which are customary for us and which we enter in the global network of information systems. At the same time we imply that this network is only a handy means for us and remains a mere overblown tool of transmitting information and simply of communication.

However, the development of AI is heading towards creating such intellectual systems which are called intellectual agents and appear as self-teaching programs, i.e. they do not rest under control of the designers or programs and, besides, enter into communication with one another. That means that the ultimate aim is the construction of some kind of socially-oriented human intelligence, the only difference being that such agents would be potentially granted access to all the information available on the web. One of the most renowned AI researchers Marvin Minsky has dubbed computer networks "the society of mind" (Minsky, 1986). Ideally, we will have to deal with the society where every single member is a bearer of all the information existent in this society even if we surmise that the abilities to process information remain limited for every agent.

Thus far it is difficult to imagine what the ramifications of the advent of such a society are going to be and whether a human being as a biological and social creature, possessing the intelligence which stands far from the principles of logical "artificial intelligence" and even from the supple and teachable neuron networks, is able to adapt to it. The only thing is clear – nowadays already a human being living in the Western civilization is forced to spend the majority of his time with intellectual machines, at times growing unpredictable even if one knows the basic principles of their functioning. Machine is becoming indispensable in our communication, in receiving information, in education and simply in everyday life.

The successful adaptation of humans to such a broad introduction of computers and intellectual information technologies in practically all the spheres of one's life hinges on the degree of the ability to reproduce the conditions for one's normal cognitive and social development under the new social environment. The development, as shown below, is grounded on complicated adaptation – social learning or on its particular aspect – social pedagogies. Millions of years ago such an adaptation secured the very ability of human social-cultural evolution and throughout human existence as a biological species allowed him to transform oneself into a creature of culture, capable of transmitting cultural information from generation to generation. Novel cultural and social conditions of information society are apparently propitious for such adaptation and for social interaction in general, which endangers the normal development of human being.

Within the short-term outlook we run a risk of confronting with a situation of incompatibility between the new social as well as cultural conditions of globalization and our adaptation potential. Such an incompatibility is expressed in a range of problems primarily topical for human development, i.e. the problems related to the psychological and physical state of juveniles, who are already born into the shaping information-based society, fully accommodating themselves to its social and cultural environment. Later on we will dwell on the possible challenges for normal cognitive and social development of children, arising from the formation of information society and the changes of social interaction, characteristic of this stage of social-cultural evolution as well as examine the peculiarity of education and upbringing, which is determined by intensive computerization of the process of teaching.

To all appearances, if we consider the level of functioning of the existing intelligent information technologies and those already broadly introduced into the education and upbringing, children should be able to progress, at least cognitively and physically, passing over intensive social interaction and personal contacts. It is too early so far to speak about full substitution of social interaction with the interaction "human - computer" because even under the conditions of globalization the role of the family and traditional learning (based on the interaction of a child with a "living teacher") is preserved, though one should foresee the consequences of such a substitution for averting the irreversible threat right now. Let us make an attempt to predict such consequences further on, stressing also the possible alternative of non-social information society.

Social learning and pedagogic adaptation.

Let us get back to the issue of the very possibility of human social-cultural evolution. To suit such a process, mechanisms must have been formed during the biological evolution of a human being which would be accountable for the transmission of cultural information, primarily the mechanisms of social learning. These mechanisms constitute that major essential psychological and cognitive adaptation, which provides for the process of cultural transmission.

Social learning means the learning via exchanging information between the socially interacting individuals, resulting in the situation, when the behavior of an individual or a "model" is mastered by another individual or an "observer". This complicated way of learning comprises at least two cognitive processes: imitation and purposeful copying of behavioral patterns and the so-called local reinforcement when the observer's attention is attracted by a particular outcome of model's behavior and then the behavior is being copied.

The main stumbling block related to social learning processes is their difference from individual learning, when an individual acquires a certain behavior pattern by trial and error. Local reinforcement may be regarded as an extreme form of individual learning, that's why, in the most general sense, during social learning a synthesis of individual experience and social interaction occurs.

If we consider the matter in a strictly formal way, one of the factors of social learning origins and its evolution priority over individual learning is the environmental variability (Boyd & Richerson, 2000). However, if the temporal dimension of environmental fluctuations appears to be about a thousand generations, the social learning, which turns to be expensive adaptation, proves to be devoid of sense and individual learning is capable of securing adaptive behaviour. On the other hand, if this very dimension constitutes dozens or even hundreds of generations, social interaction may turn to be useful for the accumulation of the whole adaptive knowledge of the population.

The main hypothesis proposed by Boyd and Richerson (2000), suggests that social learning has evolved as a non-specific cognitive mechanism with the aid of which the mammals adapted themselves to the climatic deterioration of Pleistocene when the last Ice Age set in 2,5 million years ago. This particular period distinguished itself by the instability of the environment and the surge of new adaptations along with the appearance of new species of mammals.

Social learning has become a general adaptation for many species, including birds and primates, it was accountable for song variety, ways of procuring nourishment, and, finally, for the utilization of tools. Exactly that way of adaptation stipulated for the possibility of cumulative cultural traditions and the very evolution of culture.

Actually, a large number of animals possess cultural behavior, which is reflected in the song variety of birds, the richness of ways to procure nourishment for primates and, finally, the utilizations of tools by chimpanzees. But the privilege of participation in cultural evolution is reserved for human beings exclusively. Boyd and Richerson believe that this is connected to the development of cognitive mechanism, responsible for social learning, i.e. imitation through observation (Boyd & Richerson, 1995). Precisely such complicated forms of imitation intrinsic in human beings are responsible for the possibility to accumulate cultural knowledge from generation to generation and implement it via social learning.

Pedagogic adaptation.

Social learning as a non-specific adaptation is found in animals, though in humans it receives a complex form of cognitive process organization, connected with the peculiarities of functional evolution of the brain. This complex adaptation was given the name of "pedagogic adaptation" (Csibra & Gergely, 2005). Pedagogic adaptation means that humans are adapted to transmit and receive knowledge from humans as representatives of own species via process of learning. Various phenomena of early social learning and social interaction among children confirm the existence of such an adaptation.

It was proven in the last two decades, when the intensive research on early cognitive development and functional evolution of brain has been initiated, that a child actively enters social interaction and communication almost from his birth. Thus, newborns were more inclined to concentrate on geometric figures reminiscent of human faces and the face should be straight, not upside down (Johnson, 1991). Such preference of newborns is correct also for the cases when the faces appear at the background – the children keep paying immediate attention to them and are perusing them for a long time. Besides, the particularity of this reaction, apart from its manifestation on faces directly oriented at the newborn, is prompted by its absence when the contrast is changed (if brighter features against the dark background are exchanged for darker ones against the bright background).

During the second part of the first year of life the newborns also display the reaction, called gaze following. Under laboratory conditions even the newborns have the propensity to look in the direction, where the eyes of the person standing in front of him move (Corkum & Moore, 1998). For older infants such reaction constitutes a part of a more complex pattern of joint attention when following one's glance enables one to draw attention to a particular object (Carpenter et al., 1998; Kaplan & Hafner, 2004). However, for the newborns gaze following appears to be a reflexive reaction without concentration on the object.

Finally, one of the most interesting issues of cognitive research is the imitation of new actions by the newborns. In an already classic experiment of Meltzoff the newborns aged 14 months were shown a rather unnatural action: an adult, sitting at the table leaned forward and touched a box standing on the table with head (Csibra & Gergely, 2005). A week later the newborns were back to the laboratory and the majority of them spontaneously repeated the action shown to them one week earlier. In further research of such imitation it was established that a similar action performed by a mechanism rather than a human being does not entail its reproduction by children. However, the most interesting fact is that when leaning forward the adult pushes a flashing button with his head, the newborns imitate his action only in that case when the hands of the person were lying on the table and easy to see. If hands at the moment the button flushed were hidden kept the back or hidden by a scarf (not seen), the newborns preferred to push the button with their hands rather than bend their head. This means that as early as by the age of one and a half children begin to not merely imitate the actions of the adults but rather distinguish the aims and means of such actions.

Thus, despite a seeming mechanic character of some aspects of social learning of newborns, this process demands a rather rich and stimulating social environment and intensive social interaction with other people. Such stimulating social environment is also needed at the later stages of development. It was proven that newborns aged nine months are capable of mastering new spoken sounds and this ability is related to the existence of a "critical period" in speech development (if a child at this stage does not hear sounds or is brought up by the animals, he will either not be able to talk or will be imitating the sounds of animals). Further mastering of human speech proceeds only in the case when new sounds and words are pronounced by a living adult who is bringing the child up. The most important issue is that the child is not capable of acquiring the sounds of human speech, recorded on the tape or in the form of video (Blakemore et al., 2004).

Thus, various phenomena of social interaction confirm the existence of specific adaptation, allowing a child to be actively engaged in the process of social communication and social learning virtually right from the moment of birth. "Pedagogic adaptation" signifies that the whole broad range of social learning processes in human beings is fully implemented in the case when a human being receives and masters the information from the very moment of birth and then transmits it by engaging oneself into social communication with the representatives of his own biological species. Csibra & Gergely (2005) state that our ability to learn and teach is an independent and phylogenetically earlier adaptation than language and the theory of mind are. The existence of the latter undoubtedly contributes to the existence of social learning but the cognitive mechanisms of earlier and independent origin, formed to secure pedagogic learning exactly, were conducive to both the evolution of the language and the evolution of the theory of mind.

Broad distribution of tools in human communities, as well as rich material culture and artifacts would be non-existent without effectual mechanisms of social learning which allow one to transmission both the immediately observed behavior and the less obvious but significant information. Pedagogic has become an indispensable condition of language development and acquiring linguistic competence in childhood. Most importantly, pedagogic adaptation allowed children to master information and study without direct involvement of the system of remuneration on the basis of explicit manifestation of knowledge and explicit communication.

Functional development of the plastic brain.

Social learning has become possible thanks to the changes of brain evolution programs resulting in a plastic and evolving substance, which acquires module-like structure during the process of its evolution. It is responsible for such cognitive functions as language, theory of mind etc. without which social and cultural life of humans is impossible. Plastic brain actualizes the processes of social learning during its functional development and learning in particular and gives a chance to mould functionally growing brain and shape it according to outer experience. All the types of social learning in humans such as imitation and pedagogic are grounded on the peculiarities of functional development of human brain.

Two theories of functional development of human brain highlight the supple characteristic of human brain and exactly the role of constructive learning (Johnson, 2001) . The first theory is called interactive socialization and it claims that postnatal development of human brain or, at least, of its cortex, constitutes the process of organizing interregional interaction. The very same function in children and adults may be executed by different structures and neuron channels. Thus, for example, learning words initially involves many areas of cortex and afterwards on the accumulation of lexicon of 200 words the activity is gradually localized in temporal area. This is confirmed by the plastic character of cortex when a number areas or parts may cooperate performing particular function.

The second theory, the hypothesis of skills learning, rests upon experimental data received during learning various motor skills in children. As distinct from many mammals, a humans are born unable to perform basic motor acts, for example, grasping an object. Experimental data received during primate learning in complex motor problems shows frequent activation of

prefrontal cortex at early stages of a skill acquisition and afterwards, when the skill becomes automated, the shift of activity occurs to the hind areas of cortex.

Anyway, the connections established between various structures and areas of cortex during the development of the human brain depend on the duration of maturing and critical periods in the development of particular structures and areas, inner specification of cortex and subcortical structures as well as external experience or learning. While important is not the autonomy of various modules' maturing but rather the maturing of functionally interacting parts responsible for particular cognitive functions. Thus, a belated forming of prefrontal cortex within the complex of its ties with all the other structures of brain secures the so-called frontalization of behavior, meaning that the latter becomes more voluntary and controlled (Luna et al., 2001).

The peculiarities of functional maturing of human brain and its hierarchic systems allow us to presume the necessity to activate a range of subcortical systems, proving to be primary in the process of maturing for further functional maturing of later systems. Primary brain centers may be considered to be adaptations specific enough and genetically determined, though liable to the influence from later supple systems. Thus, from the examples of social interaction dealt with above, face recognition in children is connected to the functioning of two systems. The first one, subcortical, is responsible for the preferential orientation of newborns to human faces and images resembling faces . The second one, cortical, is formed during the process of acquiring the experience of recognition. The area of cortex responsible for recognizing faces is also activated when one sees artificial objects geometrically resembling faces. In this case we possess the illustration of earlier maturing of new cortex structures (Johnson, 2001).

The research on brain maturing and development in childhood and juvenile age prove the general indivisibility of cognitive and brain development. The indivisibility is especially vivid in the case of the abovementioned maturing of frontal cortex. Thus, for example, neuroimaging research proves that in the teenage period the volume of gray matter in the frontal cortex decreases, while the volume of white substance, vica versa, increases. These data may be interpreted as a post-pubertal increase of the degree of axon (white substance) myelinogenesis and the corresponding decrease of the density of synapses. At the level of cognitive and social development these changes in frontal cortex maturing may correspond to the changes of functioning of a range of cognitive abilities in the juvenile age, which are mediated exactly by the frontal parts of the brain (prefrontal cortex). This is primarily true for the changes in social communication and social behavior in general (on the average the number of cases of anti-social behavior at this age increases tenfold), but for experimental research one generally uses the measuring of speed and the precision of executive control (Blakemore et al., 2004).

Puberté is also critical for the development of language abilities which is probably connected to certain alterations in brain maturing. According to Lenneberg hypothesis, language mastering occurs till the end of puberté for it is in compliance with lateralization, i.e. the localization of language function in the left hemisphere of the brain. Lenneberg (1967) believes that by the beginning of puberté the process of brain lateralization is finished. Thus, in order for a human being to use the language, one has to appear in the milieu of language speaker prior to this. The examples of people grown wild at early age seem to prompt Lenneberg hypothesis for the attempts to teach such children to speak bore extremely limited results.

The peculiarities of social and cognitive development of children.

One can name exactly the social learning and the functional development of brain as major parameters determining the peculiarities of social and cognitive development of children. Social learning is a primary and necessary adaptation for the development of language as the utmost way of social communication and the theory of reason as a psychological mechanism of social interaction. Normal cognitive development of a child is possible only through the mechanisms of social learning, emotionally enhanced by a system of attachment.

In further examining the major phenomena of early social interaction exhibited by children, let us dwell on the forming of a system of attachment as the earliest way of social-emotional communication. Several minutes after coming into this world the newborns put out the tongue and open the mouth wide imitating mother's behavior. Imitated is also the complex mimics, the expression of joy, sadness, fear and astonishment. Within several weeks the repertoire of the newborn is enriched by the tones of a voice and the gestures of fingers. The newborns consciously concentrate on mother's mimics, on her tones and gestures and their reaction is adequate to the emotional expression of mother. Tender, soothing mother's behavior causes smile, while impatient tone and threatening mimics result in newborn expressing fear and distress. While analyzing the tapes of mother-newborn communication, a rhythmical, reciprocal information exchange resembling of a dialogue was noted. During this process children are imitating the mimics, gestures, sounds, mother's lip and tongue movement, demonstrating thus the prehistoric way of communicating with mother (Trevarthen et al., 1999).

The emotional development of newborns also proceeds in social interaction with the adults surrounding them and taking care of the newborns. Thus, the first smile appears in child soon after the birth as a result of spontaneous activity of the central nervous system. The smile is reflex and often appears when the newborn is asleep. During the second week after the birth the children often smile vaguely after meal. At the age of one month smiling becomes more frequent and appears as an answer to the "social" signs exhibited by the human being who cares for the newborn most of all. By the end of the second month babies smile at all the familiar people but most of all at those who take care of them. By the seventh month babies often laugh when the situation turns out unexpectedly. Laughing at the unexpected, the baby demonstrates that he knows what were to be expected which indicates progress in his development. Laughter in such cases not only enhances the "parent-baby" tie, but also provides the parent with the information on the growing competence of the baby.

According to evolutionary psychologists, the system of mother and baby attachment, comprising the whole abovementioned complex of social interaction, which allows a baby to stay by the mother for quite a long time and be protected, is a complex adaptation originating exactly to resolve the problems of the helplessness of babies in the face of predators (Bowlby, 1967). The system of attachment is most likely characterized by the critical period, during which the mother and the baby are to be close in order to establish a standing attachment or tie between them.

The outcome of early social interaction and the development of joint attention is the forming of the theory of mind. But the abilities which the psychologists ascribe to the theory of mind are quite multifarious and the researchers still cannot provide a definitive answer concerning all the

patterns of their development, though it is obvious right now that acquiring the skills of the theory of mind by children is closely connected to social interpersonal communication both within the family and with the unfamiliar people, as well as related to the language abilities (Hughes & Leekam, 1994).

The term "theory of mind" itself is ascribed to the ability of human beings to ascribe to themselves and to other people some mental states, including perception, emotions, cognition and intentions. The precursors of such an ability are joint attention as well as imitation, social reference, gestures and communicative vocalization, demonstrated by babies at very early age. However, according to the established psychological concept of Flavell (1999), the theory of mind is finally developed in a child only by the age of four. The absence of such in younger children is determined by a flowed opinion task. For example, a child is given a box with colored chalk where he finds candles instead of pieces of chalk. When an experimenter asks the child what another child expects to find in the same box, a child over four answers "chalk" while a smaller child – "candles". On the basis of these results one presupposes that by the children aged younger than four the theory of mind concept is not fully developed.

At the age of about one children are setting up a system of relations between themselves, other people and the objects of external world. Later on joint attention allows them to note the tie between a human being and that he pays attention to. They do not only understand that the given person is looking somewhere or at something, they have an idea about the fact that the person sees something while looking at something. Children between two and three start distinguishing three mental states: perception (another person looking at something can see what the child does not see), wishes (if anyone wants to get something he will aspire to receive this), emotions (children are able to clearly distinguish between positive and negative emotions). By the age of four a mental concept of mind develops in children, they realize that mind contains the representations or models of environment and the people in their actions rest on these models exactly rather than on the world itself.

According to Flavell, there exist a number of central issues, which preschoolers know about thinking. Thinking for them is the activity, inherent in a human being or another living being and this activity is internal or mental. The child is also capable of distinguishing thinking from other ways of psychological activity, such as perception and speech. Besides, if another child sees some behavioral evidence or situational necessity of the process of thinking, the child ascribes one exactly the ability to think by speaking of what a person thinks.

What role does social interaction play in cognitive development? According to psychologist E. Spelke (2000), though there is no doubt that the interaction with external environment is necessary for the development of full value conceptions, it is also clear that the core, the basis of cognitive development, is laid in human genome. The "bricks", constituting a system of concepts, are called conceptual primitives. However, even taking into consideration the existence of the innate basis for cognitive development, the very process of development, according to L.C. Vygotsky, passes under the conditions of social interaction. The forming of concepts is possible only through active action with objects, which is mediated by adults, i.e. is socially determined. Primary is exactly the social interaction, and it social development which entails cognitive development. Vygotsky, acknowledging the role of inborn biological programs of development

roughly by the age of three, afterwards shifted the stress to social and cultural factors – communication and education.

But the most socially and culturally determined process of development is the development of language and language abilities. Psychologists single out several major periods in the development of language, during which a child is to exist in an adequate social environment. Decisive are the initial twelve years of child's life – roughly till the beginning of puberty, out of which the most important period is from one year to four years. In general, referring to experimental data, one can single out decisive periods for each language component. Thus, decisive period for phonology (uttering and understanding sounds, of which words are combined) is the time from six months to one year. Decisive (sensitive) syntax period (rules of the agreement of words) embraces the fourth year of life, while mastering semantics (the meaning of words) occurs at the age of fifteen and sixteen (Palmer &Palmer, 2001).

Belated social development of a child lies in the development of social roles skills, realizing the motivation and the outcomes of other people's behavior, as well as in the development of social cognition, which leads to the understanding of human social relations. Important factor of social development is the interaction of a child with his or her parents, relatives or other social environment. Exactly the intensive social interaction secures socialization, i.e. the introduction of a child into society as a result of acquisition and active reproduction of social experience.

In the process of their development children sponge practically everything that social environment can present them with: language, values, attitudes and social patterns, impression of themselves. If the children are being loved and lavished adult care upon, they begin to love themselves, feeling self-respect. They also often borrow the judgments of one's family about other people, are able to imitate the family talk and action with regard to others. All these processes, which are a part of socialization, presuppose grounding on early mechanisms of social interaction.

Critical for social interaction as a whole and social behavior in particular is teenage age when a kind of mental shift occurs touching upon social cognition, socialization and its character. However, our knowledge on the specifics of the change in all the aspects of social interaction is so far meagre because of the dearth of experimental data. It is possible that in the nearest future we will be aware not only of the change in the executive control at this stage of development, but also of the specifics of the change in social-cognitive processes primarily such as self-consciousness, awareness of other people and interpretation of complex emotions (Blakemore et al., 2004).

The major problem of the current stage of social-cultural evolution consists of the existence of huge amount of cultural information, which one has to master, reproduce and transmit to new generations, but at the same time at the subsiding role of exactly human social interaction and social learning and the ever increasing role of the means of transmitting and processing information, excluding the direct contact between human beings. The problem roots in the broad diffusion of new media and intellectual information technologies, the influence of which on cognitive and social development of both children and teenagers is important to explore and assess at present. Further on we will dwell on the results of such research and discuss core

positive and negative outcomes of the computerization of education and the facilities of children access to new technologies already at early stages of development.

Problems of cognitive and social development in information society

Computerization of school education.

In the modern western society a child starts to actively exploit computer as early as at the age of two, spending by the computer about half an hour a day. Following the 2000 U.S. Census, about 58% of children ages 3-5 live in a household with a computer present (USDC, 2001). It is significant that right from the beginning of computer use the child starts demonstrating certain preferences and tastes in choosing programs and games. No doubt that such early introduction of computer technology can have global consequences for the development of a child considering that by the age of 12 a child in western culture has to master basic skills of social communication and social interaction, while throughout the period of maturing the most important means of socialization and cognitive development appear to be exactly computer and global computer network with its standards of social interaction. The awareness of these issues as well as the growing computer access among children leaded to the calls for quantitative research in the area of technology for preschoolers by the Department of Education (Fischer & Gillespie, 2003).

Let us consider firstly what constitutes the foundation and the motivation of the process of computerization of education and upbringing children.

One of the most renowned proponents of introducing computers into the process of learning and upbringing children as well as the creator of the computer language for children LOGO is the mathematician Seymour Papert. He claimed that computers form a creative impulse in children and promote the realization of how they think and learn (Papert, 1980). Positively assessing the potential of computers in the cognitive development of children, Papert upholds the intensive computerization of schools and broad use of computers by children at home. Computers are to be integrated into common classrooms and the pedagogical process itself should be oriented at fulfilling all the tasks with the help of computer.

Papert believes that against the background of intensive social changes connected to the introduction of information technologies, we are to expect the similarly intensive evolution of schools and the very pedagogical process aimed at preparing children and teenagers to the new life under new social and communicative conditions. But in reality we observe the growing abyss between the school and the society of a new type which leads to the dissatisfaction of the children themselves and to a larger extent that of adults by the pedagogical process and the quality of school education. On the other hand, such an abyss borders on with virtually uncontrolled spreading of computers and the all expanding access to it by newborns. Children use computers practically everywhere: in their rooms, at special centers, at libraries, at computer clubs. While not all the children can effectively use computers with benefit for their education, at the same time some people in their knowledge of computers excel even their teachers.

The ability of children to use computer or the manifestation of “child power”, as coined by Papert (Papert, 1980), can be that very power which finally makes the system of education reform

and take another look at pedagogic. The new system of education inevitably collapses if only not disregard the inevitability of introducing new information technologies and methods of teaching. But what should such an introduction be like and what can present an alternative to the old pedagogic?

Papert suggested that the reform should start with teaching mathematics at school (Papert, 1996). Traditional school mathematics is resolving the tasks and drafting graphs of functions on paper. Alternative school mathematics must be founded on creating, modifying and control over dynamic objects simulated by computer. Thus, for example, a common parabola may be presented to a child in a computer game as leap of an animal or the flight of a missile, in the child language of programming parabola may be expressed as the way of a body with constant horizontal speed and vertical acceleration. For children having to do with computers, such a presentation of parabola may be more concrete than quadratic equation on paper or in a book. Dynamic definition as illustrated by psychological experiments is absolutely available even to elementary schoolchildren, provided their sufficient computer literacy.

On the whole, Papert stands for practically full computerization of learning process and for the elimination of traditional instruction when all the information comes from the teacher and the children often remain only its passive receivers. Acquiring freedom by children during their own teaching may render them much more intellectual and fully develop creativity in them. Computers and Internet may give children such freedom which will promote their intellectual development. However, so far we possess only extremely meager data of psychological research on discovering the influence of computerization on the advancement or enhancing the intellectual abilities of schoolchildren.

In a series of early experiments the application of computers in the process of learning contributed to the improvement of reading, writing and basic mathematics skills (Melmed, 1995). Later research yielded controversial results: special programs aimed at children and teenagers worked out to enhance their abilities to resolve problems had in some cases positive effect while in other – negative one. According to rather extensive psychological research conducted in the USA in 1998, the teenagers using computer at school more often than others, score worse in IQ testing as compared to the latter (Wenglinsky, 1998).

2001 saw drawing a kind of theoretical bottom line of all the research, connected to the influence of computers on the process of learning and upbringing. The use of computers at schools may seldom lead to some considerable results because of relative rarity in their use within the boundaries of school curriculum. Today computers are still used only as subsidiary means in the process of learning to support the traditional way of presenting material. The reason is not that the teachers are afraid of computerization of the process of learning or are totally computer illiterate, rather the use of computers entails a number of practical problems. The most trite of them are the breakage of the equipment, application hanging and the impossibility of Internet access speed control. As a result even in the developed countries computers are utilized only in cases of necessity within the limits of curricula when they are indispensable. Total computerization of the whole process of learning is so far out of question (Cuban, 1997).

However, the impact of new technologies on children during their stay out of school is rather significant. According to the results of 1993 survey about half of the families in developed countries bought computers exactly to provide better education to their children while the majority of children shunned purely educational and developing programs and preferred computer games instead (Giacquinta et al., 1995). Only 20% of children, says the survey, used new technologies to develop mathematical skills, rational reasoning and critical thinking but even these children used the corresponding programs from time to time only, giving them little free time. Significant result of this as well as of later research was the fact that children use home computers for any purpose except for education.

However, the apologists of the computerization of school education underscore the irreversibility of wide-scale introduction of computers into school education. By as early as 2010 new Internet-technologies will become powerful means of visualizing any learning material. The history of art will be learned via virtual museums, geology – via virtual caves, and biology – via virtual DNA structure. Virtuality exactly (which is to be dealt with separately) will become the means of education with the prospects which are so far difficult even to imagine. The same thing presents a clear peril for the psyche of children.

So far amid the developed countries entering the information era the USA appear to lead the computerization of education. To effectively utilize information technologies in the education of children and teenagers, the US Department of Education defined 5 general aims as early as in 1999. They are:

1. All the pupils (students) and teachers (tutors) are to be granted full access to information education technologies both in class, at school and at home.
2. All the teachers should effectively utilize information technologies in order to raise the educational level of students.
3. All the students are to be able to use information technologies.
4. Further scientific research and testing should be aimed at improving the next generation of information technologies used in education.
5. The utilization of information technologies should change the very essence of teaching and learning.

Interaction with computer and social interaction.

Interactivity is a natural component of interpersonal social communication. It is also intrinsic in new information technologies and allows one to actively utilize the latter in the process of teaching. However, as the research shows, children are capable of interacting with earlier media technologies, such as cinema, radio and television. Starting from six months, newborns actively perceive the contents of TV programs, from 18 on they sign along with the songs they hear, point at familiar animals and react at dialogues. Such reciprocation is a necessary component of many educational and developing programs when the presenters and participants ask questions and make the necessary pauses allowing a child to think and word his or her answer (Wartella & Jennings, 2000).

However, television and radio are of limited interactivity. Irrespective of the fact which programs (educational or non-educational) a child prefers, he or she is only perceives information

and reacts to it remaining passive in his or her interaction with television or radio. Computer programs, on the other hand, are being programmed taking into account the answer of the user which enables the latter to be active in his interaction with computer. Even early research with first personal computers has shown that utilizing computer causes more active, positive and emotionally varied facial expression, accompanied by a more intense vocalization than in the case of watching TV programs (Hyson, 1985).

Modern computer technologies not merely allow a child to interact with programs but also render interactivity an indispensable condition for utilizing the program. Moreover, children prefer interactive games exactly where animation, advanced user interface and user-control are used. High degree of program interactivity leads to the better results of mastering information and to the development of metacognitive abilities. Thus, for example, a specially developed programming language for children LOGO contributes to improving the abilities to resolve problems and also the ability to monitor decisions.

Computer interactivity may contribute to establishing closer social interaction both within the family circle and amid coevals, claims Papert in his book "The Connected Family" (1996). Firstly, the passion for computer games and the created by them virtual reality contributes to enhancing social interaction between children, establishing cooperation and friendly relations. Children more frequently approach their peers than parents and adults on the whole for advice with regard to computers. Computer literacy boosts the self-appraisal of children and grants them a certain social status amid relatives and friends, especially when they show poor progress at school and are doing badly at physical training. Secondly, common passion for computers shared by all the members of a family may not only promote closer relations within it, but also become a necessary stage in computerizing the learning of children.

However, on the other side, computer games and browsing World Wide Web occur in social solitude and social communication is shifted towards e-messages and communication in chats with no direct contact between the communicants. Psychologists express their mounting concern over this prevailing way of communication. An alternative way of communication is the "culture of family teaching" when adults and primarily parents further and enhance computer teaching, studying the basics of it together with children. As underscored by Papert (1996), at the current stage of introducing information technologies, it is important not to form the generation gap which grounds on the distrust of adults and their negative stance to computers, the inability to use them and the resulting unwillingness to take part in teaching their children.

In 1995 Papert and his colleague I.Harrel created a web site for children MaMaMedia.com aimed at stimulating direct interaction between a child and computer via World Wide Web. Such site gave the opportunity to directly and constructively teach those children who have computers with Internet access at home. Primarily and basic idea of the creators of MaMaMedia site was teaching the skills of using computer itself as well as new media technologies, the skills of searching information in the world web and Internet security. Via games and several educational programs the imagination and creativity of children is being stimulated. Besides, children while visiting the site may speak up and exchange opinions on some world events either cultural or political.

Since mid-90s in the USA a concerted creation of special information resources for children and teenagers began, which was dubbed as "child media culture" (Montgomery, 2000). Many non-commercial organizations, museums, educational establishments take part in developing the content of such sites enabling children not only to experience the world and communicate with peers from all over the globe but also create their own literary works and works of art. Educational projects allowing conducting on-line forums for children, conferences for teachers to exchange ideas and strategies of teaching are worked out under the aegis of the International Network of Education and Research, uniting schools in more than 30 countries as well as under the aegis of UNICEF. Along with this the content of TV programs for children and computer educational programs is being improved.

Internet sites for children, both commercial and non-commercial, often contain downloadable pictures, interactive games which make them resemble developmental programs containing many puzzles, pictures, games and tasks. The exclusive advantage of the Internet in this case is the possibility of children communication with each other via e-mail or in a chat.

One of the relatively early psychological research efforts was aimed at determining whether the use of computers leads to limiting their participation in social interaction (Giacquinta et al., 1995). Similar research done with the sample of adults showed that using computer correlates with significantly increasing cultural activity connected with receiving varied information, participation in social and cultural interaction and using other mass media technologies. As for the children, the results were opposite. Thus, it was proven that children having computer at home spend practically all the time alone without the support of the adults while exactly the aid of adults is necessary for the educational effect of computer and educational programs to take place. The absence of adults results in children preferring to play computer games allotting for education only a minor share of their computer time. As intended, the time spent by computer often substitutes the time otherwise given to reading, communicating with family members and active games with peers and sports. However, the substitution effect truly takes place only if computer time exceeds 8 hours a week. Besides, exactly 8 hours a week, no more, contribute to high results in tests on cognitive abilities and self-assessment.

Using computers by children in solitude with no parent supervision whatsoever leads to the substitution of real social interaction and communication by virtual communication in the Internet. Both computer games and the Internet may possess a significant social effect. Research show that moderate gaming at first even raises the level of social interaction between children, they meet friends out of school more often. New computer games, in particular those where the whole family may take part enhance communication between family members. However, on the other hand, virtually nothing is known about the prolonged effects of liberal use of computers with 7 to 9 percent of children in developed countries, which are statistically play computer games over 30 hours a week. So far we observe reinforced aggressiveness and insensibility to violence found in these children (Benoit, 1997).

Research shows that using the Internet as a means of social communication is especially popular with teenagers. Teenagers are more prone to establishing contact on-line but the social effect of such communication may hinge on who the communicant is – a family member and a friend or a stranger. According to the research conducted within the framework of HomeNet,

frequent use of the Internet within the first year of Internet access results in a slight, but statistically marked decline in social communication, measured in the intensity of communication with family members, the breadth of social contacts and the feeling of solitude (Kraut et al., 1996). The majority of the participants of the project, however, used on-line contacts to sustain communication with the closest "real" friends and family members. Using computer to dispatch and receive e-mails in such cases was sustained by telephone calls and personal communication, i.e. the Internet only supplemented the traditional means of communication but not substituted them. At the same time the Internet enables people to establish new on-line contacts with strangers via the immediate mediation of chats, forums and groups of news. As numerous survey show, the sphere of on-line communication rarely intersects with real communication remaining exclusively virtual and not resulting in interpersonal communication (Kraut et al., 1999). One can conclude that teenagers spending much time on-line shortly after they get Internet access may feel acute solitude and be depressed because they devote their time to chatting with strangers thus substituting real contacts with the socially close people able to provide support for on-line contacts.

However, as noted in HomeNet research, further and prolonged use of the Internet no more leads to the decline in social interaction. It is supposed that teenagers gradually lose the initial interest to on-line communication reserving for it the right to be a mediator in the communication with the close and dear people. On the other hand, the Internet itself is changing. While in the late 1990s the most popular sites with the teenagers were chats exactly, in the early 2000s century other programs rose to popularity. Such programs, Instant Messenger and ICQ, enable teenagers to communicate in the real time. As opposed to chats, the latter permit the teenagers to identify their circle of communication and are most frequently used to communicate with exactly the familiar people.

Virtuality: prospects and problems.

Simulated worlds created in computer games and Internet increasingly skew the development and social experience of a child exactly into the sphere of virtuality. According to one of the definitions, virtual reality (VR) is a combination of computer and interface (glasses, gloves, etc.) which creates an illusion of living in an artificial three-dimensional world of computer-generated objects. Several kinds of virtual reality are distinguished: desktop VR, immersed VR, and projected VR (Krueger, 1983). The majority of users nowadays have access to desktop VR programs, which enable to navigate in the three-dimensional world, but rarely provide true-life perception of artificial reality. Such programs include mainly three-dimensional computer games popular with the majority of today's children and teenagers.

Illusory sensation of artificial reality requires special means of immersion into VR (stereoscopes, the technologies of view regulation, etc.) and means of navigation or presence in the artificial world (e.g. city simulator and the possibility to explore it). Means of immersion are indispensable for they enable us to adjust our feelings and sensations to what is happening in the virtual world. This very adjustment creates VR sensation. The technology allows us to process afferent and efferent signals in accordance with the virtual environment, and eventually create a

complete apprehension of VR and the illusion of our being in it. Such an illusion is created with the help of a computer and software.

The complete system that creates VR includes video display, audio tools, means of haptic response, means of interactive input which enable the user to enter information into the virtual world (from keyboard to the tools of speech recognition), and finally computer work stations. The latter are specially purposed to provide coordination, manipulation and representation of the above mentioned tools and components. Application software allows to create a representation of graphic, audio, and haptic data that immerses the user into the virtual dimension.

VR, like Internet, opens new potentialities for social communication: in VR you can easily simulate communication with people, games, museum or theatre visits, and a lot more things in which people can physically take part, and not only be mere observers as in case of cinema, radio and television. In the near future immersed VR is going to become as inevitable as television in the second half of the XX century. At that, this new way to escape the reality if compared with television is ten times as powerful in its influence on the human mind.

With the help of games children interact with sham characters; Internet provides interaction with strangers and computer programs simulating on-line interlocutors. All this gives them the world which they can fail to differentiate from the real one. It was not until very recently that scientific investigations were conducted to reveal the specific character of children's apprehension of artificial virtual worlds.

Turkle (1997) discovered that some children playing computer games can hardly understand the boundaries and difference between the real and artificial life. But apart from conventional computer games, increasingly popular become interactive toys which clearly demonstrate a new level of integration of computer simulation into the social world of a child. Such electronic animals attract children's attention by various icons and symbols on the screen. According to a survey children are prone to regard their electronic pets as real.

Widespread in the Internet RPG also further integration of simulated life into the real one. In many of them computer generated characters interact with people-managed characters and this leads to a more realistic perception of the former. Such role-play games stir the process that can be called as "virtualization of personality", when people either merely idealize their personality or assume various unreal roles, e.g. the role of an animal or even an insect, and develop their virtual dialogues and legends.

On the one hand, RPG seems to be quite harmless and like theater ensuring better socialization of a child. On the other, as distinct from theatre, in a virtual game it is impossible to find out who you are playing with: a real person or a fictitious virtual character. The difference between the reality and virtuality is effaced and this leads to the transfer of the principles drawn from the role-play game, aggression being the most frequent due to the specific character of virtual games, into the real life and real social interaction. Statistical observations of the recent years show that already 8 and 9 year-old children play RPG in the Internet and we can only guess what consequences such games will entail for their social life, real social interaction and communication (Turkle, 1997).

However, the gravest consequence of the widespread adoption of multimedia technology is virtual or Internet dependence. For some people computers, Internet, and computer games are well-integrated in their lives without any threat to their mental health. And for others, computer using has become so prolonged that computer begins to substitute their job, friends and even family. Playing computer games, surfing the Internet and chatting for 10 or more hours daily indicates strong computer or Internet addiction (Greenfield, 1999). Basic symptoms of computer addiction for children are as follows:

- considerable leisure-time spended at the computer,
- falling asleep in class,
- poor school results,
- tendency to prefer computer games to conventional games with other children,
- heightened irritability failing Internet access,
- frequent lies to the questions about the time spent at the computer or in the Internet.

Computer addiction is accompanied by physical symptoms: insomnia, headache and back pain, eye dryness, and sometimes non-observance of personal hygiene.

VR and Internet cause addiction and dependence (the new classification of diseases will presumably be enriched with the term "Internet addiction disorders"). Psychological tests reveal that VR and Internet are powerful psychoactive agents capable of affecting people's mood and behavior patterns. About one third of Internet users prefer getting on-line as a means to improve their mood or to relieve the stress, and this indicates that they use Internet as a drug. It is not entirely clear yet what behavioral consequences are caused by over-keenness on the Internet and virtuality but already tentative questioning has shown aggravation of social isolation and even depression (Kraut et al., 1999).

In the context of this problem child virtual addiction arouses special apprehension. The latest psychological researches dedicated to the problems of computer and virtual addiction particularly dwell on its after-effects on the social and psychic development of children, however, these investigations do not provide definite unambiguous answers as well as they fail to suggest a treatment for this new kind of addiction. From one psychiatrist's experience to decrease Internet addiction in a child s/he first had to habituate the child to telephone conversation, and only then proceed to psychotherapy.

Prolonged chatting on-line and continuous clicking entails dissociating state at times converting to hypnotic trance. The child merely drowns in the ocean of information for hours unable to turn away from the screen. While some years ago it was usual to watch television in the family circle nowadays connecting to Internet is frequently not supervised by the parents.

Children's Internet addiction may have a crucial negative impact on the physiological cerebral development. As well as in the case of drug addiction the dominant role is played by the system of dopaminergic reward. This system includes dopaminergic midbrain neurons sending projections to the different areas of cerebral cortex. But if in the case of drugs human behaviour is regulated on the principle of positive reinforcement, in the case of Internet or gambling the role of the chief regulator belongs to the so called situational reinforcement. Activation of positive reinforcement centers produces the feeling of pleasure and satisfaction. All drugs that possess the

potential for addiction directly or indirectly stimulate these dopamine chains and brain reinforcement centers, thus being positive reinforces. Therefore, consuming drugs at the initial stage people strive to find the feeling of pleasure. Entering Internet not necessarily gives pleasure, for the majority it is just a means to change their sensations and feel a new reality; in this case they have their situational reinforcement centers activated, which are stimulated not by the reward itself or positive incentive but rather by anxious expectation of it. Therefore Internet-addicted people prefer fast connection, waiting for yet another incentive should be as short as possible and the change should be very rapid. The central problem of the functional development and maturation of child's cerebrum which continues even in adolescence roots in the possible negative impact of the system of reward that is subject to the virtual reality on the functioning of psychological processes that are vitally important for social interaction. Cerebral dopaminergic system is projected into the dorsolateral prefrontal, premotor, parietal, and orbitofrontal cortex, i.e. into the cortex areas responsible for the representation of goals, relative evaluation and expectation of reward. These very cortex areas are involved into the social cognition and the theory of mind, representation of "I" and executive control, i.e. those cognitive functions which make an individual a personality and a participant of social interaction.

Problems of children's cognitive and social development.

Papert's opponents lately increasingly assert the potential hazard of computers to children, from eyesight deterioration and spinal curvature to one-sided defective development and learning. "A child with one-sided development will have one-sided brain", briefly reads the perspective of an early "man-computer" interaction (Attewell et al., 2003). In 2000 having realized this hazard Alliance for Childhood had to declare a moratorium on children's computer usage. Alliance for Childhood among other grounds for their measure claimed that children were not ready for computer-assisted learning, maintaining that they learn with the help of tangible objects, playing and interacting in the real world. Children must spend sufficient time outdoors, in the social interaction with teachers and other children. Computers may change the course of normal learning and upbringing of a child, producing as a result a grown-up with one-sided development and one-sided thinking (Alliance for Childhood, 2000).

Hazards to children's physical health include eyesight deterioration, obesity and many other consequences of sedentary life. Constant discomfort postures while working on the computer or lap-top in the period of active growth and development of bones, muscles and nerves results in numerous skeletal and muscle abnormalities (American Academy of Pediatrics, 2000). Spending from one to three hours daily at the computer is fraught not only with short-term neck, back and shoulder ache but also with more serious far-reaching abnormalities (Oates et al., 1998).

The research into the problems of cognitive and social development primarily concentrate on the change of the mode of social interaction. Playing computer games and surfing the World Wide Web mostly happen in social solitude and social communication is shifted towards contact-free electronic mailing and chatting. This increasingly prevailing mode of communication arouses the most critical anxiety about the social and cognitive development of children. Psychologists reckon that computers may have a beneficial impact on the children's emotions and personality formation, but there is evidence that computers cause serious attention disorders (Healy, 1998).

Indeed, modern "branched" programs and hypertext Internet are conducive to the loss of concentration.

Psychologists assert that interactive character of computers cannot substitute the full spectrum of social interaction and especially its emotional component (Miller, 2000). Children who grew communicating with a computer rather than with their families and peers are more disposed to violence and extremism; they feel less empathy and evade social interaction. Exclusion from normal social life results in the above mentioned "isolated life" or social solitude. Surveys of the late 90's show that parents began to spend in average by 40% less time with their children than 30 years ago (Subrahmanyam et al., 2000). On the whole, computer using at home and in school decreases the number of real-life interpersonal contacts with parents as well as teachers and peers.

Even the necessity to establish a more intensive interaction between teacher and student in the course of computer-assisted learning, as it was declared by the proponents of computerized education, in practice results in their being focused not on each other but on the computer screen. Social interaction is superseded by interaction with computer devoid of emotional content and social support. As we have pointed out in the previous paragraph the essence of pedagogics consists exactly in close social interaction between grown-ups and children. Only a human being is able to realize the whole spectrum of cognitive and emotional processes needed to educate another human being. The corruption of normal social and emotional development of a child is fraught with social isolation and evasion of real social contacts.

Apart from the problems of social development children face the danger of intellectual development, which would otherwise seem to be facilitated by computer. The first problem that can arise is the weakening of imagination and creativity while the proponents of computerized education strive exactly for the opposite. In fact, intensive development of media technologies accompanied by high-quality animation and virtuality that enables a child to move from one imaginary world to another often leaves no place for the child's own imagination. At the level of modern developing programs even child's creative abilities are beforehand programmed. Psychologist J.M. Healy points out that creativity which can be defined as the ability to generate individual and original mental imagery becomes more and more rare among children who play computer games (Healy, 1998). The use of special programs with animation in order to study, for example, biology may result in the loss of interest and natural curiosity: children passively perceive simulated objects being not aware how far they can be from the reality.

The development of speech abilities and literacy is yet another aspect of children's cognitive and social development where computer using may cause abnormalities. As it was mentioned above the acquisition of speech abilities depends on the social interaction with people who have a better command of the language. The decrease in real interpersonal contacts may result in arrested linguistic development, for computer addicted children are constrained in self-expression in their speech and writing which in its turn leads to the inability to understand what is written and even arrested development of analytical and logical thinking.

Interactive programs worked out to monitor students' behavior and to correct their mistakes are not able so far to reproduce the whole spectrum of conventional social interaction between

teacher and student. Such a deficit first of all negatively affects literacy and the development of endophasia that guarantees successful meta-cognitive abilities, i.e. children's abilities to control and monitor their own actions.

On the whole, computerized education is fraught with turning a child into a biological computer whose agenda may be set by the "hard" computer. Children become excessively dependent on computer information and in fact do not engage in real active social interaction. Computer games and Internet beget virtual addiction which is almost impossible to fight with in the epoch of global proliferation and further perfection of media technologies that stimulate increasingly realistic and sensed virtual reality.

At the present stage of computerization of education and introduction of media technologies the overall situation is still controllable. However, taking in account numerous potential confounding factors and the wide developmental stages of children being affected, it seems almost impossible to make a broad- based general argument for or against computer use at school and home (McCarrick & Xiaoming, 2007). Both parents, teachers, and policy-makers are still awaiting studies with vigorous research methodology in well- defined learning environments to examine the gains/losses across multiple developmental domains that might provide informative data for adequate policy and control of computerization.

Prospects of information-oriented society: autism or social robots?

Generation-N and autism.

Presently to denote the young generation that lives in close interaction with computer, Internet, and media technologies specialists use Don Tapscott's (1998) term «Generation-N» (net generation). Being prone to idealize the new generation Tapscott described it as tolerant, self-cofident and open emotionally as well as intellectually. This generation in his words is able to combine humanism with social and technical progress. But it becomes clear today that such idealization is unrealistic. We shall try to examine computerization from the viewpoint of those who criticize computerized education for the isolated character of social development of computer addicted children.

If we assume that children nowadays begin to actively use computer as early as in their infancy, simultaneously interacting with computer and society and at times even giving priority to the former, then we shall have to infer that this practice can be fraught with reducing social interaction to the lowest possible notch. The problems of split attention, of the formation of the theory of mind and of other cognitive and social abilities may ensue exactly from this limited social interaction and minimal social learning. Even children without any congenital pathologies but living with minimal social contacts often suffer from a number of social, communicative and cognitive abnormalities. On the whole, social isolation may beget a generation with mental disorders, e.g. such as autism.

Autism as an abnormality of development is characterized by a number of symptoms and behavioral deviations that altogether can be defined as "social exclusion". While schizophrenia separates an individual from real environment, those who suffer from autism never enter this

world at all. In DSM-IV autism is diagnosed by the instrument AD-R by three main criteria: the quality of reciprocal social interaction, namely speech and communicative abilities, limited and stereotypical interests and behavior. Autism can be clearly diagnosed from the age of 3. However, owing to DSM-IV some individuals can be diagnosed based on the abnormal social interaction as early as from their birth, diagnostic instruments being available for the children of one and a half years old. Having studied medical evidence we can make an overall conclusion that there is a close relation between the etiology of autism and the development of social and communicative skills. Autism can be diagnosed from the age when intensive socialization begins and when behavioral deviations become clearly apparent.

Autism's "social exclusion" at the behavioral level, its early onset, neurobiological and cerebral roots and genetic nature allow us to regard the problem of autism in the context of evolution. The principal question we have to answer is whether this disease is merely pathology or we are dealing with a mechanism of adaptation that reveals in the form of behavioral strategy of social exclusion accompanied by the changes in the cognitive sphere at the level, which is essential, of cerebral organization.

As we have already pointed out, the tendencies of development of the modern information-oriented society are conducive to the substitution of interpersonal social interaction by the interaction "individual-computer" which has its own rules and principles of data processing. And tendencies of cultural evolution lead to the perfection of artificial intelligence or "pure intellect" that is free from any human limitation originating in the social life, i.e. emotions, decision-making mechanisms based on altruism and human factor. The future human society is that of coexisting people and human-created intelligent machines.

Then we have to find out what behavioral and cognitive strategies will be the most congruent in this already a social environment. The answer is obvious: those are strategies that do not rest on the socially oriented intelligence and that do not require socialization for their elaboration. To adapt in the information-oriented society one needs a concrete-oriented, efficient mind that is able to process a great amount of information and to live in social isolation cooperating in the mode "individual-artificial intellect". It is autism then and more exactly its high-function types, first of all Asperger's syndrome that to all appearance is the said adaptive mechanism which will come essential in the age of information-oriented society.

One of the major challenges of such an approach to autism is how to form the intellect under the conditions of abnormal system of social interaction, social cognition and social behavior. The study of an early detected autism and its development show that the series of derangements starts from the most primitive forms of social adaptive behavior, such as the interpretation of facial expressions, split attention, imitation abilities, the feeling of "self", the theory of mind, etc. For instance children who suffer from autism show emotional indifference to the surrounding people and treat their close relatives as if they were strangers. Such children lack in imagination and creativity, prefer a daily routine and feel strong nervousness at the slightest changes. Speech disturbances are secondary and are connected with the disorder of the system of acquisition and adoption of linguistic abilities. The inability to understand other people's ideas forces the child to interpret other people's words too literally. Specialists claim that numerous similar derangements are directly connected with the fact that autists do not have the theory of mind (Baron-Cohen,

2001). It is essential that most often abnormalities of the integrative socio-cognitive complex result in a low IQ (Frith, 2000).

On the other hand, there is a group of high-function autists and a group of children with Asperger's syndrome who not only show normal and high IQ but at times even possess extraordinary abilities. One of the cognitive theories of autism known as the theory of coherence emphasizes autists' ability to single out and concentrate on certain information. An explanation of such extraordinary abilities can be found with the help of examination of the peculiarities of the anomalous autistic cerebral organization.

At the brain level abnormalities occur functionally as well as morphologically. Concerning functional cerebral organization we can talk about a realignment of a number of functional systems responsible for the organization of social communication and cognition. The main systems include: cerebellum - (brainstem -basal gangliф), frontal cortex (particularly premotor area), amygdala – (temporal cortex - hippocampus) - prefrontal cortex (particularly orbital area). However, apart from deranged functional bonds, autists' cerebrum has a number of abnormalities that can be attributed to the activity of compensatory mechanisms (otherwise they can be novelties). Firstly, autism violates the principle of cortical localization of cognitive functions that is responsible for facial processing and working memory. The pattern of activity inherent in high-functional autists is specific and comprises in the majority of cases the areas atypical for normal people. All this gives the impression that autists even while fulfilling the tasks (in particular, involving the use of language, facial interpretation, and the theory of mind) utilize different strategies of cerebral functional bonds, though the outward behavioral effect resembles the normal one. Secondly, autists' cerebrum has been changed morphologically, which may be considered as the manifestation of the so called reactive plasticity. This results in an increase or vice-versa decrease of the sizes of different parts of cerebrum, first of all cerebellum and frontal cortex. On the other hand, such changes may determine the aforementioned extraordinary abilities of autists: due to the deranged functional lateral bonds cerebral activity is focused on certain areas, thus producing such an impressive cognitive effect.

Genetic nature of autism up to now remains obscure. It is clear, however, that autism is not the result of one gene mutation but rather of a complex aggregate of genetic mutations, and each mutation can separately be responsible for the abnormalities of neuron migration and synaptogenesis, as well as for the circulation of some neurotransmitters. It is also unknown what mechanisms are responsible for the changes in the cerebral functional organization and for the reactive plasticity, but the nature of autism undoubtedly is one of the most complicated in comparison with many other developmental derangements.

Only time will tell us whether it is right or not to regard autists as the forerunners of the future society. For the present autism owing to its peculiarities is worth of meticulous analysis as a behavioral and cognitive strategy that is able to attain the principal objective of computerized education and children upbringing at this stage of information-oriented society formation. Striking cognitive abilities at times demonstrated by autists superficially resemble the biological computer that will be able to optimally cooperate with the "hard" computer and artificial intellect and learn with the help of special programs devoid of full-fledged social interaction. Autism is an example of cognitive development outside the social environment and communication that does

not require social learning. The fact that this developmental variation is theoretically possible rivets psychologists' attention. But even among autists extraordinary abilities are quite rare, the majority remains intellectually backward, therefore we can presume that only few generation-N children will have outstanding intellectual abilities in the new conditions of changed social interaction, though all these children in general will not have any problems with computers staying within the frame of the style of thinking and creativity set by the educational programs and artificial intellect.

Socially interactive robotics.

What could possibly make an alternative to the society of autists and AI machines? If we want to oppose our children's changing and to fight further irreversible abnormalities of their development, if it is impossible to reverse the process of computerization and introduction of media technologies, we have to make these technologies conducive to social learning. The developments in this sphere being part of psychology, anthropology, sociology as well as the study of artificial intelligence and the elaboration of developmental programs are united under the name of "social robotics" and belong to a wider realm of "artificial life".

The term "social robot" designates a robot created to socially interact with people and theoretically able to emote, maintain verbal and non-verbal social communication, i.e. talk and gesticulate, and apart from this autonomously move and think. Ideally a social robot must be socially intelligent and capable of human-like interaction (Fong et al., 2003).

The project of social robotics dates back to 1940's when scientists began to engineer socially interactive robots, understood as robots that could interact with their physical environment as well as with each other. The first robots of the kind were Walter's turtles, they could "dance" interacting with each other and such interaction greatly resembled social one, though there was neither explicit communication, nor reciprocal identification between them (Mataric, 1995). In the early 90's, the time that saw the prime of "artificial life" and insectomorphous robots engineering, more attention was given to the principles of social organization and social interaction of insects. These principles were reflected in a number of group robots and distributed robotic systems oriented to accomplish collective group tasks.

But insectomorphous robots failed to reproduce the principles of social interaction of autonomous individuals that inheres in birds, mammals and humans. In contrast to anonymous insect communities mammal communities are individualized: every individual can organize its social relations and social network assuming the rules of various social groups. Therefore, according to Dautenhahn and Billard's definition, socially interactive robots are intellectual agents belonging to a heterogeneous group, i.e. a community of robots or humans (Dautenhahn et al., 2000). Social robots are able to identify and socially interact with each other, they possess their own experience based on the perception and interpretation of the material as well as social world, and, which is crucial, they are able to learn and explicitly communicate with each other.

Engineering of such individualized social robots requires models and techniques different from those used in insectomorphous robot engineering. Social learning including imitation, gestures, communication in natural languages, emotions, and identification of social partners is

fundamental in social robotics. Another challenge is to make a robot reproduce friendly social behavior, without a shadow of aggression or violence. These very robots can make not only good servants but also partners, developmental toys; they can assist teachers and even substitute them following the further improvement of computerized education and upbringing. Given intensive elaborations and researches social robotics can become an alternative to "hard" computers. It will also shift "child-computer" interaction into the sphere of social interaction.

The humans' aspiration to interact with machines as if the latter were humans can become the principal prerequisite for a widespread proliferation of social robots. According to the objectives of the use of social robots, they can involve people into social interaction and stimulate it (robots Kismet, Cog, etc.), adapt to social norms and principles of human social communication to carry out joint tasks (Pearl, Sage, etc.) or merely show social competence reacting to people's actions. Given the above mentioned aspiration and objectives we can distinguish two major lines of social robotics: biological line in which robots are designed to simulate social intelligence inherent in living beings and humans, in particular, and functional line in which robots' intelligence is just a function without a respective interior design.

The engineering of biologically inspired social robots is based on the theoretical statements drawn from anthropology, cognitive science, developmental psychology, ethnology, sociology and the theory of mind. All these theories ensure practical functioning of robots' cognitive, emotional, motivational, behavioral, and motor systems. Thus, for example, the design of robot Kismet's synthetic nervous system, and in particular some aspects of its emotional, motivational, and behavioral systems' functioning are based on the theoretical data concerning children's early social development. A robot in this case acts as a child who socially interacts with a grown-up (Breazeal, 1998).

Social interaction between Kismet and humans works on the principle of the early emotional interaction between mother and child. A child's emotions are crucial for social contacts; they furnish the clue to understanding a child's inner world, which enables grown-ups to adequately regulate social interaction. The most important function of Kismet's motivational system is not only to establish social interaction with humans but also to regulate its rate so that it is never superfluous or insufficient. Robots' emotions can show us how to make our interaction with robots more intensive, less intensive or keep it steady. In the course of learning Kismet chooses those emotional expressions that evoke satisfactory responses from humans. Robots' emotional expressions being analogous to those of a child can easily be interpreted by humans as communicative acts, making further social interaction possible.

Feelix is another known social robot that stimulates social interaction. It can facially emote responding to haptic stimulation. One of the main tasks which faced Feelix's engineers was to probe the potential that the robot could have being subject of human physical manipulation, the type of manipulation that is impossible to occur in interaction with computer programs. They found that Feelix's emotional expression depends on the degree of haptic stimulation: the less it is manipulated, the more negative emotions it shows and vice versa (Canamero et al., 2001).

On the whole, several basic features can be distinguished concerning the design of social robots. Robot's embodiment is a base for the interplay of the system and environment, including

social environment. Depending on the robot's form and structure it is perceived differently. Physical features, zoomorphic or anthropomorphic, will provoke different modes of interaction. Thus, for instance, Kismet is just a head and cannot move, therefore haptic interaction is limited, on the contrary Feelix's anthropomorphous features, it has a body and can move, further intensive social interaction.

The role of anthropomorphism is very important for interaction with humans when robots use the language of gestures, looks, etc. In this case robots should both structurally and functionally resemble humans. If a robot is programmed to learn from people using the mechanisms of social learning, then it should behave like a human being. For the time present, modern robots are far from the ideal humanoid, though certain progress has been made in engineering anthropomorphic faces with rich emotional expression (Adams et al., 2000). The robots' faces are made of silicon which covers mechanical human-like heads. Another significant advance was made in 2004 when engineers created a new humanoid Nico (Lovett & Scassellati, 2004). Although Nico's appearance hardly resembled human the robot became more functional exactly in social interaction with children.

To simultaneously resolve the problem of functionality and appearance it is also possible to use computer graphics and animation to present the robot's face on the display. In this case we combine virtuality and physical presence. One of such machines, a female robotic face named "Vikia" had more degrees of freedom than did mechanical heads, but this robot was considerably constrained in its autonomy and locomotion (Bruce et al., 2001).

The ability of social robots used in education to establish a dialogue and verbal communication with a child (speech problems we have examined earlier) can become very important. In the meantime this ability remains imaginary, though there were several attempts to simulate non-verbal "human-robotic" communication and its sub-linguistic forms, so that robots can learn commands and modify their behavior according to the latter.

Social robots are capable of learning, but social learning is the most complicated kind of education and is based on a number of cognitive mechanisms. The first researches on social learning also known as "collective robotics" (Mataric, 1995) were focused on the problem of interaction between robots. But in the recent years a lot more attention was devoted to the problem of social learning within the frame of "human-robotic" interaction. Imitation (or simulation) in this case is the principal kind of social learning. Robotic imitation is based on a number of cognitive and motor abilities. The success of simulating robots directly depends on the fact whether they will be able to correctly recognize what and when they need to simulate, and also how to render simulated behavior. The clue to such an understanding can be found in the phenomenon of joint attention: to determine the object of simulation the robot could theoretically follow the eye in the human fashion, or make use of imperatives and declaratives, but first and foremost robots need to recognize humans.

As regards the short-term outlook for the use of social robots in education, to all appearance, we will have to deal with the robots that do not have autonomous physical embodiment, i.e. mere software or so-called two-dimensional agents. Theoretically, even this simplified use of social robotics can substantially improve the quality of "child-computer" interaction.

Researchers believe that human-robot interaction fundamentally differs from human-computer interaction, as in the first case we deal with complex autonomous dynamic systems that possess cognitive ability and function in the real world. (Fong et al., 2001) Perhaps, this outlines another potential application of social robots - the therapy of virtual addiction. Robots can help to return the child from virtuality into the real world, in which all manipulations with robots are carried out physically, and communication resembles real interpersonal one.

In the context of our work the attempts to use social robots in the therapy of autism are of particular interest. The findings of the said researches could possibly furnish the clue to understanding the potentialities of social robots in establishing social interaction with children who are already out of touch with social environment and who are fully immerged into virtual reality. Computers and virtual reality are for many years used to treat autism, which once again testifies the adaptability of the behavioral and cognitive strategies of this derangement to human-computer interaction. Autists feel more secure in this interaction and it helps them to use a more predictable and familiar virtual environment for cognitive development and creativity. Project AURORA (*http://www.aurora-project.com)*, initiated in 1998 by a number of psychologists and robot engineers was aimed to create a social robot that could also be used in autism therapy (Werry & Dautenhahn, 2001).

Such robots could theoretically substitute teachers, help autists participate in various kinds of social interaction and stimulate interpersonal contacts and social communication. The fact that autists do not fear robots (in contrast to the fear of the people) must also stimulate the acquisition of various cognitive skills. Another objective of the project was to find out the extent to which social robots could further real interpersonal interaction between two autists.

Practical realization of this project resulted in a relatively small and fairly simple model of social robot that could move towards the source of the heat and pronounce short simple phrases. This robot gave positive outcome. In the course of an experiment with two high-function autists who were capable of the elementary social communication and possessed a fairly good knowledge of the language, the robot facilitated the establishment of a closer social contact between the autists, not to mention the high rate of interactivity with the robot itself.

Project AURORA, in the opinion of its initiators, provided yet another proof that robots can acquire a social role in human society. As such, social robots possess a great potential in introducing "the society of mind" into the human society. Thus people can retain genetically determined adaptations of social interaction, and at the same time enter the sphere of new information technologies not fearing mental disorders or developmental derangements. In other words, social robots can become an interface between intelligent information technologies and humans who function as biological and social beings.

Conclusion

Thus, we have examined information society in the context of social and cultural evolution of humankind, emphasizing cultural globalization, proliferation of intelligent IT and the change of social interaction as the key interconnected features of the new society. Such new social and cultural milieu can be in conflict with genetically determined adaptations of social learning

(social pedagogy) that condition normal cognitive and social human development only if intensive social interaction occurs. Nowadays the wide proliferation of IT and its application in education arouses certain apprehension among psychologists. The latter struggle to limit human-computer interaction at least at the early stages of human development. Apparently, provided that the interaction with intelligent ICT fully substitutes social interaction behavioral and cognitive strategy of autism can become adaptive. On the other hand, it is possible to apply basic principles of social interaction in the interaction with IT. This option is realized within the frame of "social robotics".

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