

The possibility of using virtual reality in the treatment of children with autism spectrum disorders

Aliaksandr Marozau, Pavel Makarevich, Volha Kutas, Tatsiana Sinitsa, Hanna Davidovich, Osama Elsharkawy, Aliaksandr Lisavets

Author	e-mail
Aliaksandr Marozau (corresponding author)	amorozov@provensolution.com
Pavel Makarevich	pmakarevich@provensolution.com
Volha Kutas	kutas.olya@gmail.com
Tatsiana Sinitsa	tatsinica@gmail.com
Hanna Davidovich	hannamajorova@gmail.com
Osama Elsharkawy	oelsharkawy@provensolution.com
Aliaksandr Lisavets	alisavets@provensolution.com

Abstract

This article discusses the use of virtual reality (VR) in the treatment of attention problems in children with autism spectrum disorder (ASD). Children with ASD often have difficulty filtering out irrelevant stimuli in their environment, which can lead to attention difficulties. We have created a VR application with a controlled environment that allows specialists to work on the attention problems of children with ASD. The virtual reality headset creates an immersive environment that allows the child to concentrate on the training process with the specialist. The article details the methodology of using this VR application, including its different stages, and the therapist's role in setting various application parameters. The article also discusses the results of a pilot study conducted with four children, which showed that the use of VR helped the children become more independent, attentive, and calmer. Objective assessments were also used to evaluate the effectiveness of the method. The article concludes that VR technology has the potential to be an effective tool for treating attention problems in children with ASD.

Keywords:

Autism spectrum disorder, attention problems, virtual reality, sensory overload, controlled environment, concentration training, behavior control.

ASD problem area

Attention problems are a common challenge faced by children with autism spectrum disorder (ASD). ASD is a neurodevelopmental condition that affects communication, social interaction, and behavior. One of the core features of ASD is difficulty with social communication and interaction, which can affect a child's ability to attend to and engage with the world around them.

Children with ASD may experience a range of attention problems, including difficulty sustaining attention, being easily distracted, and struggling to shift their attention from one task or activity to another. These attention difficulties can impact a child's ability to learn and participate in everyday activities, both at home and in school.

One of the reasons that attention problems are so common in children with ASD is that they often have difficulty filtering out irrelevant information and stimuli in their environment. This can lead to sensory overload, which can make it difficult for a child to focus on a specific task or activity. For example, a child with ASD may be easily distracted by background noise, bright lights, or other sensory stimuli that a neurotypical child might be able to ignore.

In addition to sensory issues, attention problems in children with ASD may also be related to difficulties with executive functioning. Executive functioning refers to a set of cognitive processes that are responsible for planning, organizing, and completing tasks. Children with ASD may struggle with executive functioning, which can make it challenging to stay on task, complete assignments, and manage their time effectively.

There are several strategies that parents and educators can use to support children with ASD who are experiencing attention problems. These may include creating a structured and predictable

environment, breaking tasks down into smaller steps, providing frequent breaks, and using visual aids to help children understand expectations and stay on task.

VR therapy

Proven Reality (United Arab of Emirates, Dubai) together with specialists working with people with ASD, conducted research and created a methodology for working with children with special needs using virtual reality technology. Based on this methodology, Proven Reality company made a virtual reality application with a controlled environment in which specialists can also work on attention problems of children. Also the guideline with detailed explanations to therapists on how to make a session with a child was prepared. The guideline describes how to implement the stages of working with virtual reality in a session with a child with ASD, and then how to consolidate the acquired skills in the classroom and at home with parents. When using the application in a virtual reality headset, the child is not distracted by external stimuli, has the opportunity to fully concentrate on the process of training with a specialist and is always attending exactly the same environment controlled by the therapist.

In a virtual reality application for working with children with ASD, the children find themselves in a monochromatic room, in which either a ball or a toy car moves. The therapist can observe on the phone application what the child sees, where he points with his hands (the child's hands are being monitored), and also set various application parameters. The therapist can:

- change the color of the room,
- change the color and texture of the ball,
- change the nature of the movement of the ball (jumps, rolls, flies around the room, moves like a pendulum, etc.),
- add additional obstacles behind which the ball hides,

-add a frame in which he will ask the child to take the ball,

-play animations of a toy car entering and leaving the garage,

-add an extra item,

-and so on.

The specialist can ask the child to focus on a specific object, make an assumption where the object will move, think about where the object is hidden, and so on.

Thanks to the use of a virtual reality headset, the child can fully concentrate on the task, and the child will not have the opportunity to look for “hints” to complete the task from the surrounding adults.

The guideline contains 25 different activities aimed at training various components related to concentration. However, after learning how to use the Proven Reality application, therapists can develop their own methods of working with children.

Pilot implementation

4 children (6, 7, 7, 8 years old) participated in pilot approbation of the method of working with the application. Work with a virtual reality headset was carried out for 17-18 lessons.

In the trial we saw great enthusiasm from children who wanted to practice using virtual reality.

Subjectively, after the end of the course, parents and therapists noted that the children became more independent, their pointing gesture improved, they became more attentive and calmer. For some children, these improvements were also confirmed by teachers who did not participate in the study. Upon completion of the course, some children showed improvements in speaking, reduced anxiety, and behavior control.

Classes were held 3 times a week (except for the days when the children had colds). Parents were also given homework assignments for consolidation (their number did not match the exercises in the office, so the last exercises were combined). Parents were motivated, tried to complete all tasks and record them in the questionnaire (some activities were recorded later from memory).

For an objective assessment of changes, the following were used:

- Method "Find and cross out". The goal is to find items that the specialist asked for in the image of many objects. When processing and evaluating the results, the number of objects in the picture viewed by the child for 2.5 minutes is determined, i.e. for the entire duration of the task, as well as separately for each 30-second interval
- Method "Correction test - Landolt rings". When processing and evaluating the results, the number of viewed rings is determined for every 30 seconds, as well as for 3 minutes. The number of errors is also recorded: missed according to the sample, incorrectly crossed out, inappropriate to the given sample.

Before the start of the classes, a diagnosis of children's attention was carried out, the same diagnosis was carried out at the end of all exercises.

In addition, we recorded how the child performs each task (on a 5-point scale - how the child listens and performs the instruction, what his emotional reaction is, whether he is ready to perform the next task, whether it is easy to put on and take off the virtual reality headset, etc.). Also, at the beginning and at the end of the course, therapists and parents filled out a questionnaire with questions related to the concentration of the child's attention.

Child psychologist's observations

All children found wearing glasses very pleasant and comfortable. Quite often, children (all) asked to do something else with glasses. However, they obediently agreed to take off their glasses after completing the exercises. Once, one participant (a boy, 8 years old) had a strong tantrum, did not want to take off his glasses (identified himself with a cartoon character), shouted, then cried, did not want to take off his glasses and leave. This situation was unique. From the perception of children in the study room, several points can be distinguished:
-Most of all, all the children liked the gray background (in the first exercises, the backgrounds were changed and everyone noted that gray is better)
-Children really liked the hands in VR

At the first lessons, the children were quite often distracted from listening to the instructions. They were interested in exploring the room and new perceptual possibilities. It was also important that the children did not see me with glasses, they could only rely on auditory perception and touch. But gradually, with the completion of tasks, the children began to listen more attentively, without being distracted. This effect also became noticeable when performing tasks in the office (the parents of the children also spoke about this).

An important point was the development of a pointing gesture in one of the study participants

(boy, 7 years old), this was noted by the teacher at school and the mother. Also, this child began to read better (do not jump over the lines). Prior to this, the boy, when asked to point to some object, immediately often pointed with his finger at any nearby one, and only after one or a few repetitions did he point correctly.

It should also be noted that glasses with the application served as an excellent motivational tool for children (2 children saw only the application, 2 children saw the background screensaver, several times they turned on the video on YouTube). At the same time, it was more interesting for children to be in the room - in the application.

During the last diagnostics, the children listened to the instructions more attentively, made fewer mistakes and followed the line better.

Parents of all children noted small positive changes in children's attention. The mother of one of the participants in the study (a girl of 7 years old) noted that "the daughter has become more assiduous."

Results for 6-year-old girl

Changes based on the results of the questionnaire of the therapist and parents, as well as the results of tests for an objective assessment.

Compared parameters.	Before undergoing a course of therapy using virtual reality.	After undergoing a course of therapy using virtual reality.
Child behavior	The girl regularly jumps up from her seat during class and cannot sit still.	The girl practically stopped jumping up during classes, the number of changes in posture during "restlessness" decreased. This item was also noted in the institution where the child is being prepared for school.
Cannot complete everyday activities, daily chores (brushing teeth, cleaning bed, toys, etc.). Cannot perform, complete routine activities related to preparation for a session.	Sometimes (therapist's conclusion)	Rarely (therapist's conclusion)
If you give the child a simple errand (for example, to bring something from another room), he or she forgets it on the way and is distracted by foreign objects, stimuli.	Sometimes (parents opinion)	Rarely (parents opinion)
When the child needs to	< 1 min	From 1 to 5 min

perform a task that is not the most attractive to him or her and requires a little volitional effort (for example, some task within training activities), he or she can concentrate on this type of activity.		
The child is easily distracted by insignificant extraneous stimuli during training or developmental activities.	Often (therapist's conclusion)	Sometimes (therapist's conclusion)
Correction test (Landolt rings)	The girl refused to perform a correction test (Landolt rings) after 1.4 minutes . At the intermediate control in the middle of the course, she completed the task for 3 minutes , but was distracted, skipped lines and anxiously looked for mistakes.	At the end of the course, she also completed the task for 3 minutes , but she practically didn't get distracted, didn't skip lines, didn't double-check her mistakes.
Working with images using the "Find and Cross Out" method	Child did not follow the lines, worked mainly in the center of the page, periodically returning to the part already done.	The girl had already examined all parts of the page and almost did not return to the task she had completed.

If in the first lessons, the girl was emotionally aroused by virtual reality and almost did not listen to the tasks from the therapist, then later she joined the process of classes, listened and completed the tasks. However, there were cases when, in case of failure to complete the task, the girl refused to put on the headset. The next day, she agreed to work with virtual reality and completed tasks.

Results for 7-year-old boy (a)

Changes based on the results of the questionnaire of the therapist and parents, as well as the results of tests for an objective assessment.

Compared parameters.	Before undergoing a course of therapy using virtual reality.	After undergoing a course of therapy using virtual reality.
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During a break in a session does not concentrate on a particular kind of rest, a toy.	Often (parents opinion)	Sometimes (parents opinion) Parents note that the boy began to play more with ball toys.
If you give the child a simple errand (for example, to bring something from another room), he or she forgets it on the way and is distracted by foreign objects, stimuli.	Sometimes (parents opinion)	Rarely (parents opinion) According to the parents, boy began to listen better and follow the instructions.
When the child needs to perform a task that is not the most attractive to him or her and requires a little volitional effort (for example, some task within training activities), he or she can concentrate on this type of activity.	< 1 min (parents opinion)	From 1 to 5 min (parents opinion) The boy became less distracted when doing exercises and homework.
The child is easily distracted by insignificant extraneous stimuli during play, even with subjectively attractive objects.	Often (parents opinion)	Sometimes (parents opinion)
The child is easily distracted by insignificant extraneous stimuli during training or developmental activities.	Often (parents opinion)	Sometimes (parents opinion)
The child needs to be reminded of what needs to be done now, as if he or she “loses” the purpose of the activity.	Often (parents opinion)	Sometimes (parents opinion)
During training/developmental activities you have to provide organizational assistance (“look!”, “be attentive!”, “think!”, “where should we put this part now?”, “let’s look together again!”, etc.)	Often (parents opinion) Often (therapist's conclusion)	Sometimes (parents opinion) Rarely (therapist's conclusion)
The child’s behavior can be characterized as distracted, unfocused.	Often (parents opinion)	Sometimes (parents opinion)

Schulte table (25) 3 attempts	The best time 1,58 min	The best time 1,42 min
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Results for 7-year-old boy (b)

Changes based on the results of the questionnaire of the therapist and parents, as well as the results of tests for an objective assessment.

Compared parameters.	Before undergoing a course of therapy using virtual reality.	After undergoing a course of therapy using virtual reality.
Cannot complete everyday activities, daily chores (brushing teeth, cleaning bed, toys, etc.). Cannot perform, complete routine activities related to preparation for a session.	Sometimes (parents opinion)	Rarely (parents opinion)
If you give the child a simple errand (for example, to bring something from another room), he or she forgets it on the way and is distracted by foreign objects, stimuli.	Often (parents opinion)	Sometimes (parents opinion)
When the child interacts with a familiar object that is attractive to him or her (for example, playing with a familiar and favorite toy), he or she can focus on this type of activity.	From 1 to 5 min (therapist's conclusion)	From 5 to 10 min (therapist's conclusion)
When the child needs to perform a task that is not the most attractive to him or her and requires a little volitional effort (for example, some task within training activities), he or she can concentrate on this type of activity.	From 1 to 5 min (parents opinion)	From 5 to 10 min (parents opinion)
The child is easily distracted by insignificant extraneous stimuli during play, even with subjectively attractive objects.	Often (parents opinion)	Sometimes (parents opinion)

Results for 8-year-old boy

Changes based on the results of the questionnaire of the therapist and parents, as well as the results of tests for an objective assessment.

Compared parameters.	Before undergoing a course of therapy using virtual reality.	After undergoing a course of therapy using virtual reality.
Cannot complete everyday activities, daily chores (brushing teeth, cleaning bed, toys, etc.). Cannot perform, complete routine activities related to preparation for a session.	Sometimes (therapist's conclusion)	Rarely (therapist's conclusion)
If you give the child a simple errand (for example, to bring something from another room), he or she forgets it on the way and is distracted by foreign objects, stimuli.	Often (parents opinion)	Sometimes (parents opinion)
When the child needs to perform a task that is not the most attractive to him or her and requires a little volitional effort (for example, some task within training activities), he or she can concentrate on this type of activity.	< 1 min (parents opinion)	From 1 to 5 min (parents opinion)
The child is easily distracted by insignificant extraneous stimuli during training or developmental activities.	Often (parents opinion)	Sometimes (parents opinion)
Correction test (Landolt rings)	The first 2 times he refused to complete the task.	Agreed to perform the task, did it carefully. But after 2 minutes he refused to continue.
Working with images using the "Find and Cross Out" method	5 items	6 items
Schulte table (25) 3 attempts	The best time 0,49 min	The best time 0,47 min

Conclusion and outcomes

Thus, by introducing Proven Reality's virtual reality application into the work of specialists in the work with children with ASD, significant progress can be made in indicators related to the concentration of attention and even in the behavior of the child. However, a more detailed description of the effects of working with the application requires further research.

A study is currently being conducted on younger children (4-5 years old).

Declarations

Ethics approval and consent to participate

All methods were carried out in accordance with relevant guidelines and regulations.

All peoples who participated (or their parents) in the study gave oral and written consent to participate in the study.

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