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Characteristic of Communication Model in Children with ADHD

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Abstract:There are a number of models that describe communication processes in children of typical development, while communication models in children with developmental disabilities, especially children with ADHD, have not been researched to such extent. Communication is defined as a complex process of transmitting messages from person to person, using signals (visual/auditory) from a sender to a recipient. Since communication involves a recipient and a sender of information, there are many factors that can affect the outcome of the communication process such as attention variability, as well as auditory and visual stimuli that can enhance or interfere in communication processes. The goal of communication is to provide as accurate and unaltered information as possible, while rising noise in the communication channel increases the likelihood that the information will be transmitted only partially or might be misinterpreted. The topic of this paper is the analysis of a modern communication model where emphasis is placed on visual and auditory perception, and their particularities in relation to the variability of attention as one of the most important elements of perception. The variability of attention consists of auditory and visual information processing including the time required to respond, ommision errors and errors caused by attention lapses. By studying the results of experimental research, we gain insight into the communication processes of children with ADHD, especially the particularities of the reception, processing and interpretation of auditory and/or visual stimuli, which significantly affects the communication process itself. At the cognitive level, the scientific contribution was achieved through the presentation of the particularities of the communication model in children with ADHD, and at the methodological level through the development of original methodology for qualitative comparison of stimulus thresholds by using statistical parameter analysis, while at the practical level in originality through the application of created information concepts of the communication process.

1. Introduction

Communication is defined as a complex process of transmitting messages by using signals (primarily visual/auditory) from the sender to the recipient. Since communication involves the recipient and the sender, there are many factors that can affect the outcome of the communication process such as attention variability and auditory and visual stimuli [1], as well as the intensity and

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extent of stimulus structures, novelty, unusualness, or repetition which can improve or disrupt communication processes. One of the most recent definitions of information behavior that includes the following processes: identification of information-related needs, assessment of the appropriateness of information, information or knowledge usage, and the organization of information [2]. The definition focuses on the characteristics of information (nature of information, medium, source, manner, environmental aspect). All of the above aspects of information behavior manifest differently in the communication process in children with ADHD compared to children of typical development. Successful communication involves agreement in the interpretation of the message between the sender and the recipient. During the communication process, a number of difficulties arise that produce misunderstanding, ie noise between the sender and the recipient. Noise distorts the content of the message in relation to how it was conceived by the sender, and can occur in any part of the communication process, but primarily in the reception and interpretation of information. The extent to which information will be interpreted depends on the perception and variability of the recipient's attention, the repetition of auditory and visual stimuli, and the individual's stimulus threshold. Perception and attention are the main determinants of successful communication process. Perception is defined as the way in which we organize, integrate, and interpret sensory information that allows us to learn about and recognize the meaning of objects, phenomena, and events in our environment. Perceptual experience is extremely important in communicating, receiving and processing information obtained from the environment, without direct contact with them [3]. The extent to which communication will be successful also depends on the variability of attention. Attention is a behavioral and cognitive process of selectively targeting a more important aspect of information, while neglecting less important information [4]. Attention is also described as the allocation of limited cognitive processing resources. Through sensory systems a wealth of information is received from the environment (primarily visual and auditory), but perception and response are determined by only a limited amount of that information. The effects of other stimuli are partially or completely inhibited. Attention variability affects the quality of perceptual representations, a quality that can be quantified by precision (or its inverse, variability) in simple psychophysical models that record the relationship between stimulus strength, interpretation of received stimulus, and influence on recipient behavior. Difficulties in attention variability, visible in children with ADHD can manifest in the form of difficulties in monitoring and performing tasks, instability, difficulty focusing on activity or difficulty switching from one voluntary activity to another, reduced resistance to distractors, etc. [5,6]. Observed from the perspective of communication processes, the traditional linear model [7,8] is supported by newer communication models (interactional and transactional) that try to interpret some particularities of the communication process [9,10,11]. Taking into account all the above mentioned models and observing them from different angles, each of them gives a partial answer related to the influence of auditory and visual stimuli on an individual. Also, no communication model has included the particularities of sensory processing of an individual in its communication paradigm. The researched noise in the communication channel [12,13] is aimed at transmitting information from sender to recipient, while none of the above models or definitions refers to individuals with neurospecificities and the impact of different stimuli on the communication process. Perceptual difficulties, sensory modulation difficulties, difficulties with the time required for response, or attention variability are often present in ADHD disorder, which significantly affect communication processes [14]. Deficiencies in the communication process of children with ADHD concern the ability to detect, discriminate and process stimuli arriving through our sensory system, with an emphasis on auditory and visual stimuli that can act as distractors during the communication process. The global rate of ADHD disorders is 5.29%, with a highlighted prevalence of growth [15]. In children with ADHD, particularities in sensory data processing [16,17], transmission through the

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communication channel, and their interpretation are noticeable, and the determinants influencing these processes are the variability of an individual's attention and the time required to respond after a stimulus. Despite relevant scientific research in the field of communication, attention, ADHD, auditory and visual processing, researchers are still unaware of the distinction of sensory processing in children with ADHD and the impact of distractors on the success of the communication process. Research in the field of information communication that combines all the above elements, as well as any research in any discipline, derives from standards and norms, which are the basis for a scientific approach [18].

2. Methodology

The experimental research includes 30 children aged 8 to 10 years, of normal intellectual status, of which 15 children are of normal development, and will form a control group of respondents. The experimental group consists of 15 children diagnosed with ADHD (according to DSM-V. criteria). All respondents are male and attend regular primary school in the city of Varaždin (Croatia, Europe). The selection of control group respondents was made by using equivalent pairs.

To determine attention variability, and how to respond to visual and auditory stimuli, the

T.O.V.A. test (Test of Variables of Attention) was applied since it has been used in more than 400 scientific and professional papers, and offers objectification of norms and standards for understanding the communication model.

In the T.O.V.A. test the stimulus was set at 100 ms, at 2000 ms intervals. The stimulus was presented 22.5% (n = 72) during the first half of the study and 77.5% (n = 252) during the second half. The respondent was instructed to respond to the target as quickly as possible. Different ratios of target and non-target allow us to examine the effects of different response requirements on response time variability, response time, inattention, and impulsivity [19].

The visual TOVA test consisted of 648 stimuli, displayed at 100 ms with a time interval of every 2 s. "Target" and "non-target" (Picture 1) consisted of 9.5 x 9.5 cm white squares (9 degrees x 9 degrees viewing angle) with 1.2 x 1.2 cm black inner square (1.15 degrees x 1.15 degrees) located

0.7 cm from the top (for the target) or at the bottom (for non-target). For audio visual calibration and coloration, two types of stimulus measurements were performed: signal amplitude and time occurrence. In the case of visual stimuli, measuring their amplitude meant determining the brightness of the cell, the fixation point, as well as the brightness of the calibrated screen. The brightness of the background, as well as the small inner square, was set at 0.2 CD -/-m2 and the brightness of the glossy square was set at 58 CD/m2, the fixation point of 0.03 cm in diameter, was constantly displayed in the center of the screen and a bright square.

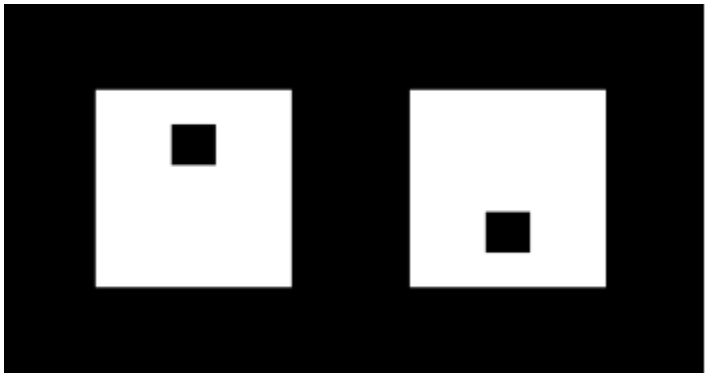

Figure 1: Visual stimulus: target/non-target

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For the auditory part of the study, two simple tones will be used, a stimulus of 390.0 Hz and 261.6 Hz [19].

The aim of the study was to determine the threshold of stimulation with visual and auditory stimuli in children with ADHD, and the impact of lapses (errors) in communication, with the aim of improving the communication model of children with ADHD.

The following hypotheses were formed from the research objectives:

H1: T.O.V.A. test can determine the threshold of stimulation of auditory and visual stimuli that negatively affect the communication process in children with ADHD.

H2: Errors that occur in the reception, processing and interpretation of information significantly affect the outcome of the communication process in children with ADHD

Tests were performed for auditory and visual stimulus according to the following variables:

1. RT Variability - variability of the time required for response
2. Commision errors - errors due to impulsivity
3. Omission errors - errors in the middle of inattention

3. Results

3.1. Stimulation threshold by auditory and visual stimuli

According to the data obtained by descriptive statistics (Table 1), it can be observed that the data do not behave in accordance with the Gaussian distribution, since the mean values (arithmetic mean and median) are not located at the same point on the x-axis. The dispersion is not large (standard deviation and variance), and the variability is very weak (coefficient of variation <10%) to relatively weak (coefficient of variation 10-30%). Moreover, according to the obtained values, it is evident that there are no extremes, but that the data behave in accordance with the theoretical probability distributions "with a tail".

By comparing the function of the variables “experimental” and “control group”, the stimulus threshold for auditory and visual stimuli has been determined through statistical data processing for the two variables.

The variability of the time required for the response is expressed in milliseconds (ms),and refers to the constancy (stability) or instability (instability) of the time required for the respondent to react to the stimulus. Despite the fact of the the stimulus on the screen alternates at fixed intervals of 2 seconds, sometimes the respondent's response time is a steady rhythm and sometimes it is uneven.

For the variable Variability response time (RT Variability), the stimulus threshold between the experimental and control groups for the auditory stimulus is 263 ms (Picture 2), while for the visual stimulus it is 371 ms (Picture 3).

From the above described data, it can be concluded that there is a statistically significant difference between the stimulus threshold between the experimental and control groups, with a higher stimulus threshold for visual stimuli compared to auditory ones. The results presented show that the T.O.V.A. test can determine the threshold of stimulation of auditory and visual stimuli that negatively affect the communication process in children with ADHD, thus confirming the first hypothesis (H1).

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Table 1: Descriptive statistics for the variable RT Variability

	Experimental group auditory	Control group visual	Experimental group auditory	Control group visual
Minimum (ms)	243	208	103	169
Maximum (ms)	296	335	256	362
Range (ms)	53	127	153	193
Arithmetic mean (ms)	267,8	300,2	182,33	283,8
Median (ms)	256	315	177	293
Variance (ms)	419,36	2230,16	2382,22	3973,36
Standard deviation (ms)	20,48	47,22	48,81	63,03
Coefficient of variation (%)	7,65	15,73	26,77	22,21

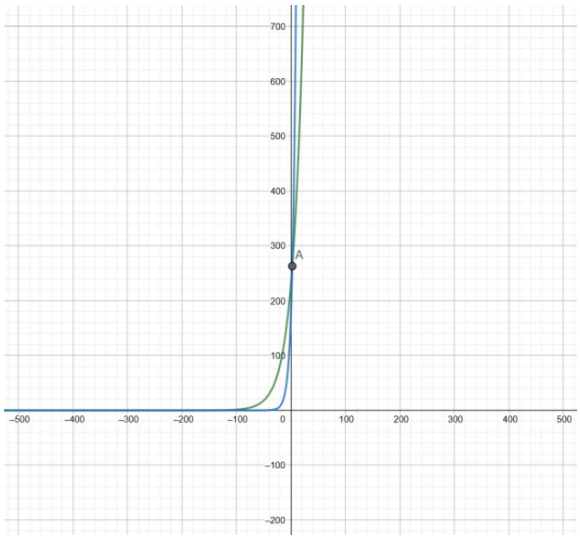

Figure 2: Intersection of RT Variability, auditory stimulus

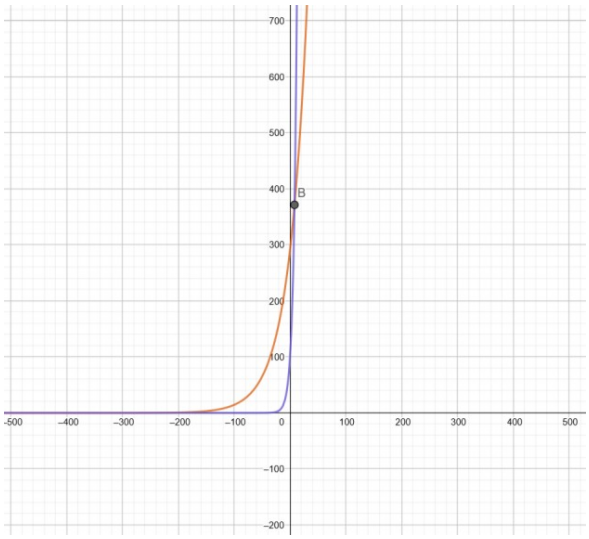

Figure 3: Intersection of RT Variability, visual stimulus

3.2. Errors in reception, processing and interpreting information

According to the data obtained by descriptive statistics (Table 3 - 4), it can be observed that the data do not behave in accordance with the Gaussian probability distribution except for the experimental population auditory - Omission errors. The dispersion is medium to large (standard deviation and variance), and the variability is very strong (coefficient of variation > 70%) for both tests of the regular population - Omission errors, which with large differences between arithmetic mean and median indicate the existence of extremes.

Errors in the midst of impulsivity occur when the respondent fails to control the response and incorrectly answers a non-target, that is, the respondent presses a button after the non-target is presented in a visual and auditory test situation.

The study confirmed that errors due to impulsivity occur to a greater extent in the experimental group of children with ADHD (Table 3). The table shows that errors occur more often as a reaction

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to a visual stimulus than to an auditory one. The obtained values can be represented by an arithmetic mean of 33.4 errors in the experimental group, compared to 27.17 errors in the auditory stimulus control group. Also, a considerable difference is noticed between the experimental and control groups in the errors that occur in relation to the visual stimulus. During the test, the experimental group made an average of 48 errors, while the control group made 8 errors.

Table 3: Descriptive statistics for impulsivity errors

	Experimental group auditory	Experimental group visual	Control group auditory	Control group visual
Minimum	7	31	12	6
Maximum	46	72	59	13
Range	39	41	47	7
Arithmetic mean	33,4	48	27,17	8
Median	37	43	16,5	7
Variance	189,04	210,80	327,14	6,8
Standard deviation	13,75	14,52	18,09	2,61
Coefficient of variation (%)	41,17	30,25	66,58	32,60

Errors in the midst of inattention occur when the respondent does not respond to the indicated target; that is, the subject fails to press the T.O.V.A. microswitch button when the target is displayed.

The table (4) shows he testing of the significance of the difference between the experimental and control groups. The table shows that there is a statistically significant difference between these two groups of respondents in relation to the examined variables. The study confirmed that inattention errors occur to a greater extent in the experimental group of children with ADHD (Table 4). The table shows that errors occur more often as a reaction to a visual stimulus than to an auditory one. The obtained values can be represented by an arithmetic mean of 28.8 errors in the experimental group, compared to 9.17 errors in the control group for auditory stimulus. Furthermore, a large difference between the experimental and control groups in the errors that occur in relation to the visual stimulus is observed. During the test, the experimental group made an average of 49 errors, while the control group made 13.8 errors.

From the results in tables (3 and 4) it is possible to determine that the errors of sensory modulation of reception, processing and interpretation of information significantly affect the outcome of the communication process in children with ADHD, which confirmed the hypothesis two (H2).

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Table 4: Descriptive statistics for omission errors

	Experimental group auditory	Experimental group visual	Control group auditory	Control group visual
Minimum	23	15	0	2
Maximum	34	69	21	32
Range	11	54	21	30
Arithmetic mean	28,8	49	9,17	13,8
Median	29	66	6,5	8
Variance	13,76	506,80	59,81	144,96
Standard deviation	3,71	22,51	7,73	12,04
Coefficient of variation (%)	12,88%	45,94%	84,36	87,25

4. Discussion

Sensory stimulus processing is an extremely complex process affected by a multitude of factors. The individual constantly receives stimuli, depicts them, responds, interprets, observes the consequences of responses, reinterprets, produces new answers, reinterprets them, and so on. Communication thus becomes a multimodal process that can no longer be explained by simplified schematic representations that are still prevalent in the professional and scientific literature.

Sensory processes modify the basic scheme of communication theory as follows: between the stimulus and the reaction, sensory process is a mediating factor, which is based on the personal particularities of an individual. These, however, are formed on the basic psychophysical characteristics of the individual, but also the interaction with the environment, in the form of specifics in the reception, processing and interpretation of stimuli from the environment.

The results of the experimental study confirm the hypothesis that the TOVA test can determine the threshold of stimuli of auditory and visual stimuli that negatively affect the communication process, showing that the variability of response is greater for visual stimuli compared to auditory ones. Individuals with ADHD show difficulty in visual-auditory prediction, and a longer time required to interpret sensory stimuli, or a longer reaction time to a stimulus. The obtained data suggest that individuals with ADHD have particularities of sensory processing of auditory and visual stimuli that are manifested through specifics in perception and the possibility of predictive information processing. The results of the research indicate several errors during the communication process in the form of receiving, processing, and interpreting information. The study showed that there is a significant difference between the experimental and control group of respondents, and confirms that in subjects with ADHD there are more errors in sensory processing of auditory and visual stimuli, with a higher probability of error in visual than in auditory stimulus,

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which needs to be taken into account when creating and interpreting modern communication models.

The modern communication model should certainly be based on individual differences and processes of selecting stimuli from the environment based on the perception and attention of the individual. Stimuli from the environment affect the outcome of the communication process to a large extent, which largely depends on the variability of attention and perceptual attributes of the stimulus, as well as their reception, processing and interpretation in children with ADHD.

5. Conclusion

Due to the fast pace of life as well as technological and organizational progress of modern societies, new possibilities within the paradigm of the communication model are emerging in the information and communication sciences. Improving such circumstances should result not only in the creation and analysis of models, but also in supporting researchers, professors, parents, and children in the creation of advanced algorithms for analyzing the impact of environmental stimuli, which would lead to the reduction of the impact of noise in the communication process.

The degree of openness to multimodal concepts is a determinant for the introduction of modernity and diversity in communication processes. Given the competitiveness, dynamics and diversity of communication processes, it is extremely important to include the importance of stimuli, as well as individual characteristics of the individual, and their threshold of stimuli depending on the difficulties they encounter to make communication a truly interactive process, taking into account “noises” and all their specifics. It is especially important to do so with the population of children with ADHD that has a prediction of growth in the coming years. Determining the threshold of auditory and visual stimuli is crucial so that the amount of noise can be reduced to a minimum, so the threshold of stimuli is a basic component of the sensory multimodal communication model. The contribution of this research is manifested in the inventiveness of the approach to the communication model, the display of stimulus thresholds and difficulties in sensory modulation that provide guidelines for further research, as well as guidelines for improving the communication competence of children with ADHD. In future scientific research, it is necessary to increase the number of respondents to make the results more relevant.

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