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Features of the perception and understanding of emoji by adolescents with different levels of intelligence

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Abstract

The present study aims at the comparative analysis of the patterns of the identification of images that reflect basic and complex emotions by adolescents with mild intellectual disturbances and by normatively developing peers. The research involved two groups of adolescents. Author's technique was developed and further applied, containing seven multiple choice tasks to study the non-verbal information perception patterns in adolescents with mild intellectual disturbances. It was determined that during saccadic eye movements, all adolescents, regardless of the level of intellectual development, better define such emotions as "joy" and "fear". For normatively developing adolescents, the zone of interest corresponds to the mouth area as the most moving part of the face, while peers with mild intellectual disturbances take longer to examine the eye area, which is inherent in children in the early stages of ontogenesis. Data indicate that normatively developing adolescents can combine individual image elements into a single whole, while adolescents with intellectual disabilities, lingering on individual image elements, are incapable of creating a single image of it.

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1. Introduction

The emergence of new communication technologies leads to optimisation of written messages, and the form of written speech is substantially transforming. During the exchange of information, digital skills form based on graphic images – graphicons – which curtail the time of writing a message without losing the semantic content (Thompson & Filik, 2016) or even add meaning to the written text (Alshenqeeti, 2016). In everyday communication, emojis

(emoticons and ideograms) are widely popular. Their combination with the text enables the reader to quickly reproduce the type of emotional nature of the message (Riordan, 2017) and the emotional state of the person in the process of encoding and decoding the message (Danesi, 2016).

All the studies aimed at describing the accuracy of identifying emojis by people indicate a significant difference in the interpretation of their meaning (Jaeger et al., 2018). Miller and co-authors discovered that 304 test subjects of the United States of America were capable of identifying and presenting the content of emojis equally only in 25% of cases (Miller et al., 2016). Most of authors agree that the direct analysis of a particular graphic image is based on the general context which can be very limited, thereby causing a different interpretation of the content of messages. In some articles, emojis are considered as a reflection of the emotional state of the author (Alshenqeeti, 2016), while others see them as an alternative gesture activity (Tolins & Samermit, 2016) which may not correspond to the inner experience of the addresser. During further research, it becomes clear that identification and interpretation of different graphic images of emotional states depends on the age, gender, and experience of interlocutors in the use of text communication, as well as the cultural context of communication (Gibson et al., 2018; Nishimura, 2005).

J. Russell (1985) finds that as early as in the first 2-4 months after birth, children are able to differentiate between some gestures and changes in the face expressions and voice intonations of the adults caring for it, and they respond to them quite adequately. However, the child does not perceive emotion as a holistic phenomenon at that age but is able to differentiate between separate elements included in the emotional symptom complex. The synthesis of these elements begins at 4-8 months, which allows children to distinguish between different classes of emotional manifestations, but Russell believes that at this age the child cannot attach meaning to them. Later, upon mastering emotional expression, children start differentiating between emotions according to two criteria: pleasantness-unpleasantness and the degree of activation. The child begins associating the emotional expressions of the state of close persons with the context in which they manifest. A realised contextuality allows to distinguish the same emotion in different communication situations. Gradually, words are added to this set of related events. During the second year of life, the child is ready to combine such diverse phenomena as the facial expression, context, behaviour, and words.

At the age of three, in the process of communication, a normatively developing child is capable of presenting sequences and combinations in the form of scenarios with predictable consequences and meaningful attachment to specific words.

The scenarios for each certain emotion are created at different ages in the course of the entire life and are determined by the child's experience, environment, culture, and many other factors (Russell, 1985). One may assume that the basis of social competence starts forming in children with the normative and deficient types of development at the same time, but gradually, cognitive differences start to manifest. Moreover, the maximum differences are observed in adolescence, since the abilities for verbalisation of scenarios are significantly weaker in adolescents with intellectual disturbances. For children with intellectual disturbances, communication with peers is described by the expression of feelings that is accompanied by changes in intonation and expression of emotions often beyond the context of the communicative situations. In communication of these children, facial expressions and pronounced intonations are observed – from affects to delight. It is difficult for these children to differentiate and understand emotions, impulsivity is inherent for such children (Jahoda et al., 2016; Matheson & Jahoda, 2005).

Indeed, it was proven that for children with intellectual disabilities, identification of facial expressions (McAlpine et al., 1991) and interpretation of emotions from the context of an event are challenging (Ališauskaitė & Butkienė, 2013). In the analysis of emotions, it is accepted to distinguish basic emotions (Ekman, 2006), although their number substantially varies in different classifications. The non-verbal communication of children with intellectual disturbances differs from the normative variant of development by certain features due to the underdevelopment of motor skills and the coordination of movements, the underdevelopment of the emotional sphere, including the inability to express personal state and understand the facial expressions of other people (Brosgole et al., 1983; Embregts & Van Nieuwenhuijzen, 2009). The social behaviour of children with intellectual disturbances is negatively affected by the difficulties in the self-control of aggressive impulses (Jahoda et al., 2016; Matheson & Jahoda, 2005). However, the issue of actual presence of difficulties in expressing and understanding emotions in these children remains controversial, since many of them adapt to different social conditions and are capable of maintaining a conversation, despite the limitations in expressing their emotions and the presence of cognitive limitations in understanding the facial expressions and gestures of interlocutors.

The wide prevalence of new types of communication brings up the issue of accessibility to master emojis of adolescents with mild intellectual disturbances, the adequacy of the interpretation of digital images of human emotions and the ability to draw correct conclusions. That is, the question is how effective they can be in such communication when compared to their peers with normative development.

On the one hand, children with intellectual disturbances perceive images that are well-known to them more accurately than text messages (Zashchirinskaya et al., 2015); on the other hand, it is proved that there are difficulties in the accuracy of their interpretation in the non-speech and paralinguistic messages (Zashchirinskaia & Nikolaeva, 2018; Zashchirinskaya et al., 2018). The main problem may be that emoji is not an emotion, but a very simplified sign of emotion. At the same time, it is the most challenging for people with intellectual disabilities to understand sign informative phenomena (Cluley, 2018).

The purpose of the present study is to conduct a comparative analysis of the patterns of identification of images that reflect basic and complex emotions by adolescents with mild intellectual disturbances and by normatively developing peers. Inborn emotions are considered to be basic if they have a known physiological basis (for example, Ekman, 2006; Izard, 2009; Tangney et al., 2007). These include disgust, anger, fear, happiness, sadness, and surprise (Feldman Barrett et al., 2007). This is an outdated view, since current research methods identify the physiological basis for all emotional experiences and link them not to specific structures, but to neural networks (Wang et al., 2019). We use the term "basic emotions" because it is widely used in the literature. Apart from basic emotions, there are emotions, in the acquisition of which experience and socio-cultural practices had a significant impact. These include primarily shame and guilt (Malti, 2016). Adolescence is the period when a person focuses more on social interactions, trying to break out of the narrow family circle. The authors hypothesised that the perception and understanding of these two groups of emotions will develop in normatively developing adolescents and adolescents with intellectual disabilities. Moreover, it appeared important to authors to compare the perception of emoji that reflect these emotions.

2. Materials and Methods

The study involved two groups of adolescents: 30 individuals at a normative level of intellectual development (the mean age of 13.3±0.45 years, 14 boys and 16 girls), and 30 adolescents with intellectual disturbances (the mean age of 14.1±0.49 years, 16 boys and 14

girls). The authors developed and employed an original technique (according to O.V. Zashchirinskaia) containing seven multiple choice tasks to investigate the patterns of perception of the non-verbal information by adolescents with mild intellectual disturbances. Each task had one word for the emotion and four emojis, one of which matched the verbal stimulus.

The study used a list of basic emotions found in different classifications: surprise, shame, joy, interest, guilt, fear, and sadness. The authors did not take the abilities to understand such emotions as interest, embarrassment, grief, and disgust into consideration, as it was proved that they were often misinterpreted by children with the deficient type of development (Nikolaeva & Kolcheva, 2010). Each adolescent was examined individually at the following stages: 1) the standardised instruction; 2) the eye tracker calibration; and 3) the completion of seven tasks presented visually one by one in random order on the computer screen. The answers chosen by each of the subjects were said aloud (for students at the normative level of intellectual development) or indicated by pointing at the screen (for students with intellectual disturbances) and then recorded by the experimenter. The time for perception, recognition, and selection of the emojis was not limited. After the adolescents made a choice, they were asked to explain why this particular choice was made.

The use of registration of the subjects' eye movements to assess the directed attention to the stimulus was used to objectify the subjective assessment of the reasons for the testee's choice. Then the duration of the fixation of a look at a particular emoji and particular word denoting emotions can suggest an assumption regarding the difficulty of the task and the duration of the decision (Loschky et al., 2015).

The registration of eye movements was performed on the EyeTech VT3 mini eye tracker at a sampling rate of 60 Hz with the Mangold Vision software. The duration of the task completion and the number of correct answers was recorded for each adolescent. The following parameters of oculomotor activity were also calculated: 1) the total number of fixations; 2) the average length of saccades; 3) the number of fixations on the correct and false answers; 4) the duration of a look at the correct and false answers; 5) the number of fixations and the duration of look at the eyes and mouths of emojis. These parameters were calculated for all seven tests on average and for each individual presentation of emojis. The obtained data were processed via the IBM SPSS 22 statistical package.

3. Results

Based on the empirical data obtained, the mean indices of the patterns of visual perception of the schematic image of emotions in the form of emoji were analysed (Table 1).

Table 1. Comparison of performance indicators of the technique by the adolescents with the normative intellectual development and adolescents with mild intellectual disturbances.

Variations	Norm		Intellectual disturbances		Significance	
	Mean	Standard deviation	Mean	Standard deviation	F	p
Duration of performance	15.36	0.57	37.40	0.48	26.413	0.000
Quality of fixations	32.42	2.99	72.11	2.40	3.065	0.006
Mean saccade length	364.84	38.08	231.65	18.61	2.268	0.011
Quality of fixations on correct answers	6.90	0.50	15.10	0.46	4.080	0.003
Duration of look at correct answers	4.92	0.25	7.35	0.12	2.495	0.009
Quality of fixations on false answers	2.96	0.30	12.01	0.40	9.235	0.001
Duration of look at false answers	1.18	0.06	6.02	0.05	11.372	0.001
Quality of fixations on the emoji's eye zone	2.05	0.30	13.00	0.40	14.233	0.000
Duration of look at the emoji's eye zone	1.02	0.03	5.33	0.07	18.828	0.000
Quality of fixations on the emoji's mouth zone	6.06	0.51	5.03	0.24	1.224	0.028
Duration of look at the emoji's mouth zone	2.82	0.12	4.02	0.05	2.599	0.012

Table 1 shows that it takes twice as much time for adolescents with intellectual disturbances to perform each task, and the number of fixations has also turned out to be twice as large in comparison with the normatively developing peers. The test subjects in both groups misidentified the emoji in case when they glimpsed at the image, although the identification speed steadily slows down by two times in adolescents with intellectual disturbances. In adolescents with the normative development, the mean length of saccades was greater, allowing them to see a complete image of the emoji. Presumably, due to a shorter length of the saccades, the adolescents with mild intellectual disturbances faced difficulties in identifying and interpreting the graphic image of emotions at large. In cases with correct answers, the adolescents statistically took a longer looked at the emojis.

The fact of a long look and the frequency of the fixation on the image of the emoji's mouth in the normatively developing adolescents is of particular interest. Their peers with intellectual disturbances often focus on the eyes. Adolescents with normative development distinguish between direct person-to-person communication, when the expression of the eyes depends on

the experienced emotion, and the identification of emoji, where the emotion is more likely to be associated with a change in the mouth. Adolescents with intellectual disturbances fail to notice this feature (Christou-Champi et al., 2014).

The study found that the adolescents with intellectual disturbances spend much more time to identify and interpret the emotions than children with normative development. Qualitative analysis showed that in their answers they are not always capable of formulating the results of the analysis of the image of emoji, inadequately interpreting people's actions; they cannot substantiate the false name of emotions. They have a specific and unified understanding of emoji. The study identified difficulties in correlating emotions and situations of interaction. These adolescents may call different schematic images of emotions by the same name. For instance, the "surprise" emoji is identified as fear, and "shame" as the emotion analogue of "guilt".

Patterns of visual perception of emoji were detected, first and foremost, with a cognitive component of non-verbal communication, the implementation of which is impaired in adolescents with mild intellectual disturbances due to underdevelopment of intellectual functions. The obtained results correspond to numerous scientific studies on the dominant value of the lower part of the face in the process of recognising emotions. The schematic representation of emoji, as well as in the visual transmission of basic human emotions, allows to display the expressiveness of the lips and mouth.

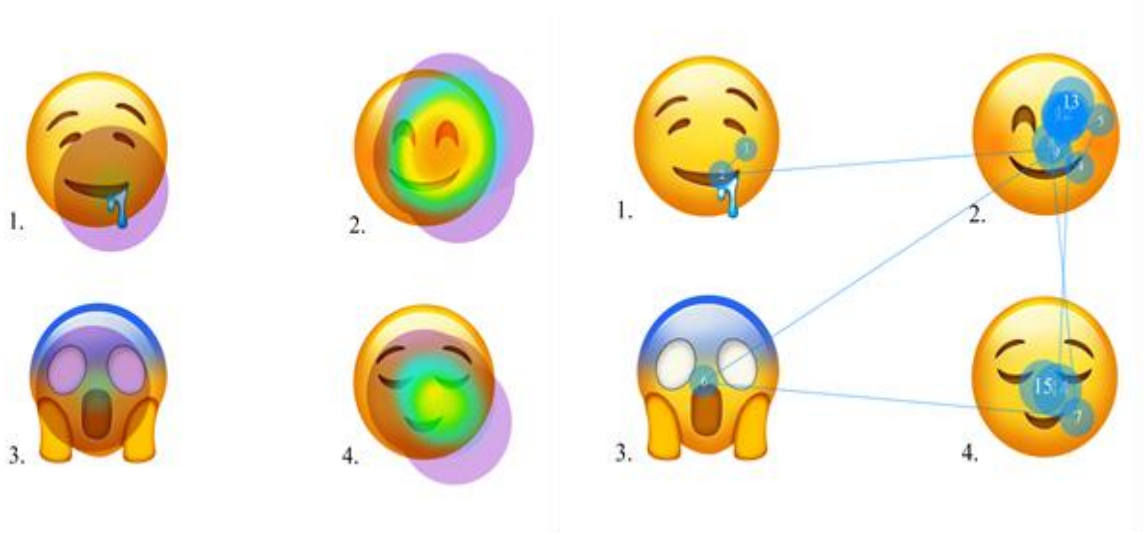
Table 2. The comparison of the success rate after the completion of tasks by adolescents with normative intellectual development and with mild intellectual disturbances

Emotions	**Group**	**Success rate after the fulfillment of the task**		**Pearson's chi-squared test**	
		Correct	**False**	**Criterion value**	**P**
Surprise	Norm	28	2	12.273	0.001
	intellectual disturbances	16	14		
Shame	Norm	26	4	14.067	0.000
	intellectual disturbances	12	18		
Joy	Norm	30	0	5.455	0.052
	intellectual disturbances	25	5		
Interest	Norm	28	2	6.667	0.021
	intellectual disturbances	20	10		
Guilt	Norm	26	4	14.067	0.000
	intellectual disturbances	12	18		
Fear	Norm	29	1	2.963	0.195
	intellectual disturbances	25	5		
Sadness	Norm	28	2	15.556	0.000
	intellectual disturbances	14	16		

Table 2 shows that all adolescents excel at recognising two particular emotions: "joy" and "fear". The normatively developing adolescents have never made a mistake in identifying the

emotion of joy (Fig. 1). All adolescents successfully identify the emotion of fear because it is directly associated with survival. The most difficult thing for the adolescents with intellectual disturbances is to identify the complex emotions of shame and guilt. It can be explained by the fact that each of the said emotions has a significant variability connected with personality features of the interlocutor expressing it and the context from which adolescents acquired their personal understanding of the emotion and its causes as a child (Keltner et al., 2014; Panksepp, 2016; Panksepp et al., 2017).

a)



b)

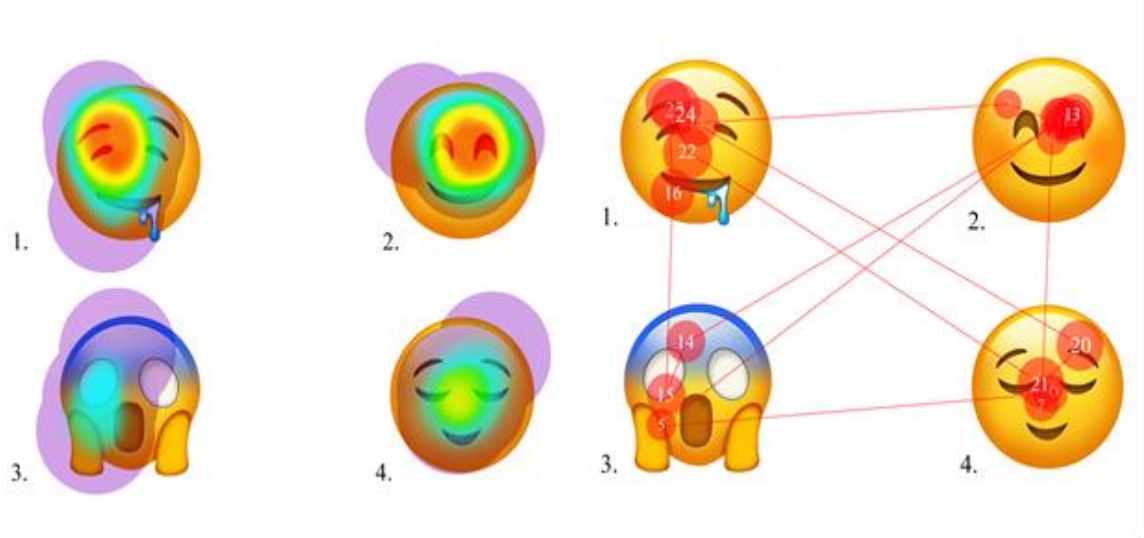


Fig.1 Areas of look fixations during the completion of the "joy" task by normal intelligence adolescents (a) and adolescents with intellectual disturbances (levels of statistical significance of differences in the duration of fixation in adolescents with different levels of intellectual development are presented in Table 1).

The emotions of interest, surprise, and sadness occupy an intermediate position. Emotions of guilt and shame are least identified by adolescents with mild intellectual disabilities. They are considered to be self-evaluative, self-conscious ones, and require complex cognitive activity, which is impaired in these adolescents (Karpova & Nikolaeva, 2020).

In this study, all adolescents also successfully identify the emotions of joy and fear. They start mastering words related to emotions as well as physiological states (Ridgeway et al., 1985). The use of words by a particular child is determined the frequency the words close to its experience are used with an emotional colouring in a conversation, as well as the frequency the child and its loved ones express this emotion.

It was previously demonstrated that normally, the maximum change in the ability to describe the emotional experience appears between the ages from 10 to 12 years old (Lewis et al., 1987). This is explained by a significant improvement in the children's verbal function. Most families rarely talk about emotional states directly, therefore children rarely use them. The relative frequency of conversations about emotions grows from 2% of all the statements at the age of 3-4 years old to 8% at the age of 5-6 years old (Peake & Egli, 1992). Little is known about the use of emotionally charged words in the case of the normative development of children in adolescence, and especially among peers with intellectual disturbances. At the same time, the number of errors presented in table 2 suggests that this occurs rather rarely. Normatively developing children gain an opportunity to test their skills of emotional communication at school, receiving both positive and negative feedback. It enhances their ability to differentiate between the emotions of others and distinguish significant features of emotional expression. Children with intellectual disturbances do not have this experience due to the disturbed reflection, and difficulties in identifying features of emotional response.

Table 3. Comparison of the duration of completion of the tasks by the adolescents of the two groups

Emotions	**Norm**		**Intellectual disturbances**		**Significance**	
	Mean	**Standard deviation**	**Mean**	**Standard deviation**	**F**	**P**
Surprise	15.24	1.46	36.78	0.54	56.991	0.000
Shame	16.50	1.51	37.13	2.55	14.533	0.000
Joy	13.49	1.13	35.28	0.41	98.605	0.000
Interest	15.96	1.60	37.86	1.75	25.539	0.000
Guilt	16.44	1.09	38.27	1.43	44.254	0.000
Fear	13.60	1.49	37.52	0.91	56.227	0.000
Sadness	16.29	0.87	38.97	1.09	79.017	0.000

The adolescents with the normative development cope with the task of identifying the emotion and understanding the meaning of emoji almost two times faster in comparison with the adolescents with mild intellectual disturbances (Table 3).

4. Discussion

Emotion identification is a key feature of emotional competence. Emotion identification skill is defined as the ability to identify, label, and describe one's emotions (Ciarrochi et al., 2008). With that, adolescence constitutes a critical period for social relationships which requires emotional competence (Collins & Steinberg, 2008; Leyden & Shale, 2012). This period is particularly challenging for adolescents with mild intellectual disturbances, since their cognitive abilities are insufficient in terms of forming successful emotion identification skills. If earlier emotions and cognitive processes used to be considered as separate phenomena, nowadays, emotions are considered as a fundamental, inseparable component of cognition and its neural underpinnings (Pessoa & Adolphs, 2010). It is precisely this fact that suggests that the more complex an emotion, the more challenging it is for an adolescent with mild intellectual disturbances to identify it.

Modern interaction technologies are connected not only with emotion identification, but also with necessity of identifying the signs of these emotions, such as emoji. Currently, emojis occur not only in everyday communication, but in various kinds of applications as well. Therefore, understanding the connection of an emoji with a particular emotion is also required for mastering new job opportunities in digital environment. It is necessary to compare the patterns of the identification of images that reflect basic and complex emotions by adolescents with mild intellectual disturbances and by their normatively developing peers.

Our data show that the most important pattern indicating the correct identification of emotions in the form of a graphic stimulus is the combination of the fixation duration and the quantity of the fixations on these stimuluses. In this case, however, the duration and the number are relative concepts, since this combination may differ for each emotion, as there are easily identifiable (i.e. joy and fear) and complex emotions (shame and guilt). It can be assumed that both the emotions of fear and joy, and their emoji signs each have unique features.

It is known that "basic" emotions require merely an automatic information processing mechanism for their elicitation (Öhman & Mineka, 2001). Unlike moral emotions such as guilt and shame, which require a higher degree of cognitive and emotional processing (Gummerum et al., 2013; Malti & Ongley, 2014; Uren, 2013). It was shown that these two group of emotions need distinct neural circuits (Michl et al., 2012), because guilt and shame recruit brain regions implicated in social cognition and social interactions, but basic emotions are not associated with these regions as it was shown in meta-analytic reviews (Fan et al., 2011).

If earlier the presence of brain structures responsible for a particular emotion was proposed as a criterion for identifying basic emotions, at present it has been proven that this criterion does

not correspond to reality. Moreover, even the concept of "the limbic system" is now considered to be obsolete, since that "system" is responsible not only for emotions, but for cognitive processes as well (Phelps et al., 2014). Moreover, at present, speaking about information analysis, not structures are considered, but neural networks (Spano et al., 2002).

Our data indicate that basic emotions can differ precisely in the ease of recognition. This means that such emotions as guilt and shame belong to social emotions, and not to the basic ones, since both the normatively developing adolescents and the adolescents with intellectual disturbances fail to recognise them in the schematic form of emoji.

The pattern that distinguishes the identification of emotions by the healthy adolescents from the adolescents with intellectual disturbances is the length of the saccades: they are longer in the normatively developing adolescents. This may suggest that due to longer saccades, adolescents with normative development perceive a more coherent image as against adolescents with mild intellectual disturbances. The study proves that normatively developing adolescents can recall a holistic image of emoji by including all its elements in the analysis. At the same time, adolescents with intellectual disturbances include a decision on modality of only part of the entire image in the final analysis, which does not allow them to draw correct conclusions as to the what emotion the emoji in front of them represents. In the course of this study, the authors discovered that one of the patterns that distinguishes the recognition of emotions in healthy adolescents from adolescents with intellectual disabilities is the length of saccades. At present, this area is understudied, therefore this can become a subject for further research.

Obviously, the schematic nature of the image of emoji is such that it is the analysis of the location and fixation of the mouth that ensures the clearest answer about the quality of the emotion, while the analysis of the image of the eyes is significantly inferior in this regard. It can be assumed that this difference is conditioned by the fact that, upon analysing emoji, normatively developing adolescents abandon the strategy of analysing emotions according to their eyes, which is customary in society (de Melo et al., 2014; Prada et al., 2018), while adolescents with intellectual disabilities rigidly transfer the strategy of analysing real human faces to the analysis of a schematic representation of an emotion (Shuman et al., 2017).

5. Conclusions

It was determined that during saccadic eye movements, all adolescents, regardless of the level of intellectual development, better define such emotions as "joy" and "fear". It can be assumed that the emotions themselves – fear and joy – and their emoji signs have special distinctive features that predetermine their correct identification. Other emotions, such as shame and guilt (and their respective emojis), have partially identical elements. The presence

of intellectual disabilities increases the time for considering emojis of basic human emotions. These adolescents have significantly higher focus when analysing parts of the face, as this simplifies the task of image perception.

Furthermore, with a decrease in intelligence, a differential analysis of images of emotions with similar details poses a greater challenge, because one particular fragment on the face of a person is being singled out, while the entire set of facial expressions transmitting certain emotional states is disregarded. Most emojis have similar elements, which complicates the identification of basic emotions in majority of the cases.

Differences in fixation of look between adolescents with different levels of intellectual development were discovered. For normatively developing adolescents, the zone of interest corresponds to the mouth area as the most moving part of the face, while their peers with mild intellectual disturbances take more time to examine the eye area, which is inherent in children in the early stages of ontogenesis.

It was established that in terms of verbal descriptions of emotions corresponding to their schematic emoji depiction, adolescents with intellectual disabilities face difficulties in accurately naming emotions and substantiating the correctness of their identification. Difficulties in verbalising any experiences and solving cognitive tasks have been described by other authors on multiple occasions. Data indicate that normatively developing adolescents can combine individual image elements into a single whole, while adolescents with intellectual disabilities, due to lingering on separate image elements, are incapable of perceiving a holistic image.

6. Limitations

Unfortunately, the sample comprised only 30 adolescents with intellectual disturbances. Conducting research with their participation is associated with objective difficulties in attracting children and their families to diagnostic programmes. An increase in the sample may allow to see the dependence of perception (or lack thereof) on the severity of intellectual disturbances. Since the effectiveness of emotional perception also depends on experience, it is useful to analyse the family composition and the specific features of the emotional atmosphere in it for all subjects.

Author Contributions

O. Zashchirinskaia – experimental design, research, interpretation of empirical results; E. Nikolaeva – writing a literature review and participation in a general discussion of the empirical results obtained; U. Hagedorn – participation in a general discussion of empirical results.

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