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**CHARACTERISTICS OF PERCEPTION AND OBJECT USE IN
AUTISM, COMPARED TO TYPICAL DEVELOPMENT**

PhD-thesis

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The theoretical framework and structure of the dissertation

In my PhD-dissertation I investigate how children are introduced into material culture, and the development of their object use. Objects, as tools of everyday activities, and as toys, are well-investigated areas of psychology, but less attention was paid to actual object use. The material world is an important mediator of culture, as well as of individual's socialization (*Williams és Costall, 2000*). However, classical cognitive psychology typically interpreted human connection with the world of objects from the perspective of problem solving (e.g. complex learning), and neglected its social context. But behavioral and the mental functions related to object use can get a more complex interpretation, if taken contextually.

In the last couple of decades a new paradigm has come to the fore in cognitive science: the so called „embodiment” perspective, which highlights the importance of the bodily realization of the individual cognizing agent, and, relatedly, the importance of the interactions with the environment via sensorimotor experiences, as well as social embeddedness.

Regarding social embeddedness of object use the question arises: how does it develop individually, in typically developing and in special populations, such as people living with autism, who have difficulties in starting and maintaining social connection with others? Research of the latter theme is timely because the number of diagnosed cases showed substantial growth in the last years, although the background of this fact is not clear (*Bognár, 2010*). Furthermore, atypical development often correlates with intellectual disability. The early recognition of the disorder – for the determination of special learning needs and the compilation of the optimal development plan – would be significant (*Jordan, 2007*). Early diagnosis and intervention is always more effective because of substantial brain plasticity in this period, and the young person's later integration into society is better supported. Thus, all research results would have serious positive impact for the affected child, as well as for his/her caregivers and educators.

The broad goal of my dissertation is to explore the sense-making of the human agent in relation to objects. The human agent is conceived as embedded in its environment, in continuous dynamic interactions. The more specific goal is to explore the sensory-perceptual- and object use characteristics of children with autism spectrum disorder, in comparison to typically developing children, as well as to explore some aspects of their eye movements in situations where they are observing object characteristics (projected for them on a computer screen).

In my dissertation, before the presentation of my studies, I provide the theoretical background as a framework for the interpretation. In the first and second chapters I review the history of research on autism, focusing on the major theories that were promoted as explanatory frameworks. After considering initial ideas of Kanner (1943/1968) and Asperger (1944) about the syndrome, I discuss attempts to explain autism as „childhood schizophrenia”, the development of (differential) diagnostic work, the therapeutic options and the ways of systematic testing. Via the presentation of retrospective investigations I discuss the spectrum feature of the disorder, then present an overview of functional imaging procedures and neurobiological studies carried out in this research area.

After that I review „ortodox” cognitive theories of autism, specifically, theories based on central coherence deficit, theory of mind deficit, and the executive functions deficit, pointing out strengths and weaknesses. Following that I review more recent sensorimotor (embodied) theories of autism spectrum disorder (specifically, simulation-, interaction-, „broken mirrors” and „relevance map” theories). Closing the theoretical background I point out recent promising results showing that the „mirroring potential/difficulty”, which is probably significant for all leading symptoms, may not be a static condition, but a function that can be improved by well-planned trainings. This is highly relevant for effective intervention.

In the third, fourth and fifth chapters of my dissertation I present the three studies that I have conducted. The first study aimed to explore and compare typically developing and autistic childrens’ sensory-perceptual characteristics. In this study I collected data on the sensory-perceptual characteristics manifested in the child’s behavior by Bogdashina’s (2003) Sensory Profile Checklist Revised (SPCR), a questionnaire filled out by parents. The second study aimed to explore various dimensions of their object use. In this investigation I applied observation of mother-child dyads in a series of structured situations, in order to explore situated object use in social context, in an ecologically valid way. I recorded the events on video, then carried out data entry and analysis by the Noldus Observer 8.0 behavior analyser program software. The third study aimed to examine patterns of eye movements in a task situation in which typically developing and autistic children had to watch pictures of objects on a computer screen. In this study I used the Tobii t120 type of eye movement investigator tool and the TobiiStudio 2.2.7. software.

What is the significance of my researches? I believe that these results, which tie into so far under-represented aspects of autism spectrum disorder, not only expand our knowledge about autism spectrum disorder, but also contribute to a deeper understanding of typical

development, as well, and to the planning of more effective, evidence-based intervention programs.

My researches

After the presentation of the theoretical background the description of my three investigations follows in my dissertation. The aims, questions, hypotheses, participants, tools and applied methods of the individual studies are summarized below (Table 1-2).

Table 1. The aims, questions and hypotheses of my researches

	The aim of the studies	The questions of the studies	Hypothesis
I.	An explorative and comparative study of sensory-perceptual characteristics in typical and autistic development	How does the sensitivity of the individual modalities develop in the subsamples?	Increased sensitivity of the modalities can be found in autism.
		How does development influence the sensitivity of the modalities?	In typical development, some modalities will be more, some will be less sensitive. In contrast, modalities will operate the same way in autism.
		Can we also find sensory problems in typical development? How are sensory problems distributed in the subsamples and how do they develop with time?	Hyper- and hyposensitivity are more pronounced in autism, in all ages.
		Can we grasp any general patterns of the sensory processes in the subsamples with the passage of time?	The operation of the sensory channels is more rigid in autism, while it is more balanced in typical development.
II.	An explorative and comparative study of the characteristics of object use in typical and autistic development	How does the use of objects develop in the subsamples?	Conventional- and creative object use will be underrepresented in autism.
		How does the „demand characteristics” of the sets influence children’s object use?	Typically developing children will recognize better the „demand characteristics” of the given set. There will be deficit in pretend play and imitation by children with autism.
		How do parents use the objects in the observed situations?	Parents will demonstrate similar types of object use to their children. Compensatory may be also observed.

		Does the „demand characteristics” of the sets and the children’s object play influence the parents’ object use?	Yes, the parents will recognize the „demand characteristics” of the sets. They will present the expected way of object use for the children, if it seemed to be impaired by them. Otherwise, the parents let the children to lead the gameplay, moreover they encourage the children to demonstrate more creative forms of object play.
III.	An explorative and comparative study of characteristics of eye movements in typical and autistic development	How does the eye movements develop in the relation of the subsamples linking to the perception of the conventional- and nonconventional objects?	Nonconventional objects will cause intensified attention by children with typical development, thus the exploration of these objects will be more thorough. Linking to the perception of the conventional objects, I suppose that the results will be similar.
		How does the perception of the conventional- and nonconventional objects develop within the groups?	Nonconventional objects will be preferred in both of the two subsamples. This will be more expressed in the control group.
		What kind of similarities and differences can we find linking to the perception of the impossible-, modified- and strange objects in relation of the subsamples?	Impossible- and modified objects will be better observed by typically developing children, while the result of the objects types will be similar in autism.
		How does the children from the subsamples perceive functional compatibility based on the eye movements?	Autistic and typically developing children will change their gaze between the appropriate and nonappropriate objects in the similar proportions.
		How does the perception of size proportionality develop in the relation of the subsamples?	Typically developing children will rather perceive size proportionality and explore the appropriate object to the basic object.

Table 2. My researches that are presented in my PhD-dissertation

	My researches	Participants	Tools		Proceedings		
I.	Sensory-perceptual characteristics	100 ASD-child (16 girls/80 boys, the data is unknown by 4 persons; age 2-13 years; M=4.700; SD=1.310) 140 TD-child (52 girls/64 boys, the data is unknown by 24 persons; age 2-7.5 years; M=5.125; SD=2.316)	Bogdashina (2003) Sensory Profil Checklist Revised (SPCR)	Raven's Coloured Progressive Matrices (CPM)	SPSS 15.0 for Windows Evaluation	The filling of the test was happened at the families' home.	
II.	Characteristics of object use	10 ASD-child (2 girls/8 boys; age 5-7.5 years; M=6.01; SD=0.978) 10 TD-child (2 girls/8 boys; age 5-7 years; M=5.90; SD=0.615)	Three types of set with different kinds of „demand characteristics”: (1) unknown/strange objects - (exploration), (2) „as if” objects- (adequate pretend play) and (3) novel objects (imitation)	Raven's Coloured Progressive Matrices (CPM)	Noldus Observer 8.0 program software	Version statistical program	The testing was made at the families' home.
III.	Characteristics of eye movements	16 ASD-child (6 girls/10 boys; age 7-12 years; M=9.94; SD=1.676) 11 TD-child (7 girls/4 boys; age 7-8 years; M=7.45; SD=0.498)	Five types of stimulus constellations: (1) impossible-, (2) modified-, (3) strange objects, (4) perception of functional togetherness and (5) perception of size proportionality		Tobii t120 type of eye movement investigater tool, TobiiStudio 2.2.7. software		The data collection took place in the children's school.

Results and discussion, by the individual studies

First study: Sensory-perceptual characteristics in autism

The third chapter of the dissertation presents an explorative – comparative investigation on the sensory-perceptual characteristics present in in autism, compared to typical development. Overall, my results confirmed the greater sensitivity of the sensory channels by children living with autism spectrum disorder, which characteristic was even more expressed in the case of boys. This stands in accordance with other studies (e.g. *Kern, Trivedi, Garver, Grannemann, Andrews, Savla, Johnson, Mehta és Schroeder, 2006; Henshall, 2008*). The modality of smell was an exception, however. It is conceivable that this modality, as a filogenetically more ancient sense, is preserved in relative balance in autism. The improvement of individual modalities was also confirmed, although the validity of the data must be handled with reservations, considering that it was a retrospective investigation in which parents had to remember their children's reactions as they were years before.

Furthermore, in both groups the incidence of the sensory problem identified as „white noise” represented the highest ratio, while hipersensitivity was the least typical. Parallel to this, the volatility and the unpredictability of the sensory function were also confirmed by the answers on the parental questionnaires. Over the years the more harmonious operation of the sensory channels could be recognized by typically developing children, against which neither the shift to the compensatory operation, nor the increased importance of certain modalities did not show itself.

What significanc do these results on sensory-perceptual characteristics have? *Kern, Trivedi, Grannemann, Garver, Johnson, Andrews, Savla, Mehta és Schroeder (2007)* pointed out that the sensitivity of the individual sensory channels correlates with the seriousness of the developmental disorder of the child, so we have to consider the sensory atypicalities as part of the disorder. This also encourages us to assume diagnostic possibility in it. According to the „rule of inverse efficiency” (*Iarocci and McDonald, 2006*), if a unimodal stimulus indicates a weaker reaction that leads to the creation of a stronger integrated sign, while a stimulus which causes more intensive reaction leads to a weaker integration. It is essential that during our interactions with the environment we acquire multisensory experiences, from which the sorting of the incongruent signs and the enhancement of the relevant elements are supported by contextual information. We are able to cope with our physical- and social environment by integrated, meaningful perception. If our modalities – in the moment by moment changing

world - do not lead to coherent, well-organized perception, obviously an „atypical image of the world” will be formed that manifests in unusual behavioral attitudes due to the effort to cope with the actual situations. Autistic individuals who either „live in their own world”, or „in our world, but in their special mode”, need support to defeat their sensory – perceptual disadvantages.

As a conclusion for the purposeful environmental arrangement, the quantity and the quality of the stimuli that affect the autistic child must be controlled so that optimal stimulation will be achieved (*Nguyen, 2008; Morris, 2013*). This controlled environment can be made more and more flexible and interoperable with time, taking the child’s individual aptitudes into consideration, so that she/he can get a sense of balance and success (*Stefanik, w.y.*). The development of movement and cognitive capacity also mutually and favorably reinforce each other, and the link to brain plasticity seems to be promising (*Diamond, 2000; Czurkó, 2008*). Appropriate, individualized therapies can lead to good results (*Rutter, 2007*). Such is, for example the „Focused, Integrated Sensomotor Therapy” by *Sarlós (2017)*, which is target of efficiency studies taking place currently in children with diversified impairments,. Until appropriate therapies will be widely available, it is important that teachers are familiarized by the behavioral problems linked to autism, as well as the optimal course of action to deal with them.

Second study: Characteristics of object use in autism in response to watching various types of objects

In the fourth chapter of the dissertation my investigation on the characteristics of object use in autism, compared to typical development, is presented. Overall, my results showed that – in accordance with *Park’s (1983)* and *Jordan’s (2007)* work – creative object use, which refers to the versatile usability of the objects, was demonstrated more often and for a longer time in all of the three sets (object use situations) by children with typical development. In contrast, autistic children preferred exploration, when they focused on an isolated, particularly noticeable feature of the objects. Although apparently this behavior seems to support the appropriate use of objects in the case of unknown objects, in fact it confirms the difficulties of object use. Furthermore, in the offered three sets, while typically developing children tended to use the objects in an appropriate and/or creative mode, recognizing the demand characteristics of the given set, autistic children’s object use was limited to exploration, and deficits of pretend-activity could be observed. While in the second set children with typical development preferred

imitation, in the third set autistic children demonstrated the same type of object use. Although on one hand the difference was not significant, but on the other hand the quality of the demonstrated imitation was not the same. Because typically developing children not only copied the movements of the parent but continued the given series of actions in a creative way, while autistic children imitated the action rigidly.

The parents of typically developing children were prone to demonstrate the same type of object use that was earlier presented by their children, while the parents of autistic children— in accordance with the results of *Kroeger, Schultz és Newsom (2007)* - increasingly strived to demonstrate the type of object use that the child did not demonstrate, and this behavior was often accompanied by explicit verbal and nonverbal communication, with a teaching intention. Parents with an autistic child reacted with increased sensitivity to the demand characteristics of the individual sets, and related object use was also demonstrated by them more often and for a longer time.

In summary, results confirmed some limitations of object use in autism, mainly in connection with appropriate and creative object use. Since objects have a significant role in the process of socialization, this kind of deficit can not be independent from the difficulties in social relations. Awareness of the material culture and our capacity for adequate object use is significant for everyday life and mediates social interactions as well. „As if” activities linked to an object, which can be very diverse on the basis of the perceived affordances, have the significance of fantasy play . According to *Beyer és Gammeltoft (2007)* play can be taught, but first of all the experience of play is of significance.

Imitation of the child's action, as demonstrated by typically developing children's parents can be an useful tool to grasp the attention of the child and this strategy could work for autistic children, and, expectedly, the child would be willing later on to imitate the adult.

Third study: Characteristics of eye movements in response to watching various types of objects

In the fifth chapter of my dissertation I present my third study which focused on the characteristics of eye movements of typically developing and autistic children in response to watching pictures of various types of objects (impossible-, modified-, strange objects and objects of functional togetherness and size proportionality) projected for them on a computer screen.

My results confirmed the visual preference of the nonconventional objects both by children with typical development and by autistic children. However, typically developing children more often looked at nonconventional objects, and they spent more time by their visual exploration. This is in accordance with the results of *Buzás* (2017), who confirmed shorter recognition time for well-known patterns. However, the visual behavior in reaction to the impossible, modified and strange objects was overall very similar in the two groups.

Children in both groups paid more attention to the matching objects (e.g. a doll and a cradle) compared to the objects that were not appropriate to the basic one (e.g. a shoe), spent longer time by their exploration and returned their gaze on these objects. Regarding size proportional objects, when two different sized objects (e.g. a bigger spoon and a smaller spoon) were offered for the children from which one was much better suited to a third target object (e.g. a plate), members of both subsamples were prone to return visually to the appropriate object, while there were less fixations on the nonappropriate objects, although duration of look was longer by children with autism. These results connect to the conception of the functional compatibility that was described by *Defeyter és German* (2000), because primary school children are already aware of the appropriate use of objects, which could be manifested in the preference of them. The results related to size compatibility are similar to *Szkárosi's* (2012) results in that they confirmed only slight difference between autistic and typically developing children regarding this capacity.

Overall, the conducted investigations led to similar results children with typical development and with autism spectrum disorder. Statistically significant differences were only found within the subsamples. Remarkably, autistic children more often returned their gaze to the nonconventional objects and explored them for a longer time than not properly sized objects, although the difference was not significant. This is probably related to the good performance of autistic children regarding dealing with parts, but difficulties in recognizing the importance of the elements (*Vermeulen*, 2014, 2015). Thus, although the difference between the stimuli (conventional- and nonconventional objects) are decoded, for their interpretation deeper exploration may be needed. While a typically developing child can interpret a context in an implicit mode, this can be problematic for somebody who lives with autism. This is the reason why they use explicit strategies and focus on the details that may have enhanced importance in social interactions (*Harms, Martin és Wallace*, 2010). This behavior during the exploration of unknown or somehow special objects may be caused by the search for reference points. Although the confirmation or rejection of this hypothesis needs more research,. We also have to be aware of the fact that similar patterns of eye movement do not necessarily indicate the

same processes of interpretation, because the connected neural pathways can be very different (*Boraston és Blakemore, 2007*).

Summary, outlook

What kind of conclusions can be drawn based on the above results? The development of theories of autism illustrates well how important it is to rethink conceptual frameworks and interventions from time to time.

As pointed out before, the embodied cognition framework highlights the role of body experiences in the process of knowledge acquisition. The focus on sensory-perceptual and motor characteristics in autism is an effort to apply this framework to further the interpretation of autism spectrum disorder. In my dissertation, I aimed to interpret the behavioral manifestations from the view of the members of the subsamples as it was recommended by *Bogdashina (2003)*. The applied research method also aimed to serve this aim. Because autistic individuals seem to be more sensitive to environmental changes, in order to enhance ecological validity I went to the families and into the schools to collect data. Thus children could stay in their ordinary environment, they did not feel stressed and were able to behave naturally.

Although I focused on children with autism spectrum disorder, related features of typically developing children could be also explored. Experiences of childhood are determinative for later years, and the earlier intervention in autism or in other kinds of development problems may have better results. Their effects often manifest in social interactions, motor capacity and the development of language use. The varied environment – with its safety – also influence favorably the quality of the child's play (*Ward, 1969*). The increasingly wide range application of everyday objects further enhances the child's willingness to participate and initiate actions (*Williams és Costall, 2000*), which – via the manipulation on the objects – with an increase in cognitive development. But primarily the child has to experience the joy of play on which she/he may feel more expressed motivation to participate in the given activity. If the adult or the trained helper is able to treat the child appropriately, according to his or her individual characteristics, then optimal development can be assured.

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