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Dolphin Assisted Therapy: Evaluation of the Impact in Neuro- Sensory-Motor Functions of Children with Mental, Behavioural and Neurodevelopmental Disorders

B. Kreivinienė[a,b], D. Mockevičienė[a]

Abstract

The aim is to evaluate the impact of dolphin assisted therapy (short-term) for neuro-sensory- motor functions of children with mental, behavioural and neurodevelopmental disorders. The study involved 123 subjects (36 girls and 87 boys). The subjects were aged from 7 to 18 years, the average age of the surveyed was 10.05 years (SD=3.16). All of the subjects have been diagnosed with mental, behavioural and neurodevelopmental disorder (ICD-10-CM) group codes: pervasive and specific developmental disorders (F80–F89), intellectual disabilities (F70–79) and behavioural and emotional disorders with onset usually occurring in childhood and adolescence (F90–F98). The duration of the participation differed as follows: the advanced subjects had complex neuro-sensory-motor activities with dolphins in the water and in the complementary sensory laboratory; the control group subjects participated without changing regular conditions of living. Overall, a complex neuro-sensory-motor intervention programme lasting for two weeks and comprising 10 activity sessions with dolphins in the water (30 minutes), 6 additional neuro-sensory-motor intervention activity sessions in the laboratory (30 minutes) oriented to the needs was applied to the participants of the investigated group. The surveyed were individually assessed on the same day before the start of the first activity session and on the next day after the last activity session. The participants of the control group participated in regular training sessions without changing the rhythm of their daily routine. After the first assessment, additionally, the control group was assessed two weeks later.All of the subjects were assessed according to: 1) questionnaire-based survey; 2) neuro- sensory-motor testing; 3) experiment, all applied before and after the investigation. Conclusions. Two weeks of complex neuro-sensory-motor interventions of dolphin assisted therapy with complementary activities had a significant influence on sensory modulation, reflex integration and balance. Meanwhile, the level of the performance of the sensory modulation and reflex integration as well as balance was not statistically significant. The set hypothesis of the research having it that, when applying complex methods of neuro- sensory-motor activity sessions involving dolphins, positive changes in the functioning of the neuro-sensory systems can yet be reported after 2 weeks, was proven.

Keywords:

1. Introduction

A group of ICD-10-CM in terms of pervasive and specific developmental disorders (F80–F89), intellectual disabilities (F70–79) and behavioural and emotional disorders with onset usually occurring in childhood and adolescence(F90–F98) are understood as disorders that also may affect the body position and movement, and cause psychomotor disturbance [1] resulting in psychosocial issues, such as adverse behavioural and emotional reactions [2]. Imbalance and muscle

[a] Klaipėda University's Faculty of Health Sciences, Klaipėda LT- 92294, Lithuania
[b] Lithuanian Sea Museum, Klaipėda LT-93100, Lithuania
**Corresponding Author: B. Kreiviniene*
Email: b.kreiviniene@muziejus.lt

weakness occur due to the immaturity of parts of the brain that control activity and movements of the muscles. The impairment is related with the part of the brain responsible for movements and sends the wrong signals to the muscles, causing the muscle tone to change [3]. The issues related to the vestibular sensory system are related to posture, balance, gaze stabilisation, spatial orientation, preparation for the "fight or flight" mode in emergency situation, physical and emotional security [4]. Such neuro-sensory-motor disturbances can also be regarded as an essential feature of emotional condition and depressiveness. Moreover, objectively measured motor behaviour, including gross motor activity, discrete body movements, speech and motor reaction time, have been shown to reliably differentiate depressed patients from normal comparison groups [5].

In the rehabilitation of children with pervasive and specific developmental disorders, alternative and non-traditional therapies are used in parallel with traditional therapies. The dolphin assisted therapy is one of these. It is believed that there is a tight connection between psychic and motor functions which is acknowledged not only by psychologists but also by physiologists, medical specialists [2; 6]. Scientific investigations prove that neuro-sensory- motor problems in people with the mental and behavioural disorder manifest as a reduced ability to adapt to stressful life events and, consequently, as a marked susceptibility to anxiety, mood, trauma and stress-related disorders as well as sometimes even to suicidal behaviours [5].

Recently, many research works have been performed on the benefits of dolphin assisted therapy for the disabled. In general, an animal plays a key role for child's motivation, emotional development, especially child's self-value, autonomy, sense of empathy towards others [7]. In the literature, we found works demonstrating positive evaluations of dolphin assisted therapy for children with mental, behavioural and neurodevelopmental disorders [8–11]. The dolphin assisted therapy can have a statistically significant positive impact on children with mental, behavioural and neurodevelopmental disorders: reduced stereotypical behaviour and better social communication [8], fine motor development, cognitive performance and verbal development [9]. Also, it is proposed that an emitted biosonar signal of the dolphin pulsed at low frequencies results in activation of piezoelectric collagen molecules within the body and generates a whole-body entertainment of the receptive nervous system. Such a mechanism could result in entertainment of the brain to produce specific low frequency components in conjunction with the previous mechanisms, as well as changes which result from increased endorphin production [10]. Moreover, it is explained by applying Malan's [11] concept of "transmission triangle" that the effect obtained in dolphin assisted therapy programmes can also be grounded on the interaction of child, dolphin and therapist, that creates a triangle in which the communication is redirected toward the child. Also, the dolphin assisted therapy involves: educational, environmental, safety, learning, interaction and many other factors determining a successful learning process. The dolphin assisted therapy in the water is performed with active movements in an ever-changing context. Such water-based activities can be fun and highly motivating. As Campion (1991, p. 12) notes, water interventions are "widening experience – physically, developmentally, cognitively, and psychologically" [12]. The psychomotor change is increased because of children with psychiatric and behavioural disorders nervous system's capacity to change in response to experience or neuroplasticity [13].

The hypothesis. We believe that when applying the neuro-sensory-motor intervention including the dolphin assisted therapy programme in the water and individual neuro-sensory- motor activity sessions outside the water, it is yet possible to report initial positive changes in the neuro-sensory-motor systems after 2 weeks.

The aim: To evaluate the impact of the dolphin assisted therapy programme in the water (10 sessions) with individual neuro-sensory motor activities outside the water (6 sessions) for neuro-sensory-motor functions of children with mental, behavioural and neurodevelopmental disorders.

We conducted our research in accordance with the Convention of the Human Rights and Dignity in Medicine approved on 19 November 1996 (The Convention of Human Rights and Biomedicine) (Rodgers and Bousingen, 2001). The subjects and their parents/ guardians were introduced the purpose of our investigation, as well as the methods, procedures and possible inconveniences. Klaipėda University Department of Holistic Medicine and Rehabilitation Committee on Biomedical Research Ethics (No. SV-HRK-8, 28-03-2019.) issued the permit for the biomedical research.

2. Materials and Methods

Materials

The study took place at the Dolphin Assisted Therapy Centre of the Lithuanian Sea Museum in

the Republic of Lithuania. The results of the survey of the control group were collected in three centres for special education in Lithuania. The investigation was being carried out throughout April– November 2019 in Lithuania. The survey involved 123 participants (33 in the investigated group, 90 in the control group). The intervention research was being implemented in compliance with the rules of good clinical practice. The criteria for selection of the participants:

- ✓ school age, from 7 to 18 years (see Table 1);
- ✓ all have the ICD-10-CM F (00–99) diagnosis;
- ✓ independently (or their parents) agree to participate in the research.

The research involved 70.7 per cent (87) of male and 29.3 per cent (36) of female participants. The average age of the surveyed was 10.05 m (SD=3.16) (see Table 1).

Table 1. **Characteristics of the participants' age.**

		Statistic	Bootstrap[a]			
			Bias	Std. Error	95% Confidence Interval	
					Lower	Upper
N	Valid	123	0	0	123	123
	Missing	0	0	0	0	0
Mean		10.05	.00	.33	10.51	11.83
Std. Deviation		3.158	-.020	.200	3.126	3.883
Minimum		7				
Maximum		18				
Percentiles	25	9.00	-.32	.46	8.00	9.00
	50	10.00	.29	.59	10.00	12.00
	75	13.00	-.21	.54	13.00	15.00

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

The study involved 123 subjects (36 girls and 87 boys) who were aged 7 to 18 years (10.5 years ± 3.16). All of the subjects were diagnosed with ICD-10-CM: intellectual disabilities (F70– F79), 30.7 per cent; pervasive and specific developmental disorders (F80–F89), 36.8 per cent; behavioural and emotional disorders with onset usually occurring in childhood and adolescence (F90–F98), 32.5 per cent. Group 1 (participants of the investigated group) comprised 33 subjects (21 boys and 12 girls) who regularly participated in dolphin assisted therapy sessions five times a week, two weeks in total with 2 days off and attending 3 additional neuro-sensory motor activities outside the water held after dolphin assisted therapy activities. Group 2 (participants of the control group) comprised 90 children (66 boys and 24 girls) who participated in the research without changing regular conditions of their living: all they were assessed for the first time and 2 weeks later in the special education centre where they live and learn.

Methods

To assess the surveyed, the following research methods have been chosen: questionnaire-based survey (A), neuro-sensory-motor testing (B), experiment (C). For Group 1 (participants of the investigated group), the test results were recorded before and at the end of the study; for Group 2 (participants of the control group), also, the results were recorded before and after the study. We used MS Office EXCEL 2003 for the data analysis. We evaluated the arithmetic average, ± standard error and the relative values. The reliability of the results was evaluated using the criteria of Student's *t-test*. The method of the questionnaire-based survey was employed to reveal objective data of the surveyed. The questionnaire consisted of two parts comprising 28 questions; its structure is presented in Table 2. The research sample is purposive because all research participants had mental, behavioural and neurodevelopmental disorders.

(A) Neuro-sensory-motor testing was evaluated:

- *Assessment of pathological reflexes:* Babinski reflex, Galant reflex, Asymmetrical tone neck reflex, Symmetrical tone neck reflex, Tonic labyrinthine neck reflex. All reflexes were assessed in a four-point scale, where indicated assessment was: 1 – hypersensitivity, 4 – no response to a trigger (positive result).

Table 2. **Structure of the questionnaire.**

	Sections	Questions
1	Socio-demographical data	Age, sex, living conditions, housing, family status, occupation, education, addictions.
2	Data of the health anamnesis and lifestyle	Chronic diseases, physical development, functional level of independent movement, mental disorder, quality of sleep, fatigue, vision, hearing, speech.

Berg balance assessment scale. It comprises 14-item tasks which are performed when sitting and standing. All tasks are assessed from 0 to 4. The ability of the surveyed to freely and independently perform specific suggested movements and retain a particular body positionfor a set length of time is assessed by 4 points, and 0 points are given if a person is unable to perform the task. A maximum available amount of test results is 56 points.

- *Sensory assessment*. The testing procedure consisted of 2 components: a trigger and participant's response to that trigger. In the course of the investigation, the following information was collected:
  - Evoked sensory type;
  - Amount of examined body sites;
  - Degree of sensory sensitivity (senses are absent, decreased sensitivity, delayed (protracted) response, normal sensitivity, increased sensitivity etc.);
  - Precise boundaries of sensory disorders – localisation (this will help to assess the site of injury);
  - Patient's subjective feelings of the sensory change;
  - Before examining a patient, his/ her spatial orientation was assessed.
- *Assessment of sensory modulation* (yes – 1; no – 2): sensory over-responsivity to a simple stimulus (SOR), sensory under-responsivity (SUR), sensory seeking (SS).

The experiment was applied when carrying out the intervention in the the Dolphin Therapy Centre's sensory integration laboratory which is adjusted for carrying out activities of vestibular, proprioperceptive and tactile intervention. All participants of the investigated group took part in the activity sessions lasting 30 min. three times per week (applied six in total) after the dolphin assisted therapy. The activity sessions proceeded individually, conducted by specialists of the Dolphin Therapy Centre. The programme of individual activities was designed in compliance with main aspects of the development of sensory systems. General principles of intervention:

1. Gradual transition from a horizontal body posture to vertical (from lying to sitting; from sitting to all-fours and/ or standing);
2. Performance of the movements on a stable ground and gradually moving to the unstable ground;
3. Training of balance while changing the size, height of the ground and gradually involving more complex exercises requiring coordination of movements;
4. Correction of pathological movements and teaching on correct movements in daily activities;
5. Stimulation of functional independence;
6. The activities were held in compliance with the principles of movement control and movement development.

(C) The experiment was held at the Dolphin Therapy Centre. The complex neuro-sensory- motor programme was being held for the participants for two weeks. On the first week, the participants attended: five dolphin assisted activity sessions in the water lasting 30 min. each, conducted by a specialist and assisted by 1–3 Black Sea bottlenose dolphins (*Tursiops truncatus ponticus*); additionally, three times per week, carried out individual neuro-sensory- motor interventions in the laboratory lasting 30 min. each, delivered according to the testing results on the day of the arrival. The water pool where the neuro-sensory-motor interventions were held had capacity of 60 m^3 and area of 55 m^2, depth from 0.40 cm to 1.50 m. The neuro- sensory-motor intervention sessions assisted by dolphins were organised while orienting toward individual testing results, stimulating purposeful interventions of the vestibular, proprioperceptive and tactile systems. The activities in the water were arranged in compliance with the animal welfare principles and applying positive reinforcement for the animals. A two- day break was made after the first week, and the same activities like on the first week were organised on the second week. On Tuesdays, Wednesdays and Thursdays, after the dolphin assisted therapy sessions, the activities continued with the neuro-sensory-motor interventions in the laboratory. Each of them lasted

30 minutes, was conducted by a specialist, orienting to individual testing results.

3. Result

The distribution of socio-demographic indicators (evaluation A) between the groups is presented in Table 3. All participants live with parents (79.8 per cent) or in care institutions (20.2 per cent), are not working (100 per cent). 77.2 per cent of the participants have primary education only, 4 per cent attend a special vocational centre, other 18.8 per cent attend a special school. Majority (58.5 per cent) of the surveyed live in a city or town and 41.5 per cent reside in a rural area or small towns. In the course of the research, 92.1 per cent of the surveyed attended institutions of either education or special education, the rest (7.9 per cent) attended social day centres only.

Table 3. **Socio-demographic characteristics of the research participants.**

	Investigated group (N=33)	Control group (N=90)	p
Age (years)	8 ± 3.4	12.1±2.9	0.001
Sex n (%)			
Girls	12 (36.4)	24 (26.7)	0.204
Boys	21 (63.6)	66 (73.3)	
Place of residence, n (%)			0.001
City, town	29 (87.9)	43 (47.8)	
Rural area	4 (12.1)	47 (52.2)	
Lives, n (%)			0.001
With parents/ guardians	33 (100)	67 (74.4)	
In a social care institution	0	23 (25.6)	
Occupation, n (%)			0.001
Learns	24 (72.8)	90 (100)	
Attends a day centre	6 (18.2)	0	
Not engaged in any activity	3 (9.1)	0	
Obtained education, n (%)			0.005
Primary	20 (60.6)	77 (85.6)	
Unfinished secondary	1 (3)	4 (4.4)	
Secondary	1 (3)	0	
Other	11 (33.3)	9 (10)	

Differences between the surveyed groups in terms of illnesses (Figure 1) with co-occurring diseases are statistically insignificant ($p>0.05$); however,the results demonstrated that nobody of the participants attributed to the investigated group indicated illnesses of the nervous system, whereas in the case of the control group there were even ten per cent of those who indicated that they had these diseases ($p<0.005$) (see Figure 2).

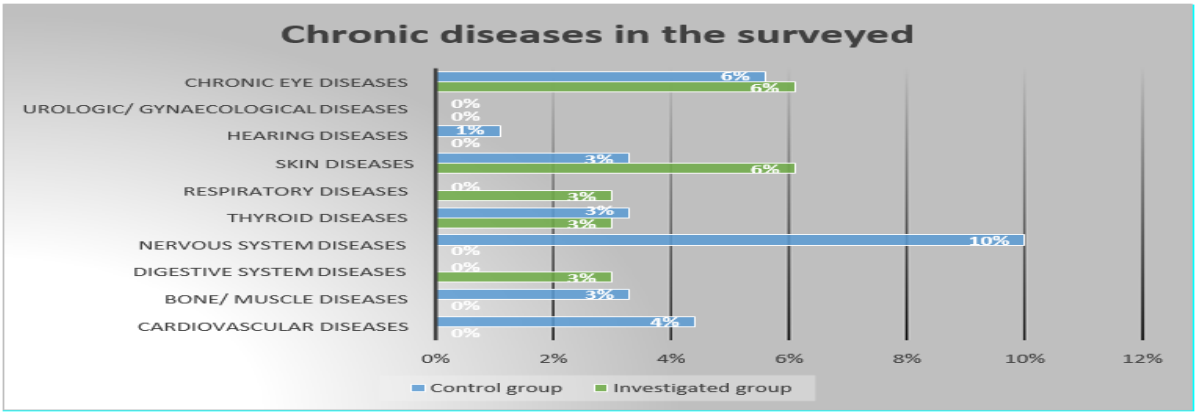

Figure 1. **Chronic diseases in the participants of the investigated and control groups, per cent.**

In terms of the disorders of the sensory systems, more than a half (52.9 per cent) of the participants of the investigated group have vision disorders and 27.7 per cent have hearing disorders (see Figure 2).

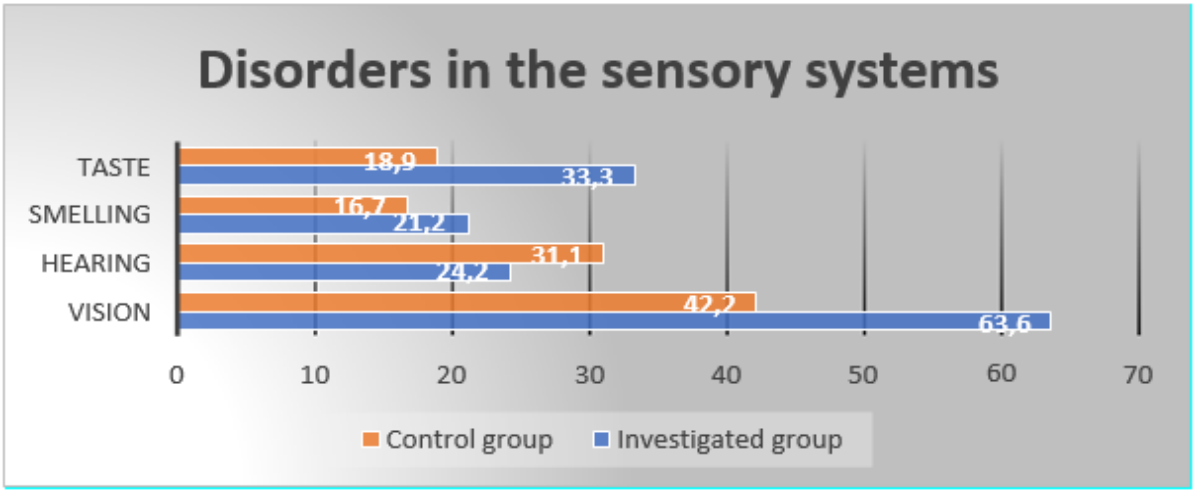

Figure 2. **Sensory-motor system disorders in the participants of the control and investigated groups (per cent).**

Assessing independent functioning of the participants of both investigated and control groups, only one participant of the investigated group was completely dependent on surrounding people and was moving using a wheelchair. Other participants did not need any assistance; nevertheless, 6.8 per cent of the participants used compensatory measures (X^2=3.887; df=3; p =.274) (see Figure 3).

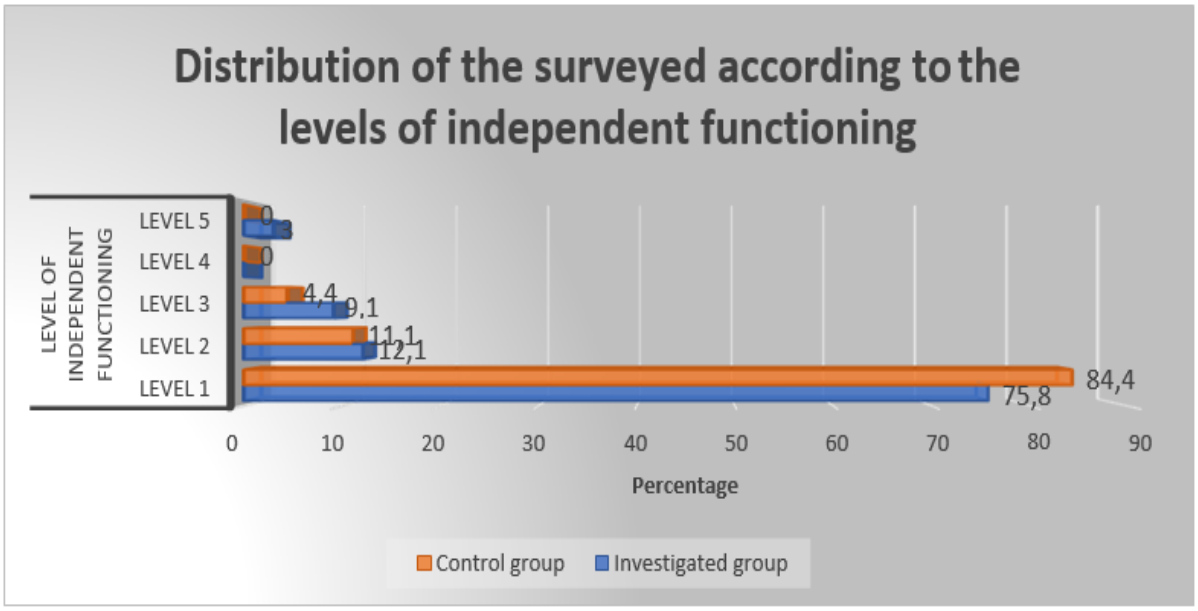

Figure 3. Distribution of control and investigated groups according to the levels of independent functioning

The neuro-sensory motor testing (evaluation B) revealed the changes in reflex integration; they are presented in Table 4. The research data demonstrated that the dolphin assisted therapy with the neuro-sensory-motor individual intervention had a significant impact on the reflex

integration for children with mental, behavioural and neurodevelopmental disorders.

Table 4. **Changes in the reflex integration for investigated and control group children with mental, behavioural and neurodevelopmental disorders (1 – evaluation on the first day, 2 – evaluation two weeks later).**

Reflexes	Groups	Evaluation	Mean	SD	Std. Error Mean	t	df	Sig. (2-tailed)
Babinski reflex	Investigated	1	3.73	1.153	0.201	-3.200	32	0.003
		2	4.09	0.980	0.171			
	Control	1	4.37	1.213	0.128	-1.288	89	0.025
		2	4.40	1.190	0.125			
Galant reflex	Investigated	1	3.97	1.104	0.192	-3.200	32	0.003
		2	4.33	0.854	0.149			
	Control	1	4.80	0.603	0.064	-1.752	89	0.083
		2	4.82	0.402	0.042			
Asymmetrical tone neck reflex	Investigated	1	2.91	1.739	0.303	-1.277	32	0.211
		2	3.03	1.741	0.303			
	Control	1	4.70	0.589	0.062	-1.521	89	0.013
		2	4.72	0.562	0.059			
Symmetrical tone neck reflex	Investigated	1	2.97	1.723	0.300	-1.971	32	0.057
		2	3.12	1.691	0.294			
	Control	1	4.63	0.726	0.077	-1.219	89	0.000
		2	4.65	0.545	0.057			
Tonic labyrinthine neck reflex	Investigated	1	2.82	1.776	0.309	-2.268	32	0.030
		2	3.06	1.767	0.308			
	Control	1	4.70	0.570	0.060	-1.816	89	0.006
		2	4.72	0.402	0.042			

After the evaluation of the balance of the surveyed participants in both investigated and control groups, we observe that the results of the control group in the initial evaluation were better than those of the investigated group; however, the results of the investigated group significantly improved after the intervention (see Table 5).

Assessing the sensory modulation in both investigated and control groups, a statistically significant change is reported in the investigated group, when the dolphin assisted therapy and complementary neuro-sensory-motor intervention activity sessions were applied (see Figure 4). In the case of children of the control group, the changes were also recorded, but they were considered as mildly changed (see Figure 5)

The evaluation of sensory modulation was carried out by surveying the parents (see Table 6). They answered the formulated statements on the first day and two weeks later.

Assessing the results of the sensory modulation in both investigated and control groups, when carrying out the repeated evaluation in the control group, no changes were reported concerning the sensory under-responsive (SUR) and sensory seeking (SS) cases; therefore, Figures 6–7 display the results of changes in the investigated group only, and Tables 7–8 display the content of their evaluation.

4. Discussion

The aim of the research was to evaluate the impact of the two-week neuro-sensory-motor complex intervention programme involving dolphins on school students at the age from 7 to 18 years who were diagnosed with ICD-10-CM, pervasive and specific developmental disorders (F80–F89), intellectual disabilities (F70–79) and behavioural and emotional disorders with onset usually occurring in childhood and adolescence (F90–F98). To sum up the results of the participants of both investigated and control groups, it can be stated the significant differences between the groups were found. The research results demonstrated that in the control group of the surveyed, with no regard to education institution, all evaluated parameters did not change or the changes were small because no complementary

interventions were applied to them between the evaluations. In the investigated group, statistically significant ($p < 0.05$) changes in the participants have been reported in all areas of evaluation.

How did the complex intervention improve the neuro-sensory-motor functions of school-age children and youth with mental and behavioural disorders?

Even though many articles dealing with the effect of rehabilitation and sensory intervention on general changes in motor, balance, sensory functions of children with mental and behavioural disorders can be found, nevertheless, no research evaluating the impact of a complex intervention programme including the dolphin assisted therapy and neuro-sensory-motor intervention was found. As the classic creators of the sensory integration have it, sensory interventions can improve person's behaviour and well-being; however, activity sessions must include fun and playful motivation to engage and "just-right" challenges [14]. Complexity and motivation in activities are the essential factors of success in performing neuro-sensory-motor interventions [14, 15], and improvement of the functioning of the sensory systems is observed in the ability to better participate in social terms [15]. The conducted investigation has proven that when applying the programme in a complex way, i.e. during neuro-sensory-motor activity sessions in the water, involving the dolphin, it is possible to statistically significantly improve neuro-sensory-motor functions of school-age children. Similar results were also obtained in other research on dolphin assisted therapy, where improvement of sensory-motor functions [9] or cognitive and psychosocial [16] or social participation [16, 17] when applying dolphin assisted therapy is discussed. The authors of the paper are acquainted with the tendentious papers on the dolphin assisted therapy, criticising the benefit of the dolphin assisted therapy [18–20]. The majority of criticism is focused on the use of dolphins as animals in the therapy process [19–20] due to the effect of novelty caused by them, the abilities to have a complex interaction with humans, general cooperative and playful attitude, non-threatening expression etc.

The water is one of the essential methods of sensory effect in the dolphin assisted therapy. The presence in it allows repeating the principles of sensory integration performed in a hall. The water therapy renders a sense of satisfaction, increases person's self-value and creates an opportunity to build reciprocal relationships. The water therapy applied to children with disabilities can be also useful due to additional activities: dressing up, undressing, taking a shower, traveling to/ from the pool. This is a constituent part in the development of skills. The water renders different sensory information to the human body. A movement in the water is felt in a different way than when walking on the ground. The tactile system is being constantly strongly stimulated; other systems continuously receive information about the moving water, especially when other people are present in the pool. A movement in the pool can be stimulated in both vertical and horizontal axes. Due to the waves, human's body rotation movements often occur, too; therefore, the sensory information obtained while staying in the water makes a strong impact on the improvement of the performance of the vestibular system [12]. Meanwhile, the National Autism Association states that water is highly attractive to people with disabilities, and people with the autism spectrum disorder treat water as a factor of high interest [21]. In the water, other systems become activated, for instance, if moves are made to resist the water, the proprioperceptive system is activated, and mostly the power of gravity and pull down operates. However, a highly activated tactile system may evoke proprioperceptive senses [12]. Although no clinical reasoning exists to explain water attraction in ASD, many theorise that the sensory input may play a role. According to the IAN findings, the top five reasons parents believed their children eloped include enjoying exploring (54%), heading for a favourite place (36%), escapes demands/ anxieties (33%), pursues special topic (31%), and escapes sensory discomfort (27%) [21]. Engagement of a dolphin into the activities may be an especially highly motivating factor.

Analysing the research data, the authors did not find any scientific research investigating the results of pathological reflex intervention into movement functions (Table 4) during dolphin assisted therapy. The correlation between the age and pathological reflex intervention into the movement functions was found, since the younger the surveyed, independently from activity of the pathological reflex, the more the pathological reflexes were restrained and integrated into the movement functions. In the cases of even four children from the investigated group, the results of Babinski, Galant and asymmetrical tone neck reflexes changed from hypersensitivity (1 point) to mild response to a trigger (4 points).

It is acknowledged that there is the created intrinsic model (CNS mechanisms which are capable of sensing the force required for movement) in human's cortex, which allows adjusting to a new

dynamic environment [22]. This has been also proven by our research data demonstrating that intensive dolphin assisted therapy and neuro-sensory-motor intervention help child to develop one's balance more precisely. For the surveyed who took part in such programme, general motor functions demonstrated a statistically significant improvement comparing the results before and after the experiment ($p < 0.05$) (Table 5). This can be explained by the impact of the complexity of the therapeutic programme manifesting most effectively: the water, triangulation communication with an animal and neuro-sensory-motor intervention influence child's CNS neuroplasticity effect, and this, in turn, can help to increase the functional activities. The literature has it that brain shrinks with impoverishment and grows in an enriched environment at any age; there are five essentials for a healthy brain: newness, challenge, exercise, diet and love [23]. Neuroplasticity, the capacity of brain cells to change in response to intrinsic and extrinsic factors, can have negative or positive influence at any age across the entire lifespan. [24]. Scientific studies demonstrate that when the "drive in" is included in the therapy for a patient, his/ her motivation to participate in activity changes significantly and neuroplasticity takes place [2], whereas emotions and motivations cannot be separated [25, 26].

It is difficult to compare the data of our research with those obtained by other authors because such parameters as participation in complex intervention where the dolphin assisted therapy performed a dominant role were not found. The closest investigation to our research was dealing with children with the autism spectrum disorder and partly approved our hypothesis stating that the dolphin assisted therapy serves best as a complement to other conventional therapies and should not be used as a sole treatment for children with autism [27].

Our conducted research reported statistically significant results for the investigated group in terms of evaluation of sensory modulation: sensory over-responsive to a simple stimulus (SOR), sensory under-responsive (SUR), sensory seeking (SS) (Fig. 4–7); whereas no changes in the sensory modulation were reported in the control group. Parents of the surveyed who participated in the complex intervention also observed that even though some surveyed did not demonstrate any statistically significant difference in quantitative aspects, nevertheless, the balance and mobility of the surveyed improved, i.e. they became psycho-emotionally more stable, more controlling themselves, physical capacity and balance improved. Their movements became more precise, free. It has been approved that once the neuro-sensory-motor functions improved, the coordination of ill person's movements, functional mobility and psycho-emotional condition will improve too. Similar results were also obtained in scientific studies which demonstrated that after the dolphin assisted therapy significant reduction in stereotyped behaviours and a significant improvement in communication and social interaction [27] as well as stable, positive changes in children's communicative abilities and social-emotional behaviour and in parental quality of life, with mainly large effect sizes [28], took place.

We can state that the impact of the complex neuro-sensory-motor intervention is more efficient than that of social or medical rehabilitation due to several factors. First, our investigation integrated the animal assisted therapy engaging dolphins, specialists, there was also influence of the environmental factors – water, surrounding environment, family community. Second, it should be admitted that participants of the investigated group participated in the activity sessions of the neuro-sensory-motor intervention, without receiving any other rehabilitation services. Meanwhile in the period of two weeks, participants of the control group received regular rehabilitation services, such as massage, physical therapy and other rehabilitation services. Third, the impact of specific diagnoses on the development process cannot be rejected, and this could have had influence on the final results of the investigation. However, the key finding of this research is that the dolphin assisted therapy is a highly effective measure of therapy when applied in a complex way with other complementary, in this case, neuro-sensory-motor, interventions, which is proven by other similar research studies [27, 28].

5. Conclusions

Ten dolphin assisted therapy activity sessions when applying complementary neuro-sensory motor activities significantly influenced school-age children according to ICD-10-CM: intellectual disabilities (F70–F79), pervasive and specific developmental disorders (F80–F89) and behavioural and emotional disorders with onset usually occurring in childhood and adolescence (F90–98); can significantly improve reflex integration into the motor functions, balance and sensory modulation changes. To sum up the research results, it can be stated that over the same period the results of the investigated group

changed statistically significantly, whereas the results of the control group changed statistically insignificantly or remained the same. The research hypothesis stating that after applying the neuro-sensory-motor dolphin assisted therapy programme in the water with individual neuro-sensory-motor activity sessions outside the water for duration of 16 sessions it is yet possible to record first positive changes of the neuro-sensory-motor systems has been proven.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the submission of this manuscript.

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Table 5. **Changes in balance in the investigated and control group children with mental, behavioural and neurodevelopmental disorders (1 – evaluation on the first day, 2 – evaluation two weeks later).**

	Groups	Evaluation	Mean	SD	Std. Error Mean	t	df	Sig. (2-tailed)
Standing on a stable surface with open eyes	Investigated	1	4.36	1.194	0.208	-2.101	32	.044
		2	4.48	1.121	0.195			
	Control	1	4.67	0.936	0.099	-0.770	89	.007
		2	4.68	0.683	0.072			
Standing on a stable surface with closed eyes	Investigated	1	2.79	1.556	0.271	-1.854	32	.073
		2	3.03	1.610	0.280			
	Control	1	4.40	1.149	0.121	-0.974	89	.000
		2	4.42	0.706	0.074			
Standing on the right leg with open eyes	Investigated	1	1.88	1.244	0.217	-3.546	32	.001
		2	2.21	1.341	0.233			
	Control	1	3.26	1.611	0.170	-0.442	89	.000
		2	3.27	1.477	0.156			
Standing on the right leg with closed eyes	Investigated	1	1.39	0.747	0.130	-2.667	32	.012
		2	1.58	0.867	0.151			
	Control	1	2.20	1.073	0.113	-1.455	89	.000
		2	2.24	1.146	0.121			
Standing on the left leg with open eyes	Investigated	1	1.88	1.244	0.217	-2.775	32	.009
		2	2.12	1.293	0.225			
	Control	1	3.21	1.686	0.178	-0.541	89	.001
		2	3.23	1.536	0.162			
Standing on the left leg with closed eyes	Investigated	1	1.36	0.742	0.129	-2.390	32	.023
		2	1.52	0.795	0.138			
	Control	1	2.11	1.136	0.120	-1.550	89	.000
		2	2.21	1.154	0.122			
Standing with one foot put in front of the other	Investigated	1	2.42	1.621	0.282	-2.775	32	.009
		2	2.67	1.652	0.288			
	Control	1	3.39	1.497	0.158	-1.391	89	.000
		2	3.47	1.374	0.145			
Rotation 360°	Investigated	1	3.85	1.503	0.262	-2.667	32	.012
		2	4.03	1.380	0.240			
	Control	1	4.36	1.020	0.108	-1.035	89	.045
		2	4.40	0.996	0.105			
Lifting of items from the floor	Investigated	1	4.24	1.226	0.213	-2.390	32	.023
		2	4.39	1.088	0.189			
	Control	1	4.69	0.816	0.086	-1.000	89	.320
		2	4.70	0.800	0.084			
	Investigated	1	3.61	1.456	0.254	-2.667	32	.012
Rotation looking back		2	3.79	1.341	0.233			
	Control	1	4.09	0.979	0.103	-0.324	89	.001
		2	4.13	0.900	0.095			
Reaching forward with a straight arm	Investigated	1	3.82	1.357	0.236	-2.101	32	.044
		2	3.94	1.273	0.222			
	Control	1	3.96	1.090	0.115	-.630	89	.530
		2	3.98	1.038	0.109			

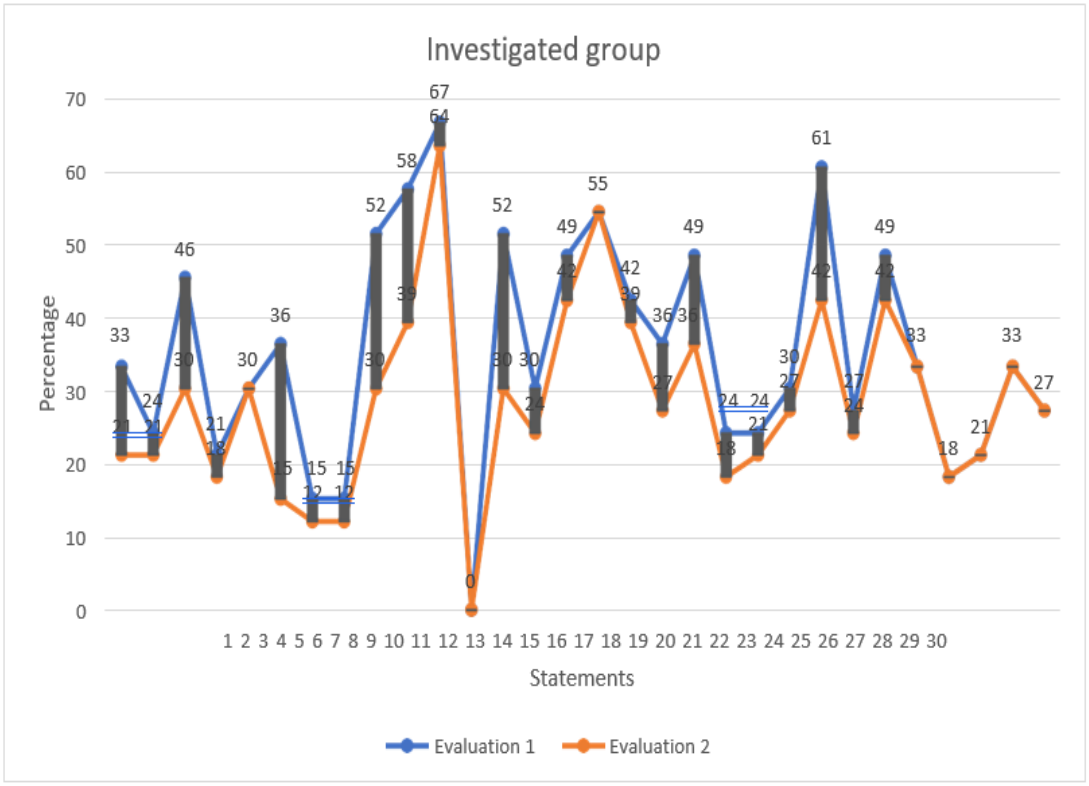

Figure 4. **The change of sensory modulation in the investigated group before and after the intervention (1 – evaluation on the first day, 2 – evaluation two weeks later).**

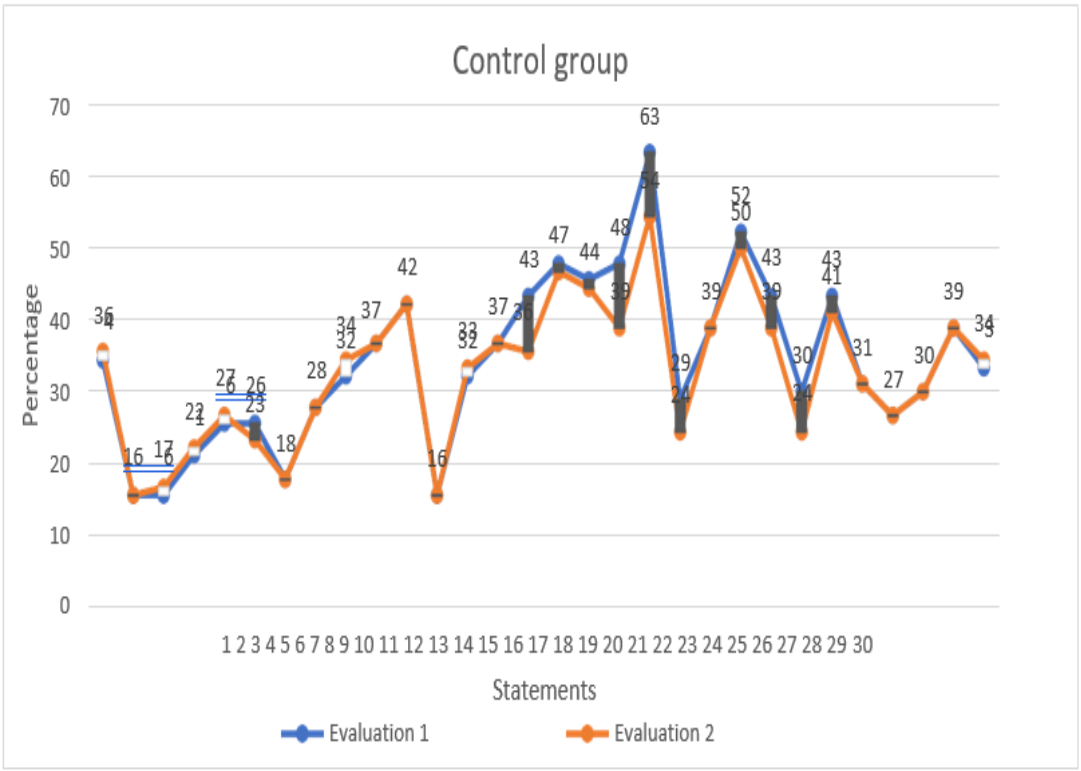

Figure 5. **The change of sensory modulation in the control group without changing regular conditions (1 – evaluation on the first day, 2 – evaluation two weeks later)**

Table 6. **Sensory over-responsive (SOR) evaluation questions for children with mental, behavioural and neurodevelopmental disorders (1 – evaluation on the first day, 2 – evaluation two weeks later).**

	Statements		Statements
1	May behave in an aggressive manner/ be frightened, if someone unexpectedly touches	16	Emotionally highly sensitive, labile
2	Does not like taking a shower: is afraid/ too much tickling	17	Is highly attached to one of the parents, difficult to separate
3	Feels discomfort when someone combs hair	18	Gets quickly distracted by a low sound
4	Does not like gentle touch/ caress	19	Enjoys performing activities in silent premises
5	Likes wearing the same clothes for a long time	20	Sensitively reacts to noise caused by domestic appliances (microwave oven, WC, ventilators, voices, vacuum cleaners etc.)
6	Avoids touching different surfaces	21	Cannot sleep if a room is not completely dark or quiet
7	Avoids a group of people to evade unintentional touch	22	Does not like bright sparkling light
8	Sensitively negatively reacts if overheats or it seems that is getting cold faster than others	23	It is difficult to maintain an eye contact
9	Gets frightened if somebody lifts up/ moves	24	Sometimes covers his/ her eyes because of unpleasantness
10	Movements are more static, there is no flexibility, easiness/ plasticity in movements	25	Avoids tasting new food products
11	Difficult to ride a bike	26	Does not like brushing teeth with a toothpaste
12	Feels nausea when going by bus/ car or flying by plane	27	Can eat only cold/ only hot meals
13	Is afraid of height	28	Sensitive to smells which do not irritate others
14	Can easily become dizzy (from movements)	29	Can refuse eating food because of its smell
15	Is shy, hard to make friends	30	Notices smells of things/ tools/ premises which would not be noticed by others

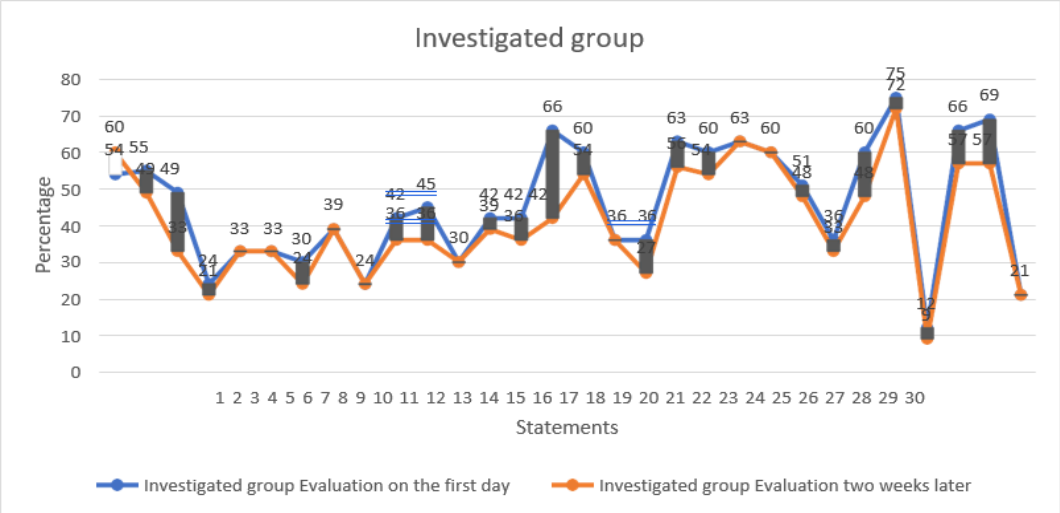

Figure 6. **The change of the sensory under-responsiveness in the investigated group before and after the intervention (1 – evaluation on the first day, 2 – evaluation two weeks later).**

Table 7. **Sensory under-responsive (SUR) evaluation questions for children with mental, behavioural and neurodevelopmental disorders (1 – evaluation on the first day, 2 – evaluation two weeks later).**

	Statements		Statements
1	Decreased reaction to touching by others	16	Enjoys being tightly embraced, held
2	Hard to take small items: to button etc.	17	Quickly gets lost in a shop or other buildings
3	Less intensively reacts to traumas, bruises, injuries	18	Often applies too much force when doing something
4	When eating, makes the zone around his/ her mouth dirty and does not clean it	19	Dos not notice the likely threat around (e.g. a car)
5	Enjoys food that has a strong taste	20	Enjoys lying on furniture/ floor very much
6	When making clothes or body dirty, does not have a need to wash/ change clothes	21	Enjoys when other people lift him/ her up
7	Constantly stimulates the moth zone: puts items into his/ her mouth, plays with saliva or pronounces imitative words	22	Enjoys speed
8	Chews a pen/ drinking straw etc.	23	Can swing for a long time and remain not dizzy
9	Is not sensitive to temperature: can feel no overheating or it seems that feels good in cold	24	Likes being an “observer”, not a “participant”
10	Does not differentiate at least one of the shapes: triangle, square, circle	25	Hard to copy actions
11	Hard to use cutlery when eating	26	Hard to wake up in the morning when an alarm clock sounds
12	“Collapsed” body	27	Does not react when called his/ her name
13	Eats in a “messy” manner, spatters around much	28	Hard to remember what people say
14	When writing, presses the pen too much	29	Hard to follow an instruction
15	Hard to organise daily routine: is not capable of finding/ putting personal belongings	30	Involuntarily has a movement or voids

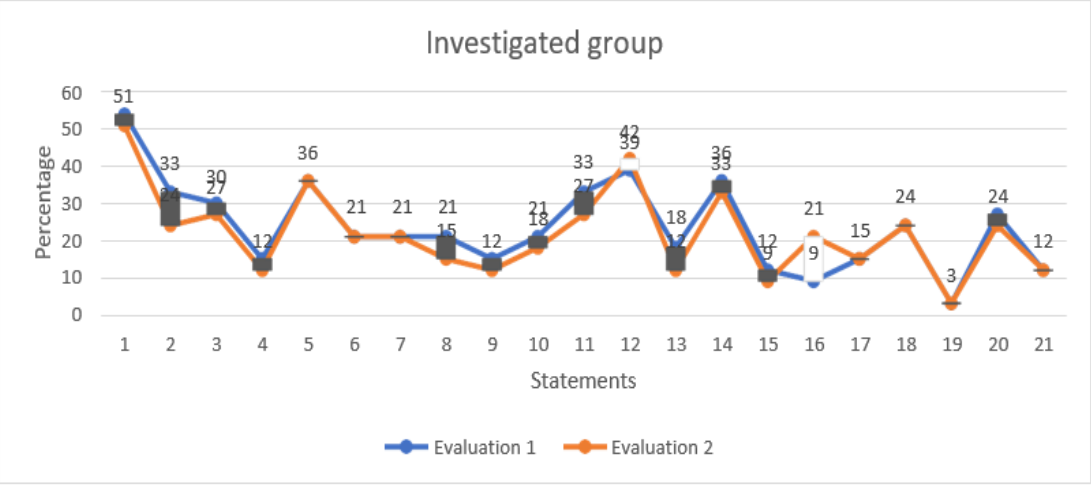

Figure 7. **The change of the sensory seeking in the investigated group before and after the intervention (1 – evaluation on the first day, 2 – evaluation two weeks later).**

Table 8. **Sensory seeking (SS) evaluation questions for children with mental, behavioural and neurodevelopmental disorders (1 – evaluation on the first day, 2 – evaluation two weeks later).**

	Statements		Statements
1	Likes touching everything	12	Constantly moves, high level of agility
2	Constantly "plays" with items – ball-pens, pencils etc.	13	Walks on tips of the toes
3	Calms down when sucking a thumb, swinging or embracing a beloved toy	14	Sometimes rotates, swings
4	Touches his/ her body with no reason or stokes hair	15	When sitting on a chair, often swings or sits on 2 legs of a chair
5	Performs routine senseless actions	16	Constantly wants to swing, as high as possible or turning round
6	Grinds the teeth	17	Wants food having a strong smell and taste
7	Seeks risky activities causing adrenaline rise	18	Enjoys hard consistency food which requires chewing/ nibbling
8	Seeks activities where one could hit, himself/ herself, fall down, bang	19	Over-analyses oneself, initiates activities related to the alteration of the body physiology
9	Intentionally molests others, tries to push	20	When eating, packs full mouth
10	Chews a pencil/ drinking straw etc.	21	Has problems related to movement or void (retains it)
11	Can jump on a trampoline endlessly		