

Potential Application of Virtual Reality in ASD Intervention

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Abstract. Autism spectrum disorder (ASD) is one of the most widespread developmental mental illnesses. According to the CDC's Autism and Developmental Disabilities Monitoring (ADDM) Network, about 1 in 44 children in United States has been diagnosed with ASD, and the number is still increasing. The current treatment options show many problems and limitations, and Virtual reality (VR) appears to be an innovative approach that may overcome these limitations. The survey in this study asked 57 parents with autistic children to rate their children's ability, behavioral observations, and level of concern. The level of optimism regarding the potential of Virtual Reality was also compared between the ASD group and the control group, indicating that parents with ASD children are more pessimistic towards the VR treatment. There are several factors might contribute to their pessimism, such as more pressure and worse mental conditions in real life, the ineffectiveness of current treatment, and financial burdens. The result is consistent with previous research that parents with ASD children face a lot of challenges and the current autism interventions appear to be not very effective in dealing with core symptoms and co-occurring problems. Therefore, virtual Reality intervention has great potential for improving social and interaction skills, saving labor and time, and generalizing the improvement in VR programs to the real world.

Keywords: Autism; Virtual Reality; life of quality; co-occurring problems; questionnaire.

1. Introduction

Autism spectrum disorder (ASD) is a behaviorally defined neurodevelopmental disorder associated with communication deficits, restricted and repetitive patterns of behavior and interests [1]. According to the CDC's Autism and Developmental Disabilities Monitoring (ADDM) Network [2], about 1 in 44 children in United States has been diagnosed with ASD, and the number is still increasing. It is a heterogeneous disorder that may significantly vary in different people. Different autistic people might show strikingly different symptoms, and even the same person may present differently at different stages of life [3].

The core characteristics of ASD can be divided into two areas -lack of social communication and restricted, repetitive sensory-motor [4]. Apart from core symptoms, many co-occurring disorders or health problems also commonly presented, such as delayed language skills, epilepsy, sleep problems for preschool children [5], ADHD, anxiety, and irritability for school-aged children [6]. Additionally, growing evidence illustrates that ASD people have a higher premature mortality rate, and increases the risk of self-harm and suicide [7]. The reason behind this trend is largely related to the co-occurring health issues, such as depression, obesity, and sleep disorders [8].

Today, there are various interventions being used to improve the symptoms and co-occurring problems of ASD people. Behavioral interventions are commonly used to improve the core symptoms of autism, but they require large-scale venues, one-to-one treatment, special facilities, and help from professionals in the long term [9]. Applied Behavioral Approach (ABA) is one of the most used behavioral interventions, which arose from Skinner's research on reinforcement and favorable consequences [10]. ABA is often applied to improve social interactions, tasks completing, atypical behaviors, and so on. When it comes to other co-occurring difficulties, drug treatment is commonly used, for example, reducing irritability and hyperactivity behavior [11]. Psychological interventions, modeling, attention training, physical training, language training, and vocational training are also widely used and combined with behavioral interventions to improve the overall symptoms and performances.

However, there are several limitations of the current treatments. Co-occurring symptoms are prevailing among ASD children. In 2008, Simonoff has found that about 70% of ASD children were diagnosed with at least one co-occurring condition. Yet, studies regarding how co-occurring conditions are associated with service use are still very limited [12]. Compared to those ASD children without any co-occurring conditions, children with ASD and co-occurring conditions receive a higher number of medication and service use and are more likely to have unmet treatment and service needs at the same time. More specifically, only 32.5% with current treatment and services and 24.8% with providers and supporters [12].

Furthermore, although many treatments modalities have been proven to be effective for the core symptoms of ASD, parents' dissatisfaction still occur with many interventions program. For instance, Nicole, Abbey, Alice & Jan [13] revealed that over 60% of parents with ASD children were dissatisfied with at least one of the faces of Individualized Education Programs (IEP), only half of the participants chose 'moderate' to 'high' satisfaction).

Parents of ASD children face a few challenges and difficulties in life. The psychological state of parents with ASD children is also very distinctive from parents who without ASD children. Lam & Doris [14] shows that the parents of ASD preschoolers have a much lower frequency of experiencing positive emotions than the parents of preschoolers without ASD. Many ASD families also report financial problems and need extra income in order to pay the fee for medical care. Many of them must reduce their time spent on work or even stop working, spend more than 10 hours per week taking care of their child, and pay >1000 dollars for medical care [15]. Baghdadi et.al [16] find autism severity, more challenging behaviors, and developmental delay are negatively associated with parental quality of life (QOL) scores. QOL is also negative associated with comorbidities, communication problems [17, 18], and co-occurring psychiatric disorders.

From the above, we can clearly see a wide range of difficulties parents of ASD children encountered under current treatment modalities. And here is another potential treatment modality that might resolve some of the current parent's difficulties and appear as an effective intervention for ASD. Virtual reality (VR) is a technology that creates a 3D virtual environment where people can interact in a seemingly real way (MBN). VR has been considered as an effective treatment modality in many health fields, such as mental health treatment, diagnosis, and treating disorders [19].

Although the overall studies regarding VR and ASD are still limited and not so well-founded, there is still some experiment in the past showing that VR has the potential to improve social engagement and interaction skills. There was a research project in 2010 in the U.K. aimed to facilitate social understanding for high-functioning children with ASD. The participants in the project were asked to complete several tasks in the virtual environment (a cafeteria), such as finding somewhere to sit and buy a drink [20]. In 2005, a follow-up study, composed of 12 children aged ranged from 13-18, explored the social conventions, such as avoiding walking to the neighbor's garden and keeping the personal space with other people in conversation. In the end of experiment, most of the children in both experiments showed improvement in interacting skills, verbal speaking skills, and frequency of and body movements. More and more study has incorporated complicated images of facial expressions into VR system in order to train ASD children how to gaze at others and respond to stimuli of faces.

Another two treatments studies of VR and ASD also shown improvement in emotion recognition, theory of mind, and social performance. The first one was training a verbally minimally child with ASD to recognize and track a common object in the virtual world, and the result was the child successfully completed the tasks, finding the object, and walking toward it. In the second study, eight adult participants aged ranged from 18-26 were put in various sceneries and engaged in some social interactions, such as communicating with new roommates and interviewing for a new employee.

In short, there is a need for new treatments for ASD, which exert less economic and psychological pressure on parents with autistic children and has better interventions result. While VR treatment looks like a promising solution, the voice of parents remains unheard. We need to hear from parents who closely with choosing the type of treatment given to their children. This study aims to understand their experience with different type of treatment an attitude toward VR. This will help us design a

better solution to reduce their concern and eliminate their psychological burden towards the new treatment. In this study, parents from the ASD group and the control group were asked to complete a questionnaire. Through the questionnaire, we will be able to understand the current needs of parents of autistic children and their level of concern for their children, as well as their attitudes towards VR intervention compared to the general population, which will provide an information base for the future development of VR interventions.

2. Method

2.1. Design

This study deployed a between-participant design which included two groups: group 1 was the control group and group 2 was the ASD group. The independent variable is the severity of the symptoms, the dependent variable is parent's concern and evaluation.

2.2. Participant

There are 102 participants completed the questionnaire. About 45 from the ASD group in which they had a child diagnosed with ASD and 57 in the control group who were parents with typical developed children. 71% of parents age over 45. 20% of parents aged between 36 and 45.

In the control group, only 2 were male and 43 were female. In the ASD group, 20 were male and 37 were female. 43.8% age over 45, 45.6% age between 36-45. Most of the participants were located in Beijing, China (N=97).

2.3. Materials

Apart from the demographic part, all the questions remaining were 7-point Likert scale questions where 1 is the most negative and 7 is the most positive, for example, when rating the level of understanding of VR, 1 is equal to very unfamiliar, 4 is equal to neutral, and 7 is equal to very familiar.

2.3.1. Demographic

In both groups, parents were asked to complete a series of questions about the basic information about their child and themselves, including the ages, gender, sibling, history of major disease of the children and educational level, working state, and age distribution of parents. For the ASD group, there were some extra questions related to autism, such as the age distribution of diagnosis and educational mode.

2.3.2. Ability and behavioral observation rating (ASD group)

Parents with ASD children were asked to rate the ability and frequency of some behaviors compared with average children in mainstream school. In the ability part, there were several areas, such as reading comprehension, math ability, writing and spelling ability, and verbal communication. In the behavioral observation part, there were forging friendships, initiating conversation, body language, eye contact, etc.

2.3.3. Parents' concern (ASD group)

In this part, parents rated their level of concern in various aspects, including finding a job, dealing with ridicule or prejudice, finding a spouse, and so on.

2.3.4. Treatment modalities (ASD group)

According to Table 6, parents with ASD children were asked to choose the treatment their child received, past or present, from the list and rate the effectiveness.

2.3.5. Understanding and level of concern of ASD (Control group)

In this part, only parents without ASD children were asked to answer the questions. First was rating their understanding of ASD and then was rating their level of concern.

2.3.6. Level of understanding of Virtual Reality

Both parents in the control group and ASD group were told to answer the questions in this part, rating their level of understanding.

2.3.7. The attitude of the potential of Virtual Reality

This was the final part of the questionnaire and parents from both groups were asked to rate their level of confidence in various aspects of VR intervention, including attention, learning ability, basic life skills, vocation skills, body movement and fine motion ability, communication skills, and so on.

2.4. Procedure

The questionnaire was designed, and data was collected using Qualtrics. For the ASD group, the questionnaire was allocated to an ASD parent's WeChat group, and for the control group, the questionnaire was directly sent to various parents through social media. All the participants completed the survey anonymously and voluntarily

2.5. Data analytic plan

Between-participant T-tests were conducted to compare the level of optimism about Virtual Reality intervention in the ASD group and the control group. Regarding the demographics and other parts of the questionnaire, we analyzed the frequency of people who chose different options or scales and put them in a table shown in the appendix.

3. Result

3.1. Demographic (Table1&2)

Table 1. Demographics of study sample (Children) compared ASD group and control group.

Factor		Total sample	ASD group	Control group
Gender	n	102	45	57
	% Male	68.6	75.5	63.1
	% Female	31.4	24.5	36.9
Age distribution	n	102	45	57
	% 0-10	20.5	11.1	28.1
	% 11-18	49.0	42.2	54.3
	% >18	30.5	46.7	17.6
Sibling	n	102	45	57
	% Yes	29.4	24.4	33.3
	% No	70.6	75.6	66.7
History of major disease of siblings(Whether they have physical diseases, disability, neurological disorder)				
	n	32	13	19
	% Yes	6.3	15.4	0.0
	% No	93.7	84.6	100.0
Educational Mode				
	n	44	44	
	% Mainstream school	34.1	34.1	
	% Special school	31.8	31.8	
	% Study at home	15.9	15.9	
	% Other options	18.2	18.2	
Age distribution of diagnosis (ASD)				
	n	45	45	
	% <2	22.2	22.2	
	% 2-3	48.9	48.9	
	% 3-4	13.3	13.3	
	% >4	15.6	15.6	

Note. Other options in educational mode include already working, stay at home unemployed, stay in community, etc.

There are 102 people in total took part in this part of the questionnaire: 45 people in ASD group and 57 people in control group. Males make up about 70% of the total participants, and there are 75.5% males in ASD group and 63.1% male in control group. Among all the participants, about half of them are between the ages of 11 and 18, and 20% are under the ages of 10 and 30% are adults. In the ASD group, 46.7% are adults and 42.2% are between the ages of 11 and 18. In the control group, adults only take a proportion of 17.6%, and 54.3% of the people in control group are between the ages of 11-18. There are about 30% of the participants have siblings, and this rate is slightly lower in ASD group (24.4%) compared to control group (33.3%) And there are 15.4% of the siblings in the ASD group have a history of serious diseases (physical diseases, disability, neurological or psychological disorder), but none of the siblings in the control group have such problem. The percentage of ASD children who are in mainstream school and special school are similar; the former is 34.1% and the latter is 31.8%. There are 15.9% ASD children study at home currently and 18.9% people choose “other options”, such as already working, stay at home unemployed, stay in the community, and so on. About 60% of the ASD children are diagnosed before the age of three, and there is only 15.6% children are diagnosed after 4 years old and didn’t receive an early intervention.

Table 2. Demographics of study sample (Parents) compared ASD group and control group.

Factor	Total sample	ASD group	Control group
Gender			
n	102	45	57
% Male	21.6	4.6	35.1
% Female	78.4	95.4	64.9
Age distribution			
n	102	45	57
% <35	9.8	8.9	10.5
% 36-45	34.3	20.0	45.6
% >45	55.9	71.1	43.8
History of major disease (Whether they have physical diseases, disability, neurological disorder)			
n	102	45	57
% Yes	1.9	2.2	1.7
% No	98.1	97.8	98.3
Working state			
n	102	45	57
% Both work either full time or part time	63.7	46.7	77.2
% Only one works	25.5	35.5	17.5
% Both don’t work or retired	8.8	15.6	3.5
% Other options	2.0	2.2	1.8
Educational Level (degree)			
n	102	45	57
% Secondary and high school, vocational school	16.6	22.2	12.2
% College and junior college	60.8	53.3	66.7
% Master and doctor	22.6	24.5	21.1

Note. Other option in working state is both work with freelance.

This part of the questionnaire composed of 45 parents from ASD group and 57 parents from control group. In total sample, 78.4% participants are mothers, and 21.6% participants are fathers. There are only 4.6% participants in ASD group are fathers, compared to 35.1% in control group. In ASD group, the parents over the ages of 45 take a proportion of 71.1%, while there are only 43.8% parents in the control group are older than 45. There are only two parents in the total sample have a history serious disease (physical disease, disability, neurological or psychological disorder), and each group has one. There are 77.2% parents in control group chose the option “Both work either full time or part time”, while in the ASD group, only 46.7% chose this option, and 35.5% parents chose “only one works”. Parents’ educational level are basically similar in ASD group and control group. There are 24.5% parents in ASD group and 21.1% parents in control group have a master or doctor degree, and the

percentage of having a college or junior college degree is 53.3% in ASD group and 66.7 in control group.

3.2. Ability and behavior observation rating for ASD group (table 3&4)

Table 3. Percentage rating of ability compared with average children (ASD group).

Ability	1	2	3	4	5	6	7
Reading comprehension	84.2	6.8	4.5	4.5	0.0	0.0	0.0
Math ability	77.3	9.2	4.5	4.5	4.5	0.0	0.0
Writing and spelling ability	79.5	15.9	4.6	0.0	0.0	0.0	0.0
Verbal communication	78.6	19.0	0.0	2.4	0.0	0.0	0.0
Ability to focus their attention	67.4	23.2	6.9	0.0	0.0	2.5	0.0
Ability of control emotions	51.2	27.9	13.9	4.6	0.0	2.4	0.0
Curiosity	41.4	39.0	9.7	7.3	0.0	2.6	0.0
Basic life skill	39.5	32.5	11.6	16.4	0.0	0.0	0.0
Ability to sit still for the duration of the class	38.1	19.0	23.8	16.6	0.0	0.0	2.5
Ability of control body movements and facial expressions	32.5	34.8	23.2	9.5	0.0	0.0	0.0
Athletic ability	28.5	30.9	21.4	7.1	4.7	4.7	2.7

Note. n=45, there are 1-2 missing data in each row. 1 equal to far below average; 2 equals to below average; 3 equals to slightly below average; 4 equals to slightly above average; 5 equals to above average; 6 above averages; 7 equals to far above average.

There are 45 people from ASD group completed the question of rating the ability compared with average children, even if there are 1-2 missing data in each row. Overall, ASD parents rated their children poorly in these areas. Most parents chose 1, 2, 3, which represent far below average, below average and slightly below average respectively. In reading comprehension, 84.2% parents chose far below average, and the percentage of choosing “far below average” was above 50% in Math ability, writing and spelling ability, verbal communication, ability to focus their attention and ability of control emotions. Far fewer people chose “far below average in curiosity, basic life skills, ability to sit still for the duration of the class, ability of control body movements and facial expressions and athletic ability. There are even 2.5% parents and 2.7% parents chose far above average in “Ability to sit still for the duration of the class” and “athletic ability” respectively.

Table 4. Percentage rating of behavioral observation compared with average children (ASD group).

Behavioral observation	1	2	3	4	5	6	7
Forge friendships	55.8	25.6	9.3	2.3	2.3	0.0	4.7
Initiate a conversation	44.2	16.3	13.9	11.6	11.6	2.4	0.0
Body language	30.9	30.9	11.9	16.7	7.1	0.0	2.5
Narrow interests	20.9	14.0	20.9	11.6	4.6	14.0	14.0
Eye contact	18.6	37.2	20.9	11.6	9.3	0.0	2.4
Been prejudiced or teased by peers	12.1	9.5	19.0	23.8	4.7	19.0	11.9
Respond strongly towards the environment	7.2	9.6	19.0	19.0	19.0	11.9	14.3

Note. n=45, there are 2-4 missing data each row. 1 equal to extremely low-frequency; 2 equal to low-frequency; 3 equal to slightly low-frequency; 4 equal to average frequency; 5 equal to slightly high-frequency; 6 equal to high-frequency; 7 equal to extremely high-frequency. Also, the Likert scale has been reversed in “Narrow interest”, “Respond strongly towards the environment” and “Been prejudiced or teased by peers”.

In this part, parents are asked to rate behavior observation compared with averaged children. There are 45 parents completed the questions with 2-4 missing data each row. In forge friendships, initiate a conversation and body language, over 30% parents chose extremely low frequency. In other areas, the distribution of choices is more widespread, which means these areas, such as narrow interest and eye contact, are not obvious features or problems of ASD children in this sample.

3.3. Parents' concern of ASD group (table 5)

In every aspect in this part, at least 55.6% of parent participants chose “very concerned”, and there are three aspects having more than 66% chose “very concerned”: Finding a job (71.1%), finding a spouse (66.7%), and dealing with ridicule or prejudice (62.2%).

Table 5. Percentage rating of parents' concern (ASD group).

Areas	1	2	3	4	5	6	7
Finding a job	71.1	8.8	0.0	11.1	0.0	4.5	4.5
Dealing with ridicule or prejudice	62.2	24.3	6.6	2.3	2.3	2.3	0.0
Finding a spouse	66.7	15.6	4.4	2.2	0.0	6.7	4.4
Ability to care for themselves	55.6	26.7	13.3	2.2	0.0	2.2	0.0
Developing friendships	57.9	31.1	4.4	2.2	0.0	4.4	0.0
Dealing with ridicule or prejudice	62.2	24.3	6.6	2.3	2.3	2.3	0.0
Effectively communicate with others and express his/her feelings	55.6	26.7	13.3	0.0	0.0	4.4	0.0

Note. n=45. There is 1 missing data in the first row. 1 equal to very concerned; 2 equal to concerned; 3 equal to a little concerned; 4 equal to neutral; 5 equal to a little unconcerned; 6 equal to unconcerned; 7 equal to very unconcerned.

In this part, ASD children's parents are asked to rate their concern, and 45 parents answered the question with 1 missing data in the first row. It is obvious that most parents are highly concerned about their child's future since the lowest percentage of choosing very concerned is 55.6%. Most parents “very concerned” and “concerned” in almost every row. For example, there are 71.1% parents are very concerned about their children in “finding a job”, and there are 62.2% parents and 24.3% parents choose “very concerned” and “concerned” respectively in “dealing with ridicule or prejudice. It's almost the same story for other areas.

3.4. Treatment modalities (ASD group) (table 6)

Treatments that more than 15 people are receiving or have received are behavior therapy (30), language therapy(24), physical training (23), natural teaching therapy (19), attention training (17), music therapy (17) and cognitive behavior (16). The effectiveness rating among each treatment modality varied, but for most treatments, 5 (a little effective) and 6 (effective) account for the greatest proportion.

Table 6. Treatment modality and effectiveness rating by percentage (ASD group).

Treatments	Number of people who take the treatment	Effectiveness						
		1	2	3	4	5	6	7
Behavior therapy	30	3.3	3.3	3.3	13.3	40.0	33.4	3.4
Language training	24	8.3	8.3	12.5	0.0	41.7	29.2	0.0
Physical training	23	4.3	0.0	0.0	17.4	43.4	21.7	13.2
Natural teaching therapy	19	0.0	0.0	5.3	5.3	47.3	36.8	5.3
Attention training	17	5.9	5.9	5.9	11.7	58.9	11.7	0.0
Music therapy	17	5.8	0.0	11.7	17.7	29.5	29.5	5.8
Cognitive behavior intervention	16	6.3	6.3	6.3	6.3	31.3	43.5	0.0
Modelling	14	7.1	0.0	14.3	7.1	28.5	43.0	0.0
Vocational training	13	15.4	0.0	0.0	15.4	30.7	30.7	7.8
Massager therapy	13	15.4	7.6	0.0	23.0	38.6	15.4	0.0
Social skill intervention	13	0.0	7.8	15.4	0.0	38.4	38.4	0.0
Self-management	12	8.3	0.0	0.0	0.0	33.4	50.0	8.3
Peer training	11	0.0	0.0	18.2	27.2	9.1	45.5	0.0
Pharmacotherapy	9	0.0	0.0	0.0	22.2	44.4	33.4	0.0
Psychological therapy	9	0.0	11.1	11.1	22.2	33.3	22.3	0.0
Schedules	8	0.0	0.0	0.0	12.5	25.0	62.5	0.0
Scripts	7	0.0	0.0	0.0	0.0	57.1	42.9	0.0
Story-based intervention	4	0.0	0.0	0.0	0.0	0.0	100	0.0
Sign language training	3	66.7	0.0	0.0	0.0	33.3	0.0	0.0

Note, 1 equal to very ineffective; 2 equals to ineffective; 3 equals to a little ineffective; 4 equals to neutral; 5 equals to a little effective; 6 equals to effective; 7 equals to very effective.

In this part, parents are asked to choose the treatment modalities their child received, past or present, from the list and rate the effectiveness. The treatment that more than 15 people are receiving or have received are behavior therapy (30), language therapy(24), physical training (23), natural teaching therapy (19), attention training (17), music therapy (17) and cognitive behavior (16). However, the popular treatments are not necessarily equal to effective. Actually, the percentage of choosing a little effective and effective are similar in most treatments in the list, and some unpopular treatments are considered as relatively effective, such as Scripts, with 57.1% parents choose a little effective and 42.9% parents chose effective. On the contrary, a very popular treatment modality, music therapy, only have 29.5% people choosing a little effective and 29.5% choosing effective, which is much lower than Scripts’.

3.5. Understanding and level of concern of ASD (Control group)

In this part, there are 55 people (n=55) from control group, rating their understanding of autism spectrum disorder (ASD) and their level of concern of ASD people. The understanding of ASD varies among people. There are about 50.9% people are a little familiar with ASD, and 34.5% people choose “unfamiliar and a little unfamiliar”. In “level of concern”, people’s answers are more concentrative in distribution. There are 40% people are a little concerned with ASD people, 20% people are concerned and 25.4% people hold a neutral attitude on rating the concern of ASD people. In both “understanding” and “level of concern”, nobody choose option 1, which means very unfamiliar with ASD and very unconcerned of ASD people.

3.6. Understanding of Virtual Reality (table 7)

Table 7. Percentage rating of understanding of Virtual Reality (VR).

Level of understanding	Total sample (n=95)	ASD group (n=40)	Control (n=55)	Group
1 Very unfamiliar	15.7	22.5	10.9	
2 Unfamiliar	20.0	27.5	14.5	
3 A little unfamiliar	13.7	10.0	16.4	
4 Average	8.4	10.0	7.2	
5 A little familiar	33.7	27.5	38.1	
6 Familiar	7.4	2.5	10.9	
7 Very familiar	1.1	0.0	2.0	

Parents are asked to rate the understanding of Virtual Reality (VR) in this part, and there are 95 people answered the question in total, 40 people from ASD group and 55 people from control group. Although the parents in control group have a slightly better understanding of VR compared to ASD group, the level of understanding of VR are almost same in two groups in general. There are 27.5% people choose a little familiar in ASD group and 38.1% people in control group; 10.0% people in ASD group choose average and there are 7.2% choose this option in control group. In total sample, 33.7% people are just a little familiar with VR and 48% people are very unfamiliar, unfamiliar or a little unfamiliar with VR.

3.7. The attitude of the potential of Virtual Reality intervention

Table 8. Attitude of the potential of VR in various aspects rating by percentage.

Areas	ASD group						
	1	2	3	4	5	6	7
Attention	11.6	16.3	13.9	11.6	37.2	13.9	0.0
Learning ability	11.6	13.9	5.9	11.7	34.9	18.6	0.0
Basic life skill	11.6	13.9	4.6	5.3	34.1	18.2	2.3
Vocation skills	11.6	6.9	9.3	16.2	30.7	16.3	2.3
Body movement and fine motion ability	13.9	9.3	13.9	18.6	34.9	6.9	2.3
Communicative skills	9.3	16.3	18.6	18.6	31.3	6.9	4.6
Sensory integration skill	9.1	13.6	20.9	13.6	27.2	13.6	2.3
Emotion control skills	9.3	23.2	9.3	18.6	27.9	11.6	0.0
Social ability	9.1	11.4	13.6	25.0	25.0	11.3	4.5
Control group							
Sensory integration skill	0.0	0.0	6.0	26.0	40.0	26.0	2.0
Body movement and fine motion ability	0.0	1.9	3.8	25.0	36.5	28.9	3.8
Attention	0.0	0.0	9.8	25.4	29.4	31.4	3.9
Learning ability	0.0	2.0	10.0	32.0	28.0	28.0	0.0
Communicative skills	2.0	2.0	10.0	34.0	24.0	28.0	0.0
Basic life skill	0.0	1.9	9.8	33.4	33.4	19.6	1.9
Vocation skills	2.0	2.0	12.0	30.0	32.0	18.0	4.0
Social ability	0.0	1.9	12.7	38.2	29.1	18.2	0.0
Emotion control skills	0.0	11.7	13.7	33.4	17.6	21.6	1.9

Note. 1 equal to very unconfident, 2 equal to unconfident, 3 equal to a little unconfident, 4 equal to neutral, 5 equal to a little confident, 6 equal to confident, 7 equal to very confident.

In this part of the questionnaire, parents from both groups are asked to rate their attitude of the potential of VR in various aspects after reading a short introduction about using VR in ASD intervention. In ASD group, the answers in most rows are spread relatively widely, and there are still many people in ASD group hold skeptical and negative attitude towards the future of VR treatment. However, in control group, most answers centered on average, a little confident and confident. These three options are roughly all 25%-30% in most rows, and people hardly choose very unconfident and unconfident. In this way, it is obvious that parents in control group hold a more positive and optimistic attitude than the parents in ASD group.

3.8. Figure

3.8.1. Avegre rating of treatment effectiveness

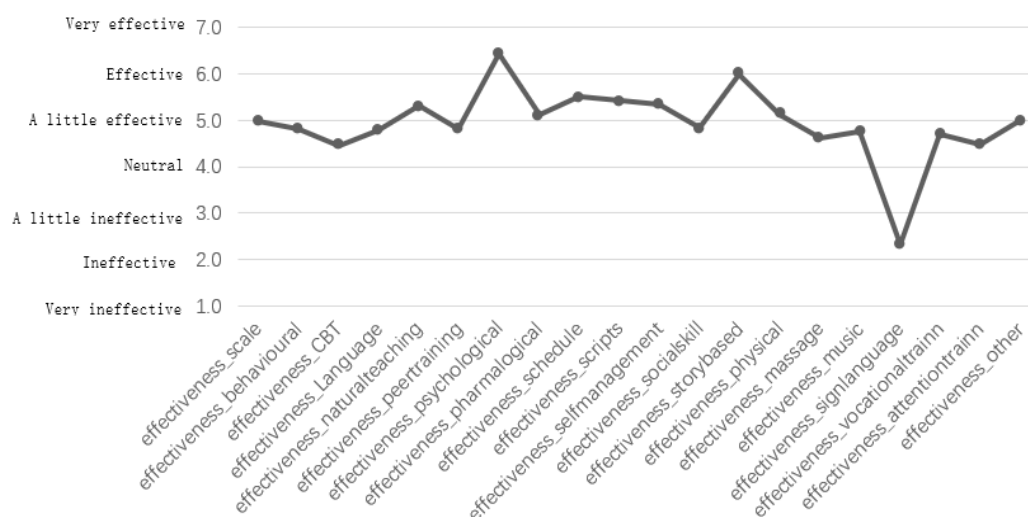


Figure 1. Avegre rating of treatment effectiveness.

Figure 1 shows the effectiveness of various treatments presented to ASD parents. Most of the treatment modalities are within the range of 4.5 and 5.5. There are only two treatments that have a score above 6, psychological treatment and story-based intervention. Only 4 ASD people in the survey tried story-based intervention and 9 people took psychological intervention. Sign-language therapy is the most ineffective treatment ($M=2.33$), but still, only 3 participants tried it before.

3.8.2. T test

Table 9. T test.

Group Statistics										
GROUP				N	Mean	Std. Deviation			Std. Error Mean	
ASD_VR_all	ASD			38	38.6579	13.04519			2.11621	
	CONTROL			50	45.9400	7.69948			1.08887	
Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2- tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ASD_V R_all	Equal variances assumed	9.784	0.002	-3.271	86	0.002	-7.28211	2.22608	-11.70741	-2.85680
	Equal variances not assumed			-3.060	56.210	0.003	-7.28211	2.37991	-12.04925	-2.51496

The T test indicated that optimism scores were significantly higher for participants in the control group ($M=38.66$, $SD=13.05$) than in the ASD group ($M=45.94$, $SD= 7.70$), $t(86) = 3.271$, $p = .002$ when equal variances are assumed.

4. Discussion

The study mainly examined the parents' concerns and attitudes toward VR intervention. Over half of parents considered their child was far below average in six areas of ability compared with average children, for example, reading comprehension, verbal communication, social ability, etc. It's almost the same story when it comes to behavioral observation; over a third of parents rated their child as having an extremely low frequency of forging friendships, initiating a conversation, and using body language. This suggests that children with ASD really require a lot of either professional intervention or parental education and accompany. At the same time, over 60% parents with autistic children revealed being very concerned about their children landing a job, finding a spouse, and dealing with ridicule, which indicates that many of the current treatment is not so effective in improving the core symptoms or those children didn't receive enough professional guidance and intervention continually. This may all contribute to the ASD parents' low level of optimism towards future interventions. We are unable to know whether the hypothesis regarding VR intervention is correct because most parents in our study didn't even hear of it before, not to mention take their child to try it. Of course, VR used in treating ASD is still a very new and immature technology, so this phenomenon is not surprising.

Parents with ASD children faced a lot of difficulties, which is why they are less optimistic than the control group in our survey; specifically, level of confidence towards the future VR intervention in various aspects was much lower in the ASD group than that in the control group. There are several reasons that might contribute to their pessimism. Lan and Doris [14] showed that the frequency of experiencing positive emotions is much lower in preschooler's parents with ASD children than in parents without ASD children, much research done before listed many factors associated with parental quality of life (QOL) in autism. Negative associations have been found between severity, challenging behaviors, developmental delay, comorbidities, communication problems, co-occurring

psychiatric disorders, and parental QoL [16,17,18], and social-economic factors, marital and family support and access to professional institutions and interventions have been revealed to be positively associated with quality of life of ASD parents. In this study, the proportion of the ASD group parents working full time is significantly less than that of the control group. And this result is consistent with the study conducted by Michael, Bonnie, and Stephen [15], which reports that many parents must reduce their working time or even stop working. This not only affects the parental QoL but also creates an extra financial burden. Financial problems also exist in many ASD families due to the expensive fee of medical care or professional intervention and the loss of income by working less.

Currently, most ASD interventions are time-consuming, costly, and sometimes ineffective. Traditional treatment modalities require a lot of human labor and time effort, either for parents or professionals. Behavioral intervention, one of the most used therapies, requires large-scale venues, specialized facilities, and long-term professional training in institutions [21] ABA intervention, for example, needs at least 25 hours weekly in a comprehensive program to address the deficits and disorders. For parents, hiring specialists or taking treatment in professional organizations will even worsen their financial problems. In fact, according to a survey conducted by Michael et al [15], in the United States, ASD parents spend over 1000 dollars for professional medical care on average. In many cases, there is a lack of enough professional support and institutions, which means the parents in those regions must spend even more time accompanying and educating their children. A study conducted by Benjamin and Beverly [12] suggested that there are 32.5% of parents with ASD children with co-occurring problems have unmet needs with current treatments and 24.8% with professional providers. Generalization is one of the main limitations of most current treatments. Participants will show progress and symptoms improved in the given program or experiment, but they can't generalize the improvement of the same type of behavior to another scenario with some difference or to the real world. In the survey, each parent in our survey took approximately 6 interventions on average, but the mean effectiveness of most treatment modalities is just about average.

Virtual Reality intervention has a few benefits over traditional therapy and appeared to be more effective in some areas. VR provides a personalized and individualized treatment; the environment created in the virtual world is much safer than the real world, and the outside stimuli can be carefully manipulated and controlled. More specifically, as the participant gradually gets used to the program and successfully completed the previous task, more stimuli (sound, people, and objects) can be added to the program and participants can therefore effectively improve their symptoms in a relatively safe and relaxed environment. Additionally, VR intervention showed generalization in many programs because of its accurate and specialized adjusting system. This is vitally important when treating the core symptoms of ASD, especially in social training. An increasing study and training also incorporated a system with complex facial expressions in order to improve eye contact and effective responding, which is of great benefit when dealing with social deficits. Parents from the ASD group expressed a high level of concern regarding making social interactions and building relationships with other people, and at the same time, a social problem is one of the most prevailing features of children with ASD. Even if many people in the control group expressed their concern over the advantage of VR in improving social skills, which should be involved with real people in many people's minds that might just be because they are not familiar with VR intervention's advantages and its amazing pace of development. More importantly, once the VR system is successfully programmed, the demand for one-to-one professional training will strikingly decrease, and parents can even learn how to adjust and control the stimuli and environment in the VR system gradually. This will lessen the pressure endured by parents, increase the life of quality, and reduce the financial burden.

This study introduces virtual reality intervention for autistic children's parents, especially for those skeptical parents. We can clearly see from our results that a considerable number of ASD parents are pessimistic because of their relatively low life quality, mental anxiety, exhaustion, etc. And for many of them, virtual reality is a totally brand-new idea, so by introducing them to the introduction and benefits over traditional intervention, even though it won't be immediately accepted, it will at least engage some of the parents who want to change their child's symptoms in the discussion of future VR

interventions. This will also lay the foundation for future parents to actively take their children to try VR interventions.

ASD parents' concerns are of great importance because it may help to know the real challenges their children faced in the real life, and this will also give some insights for those VR program makers to improve the treatment modalities. In many cases, it's difficult to see the big picture as outsiders, and a lot of what we think are the needs of autistic children may be wrong or incomplete. By asking the ASD children's parents' feelings and listening to their real experiences, we may get to know what it's really like to be an ASD child, and thus the VR program designer can try to add tasks to help them overcome these issues. Currently, in most cases, we can only ask autistic children's parents to know their feelings and needs because many of them lack language skills or social skills, or maybe overstimulating by the strange people or environment, and indeed there will be a difference between what the child thinks and what the parents articulate, but that is the most effective way at this point. It would also be a huge leap if we could find a way to effectively communicate with children with autism in the future.

In the future, I suggest more actual VR experiences for children with autism. Currently, VR interventions haven't been widely used and many of the real case studies regarding this topic were written in the past decades, and there is not enough study sample to test the effectiveness of various VR programs, and thus it's hard to know the get improved without a large amount of feedback. In this way, we should invite more and more parents, who are willing to help improve their children's symptoms and feel open to new technology, to let their children participate in the VR program and provide feedback and suggestions.

Most of the participants in this study come from Beijing and it's not broadly geographically representative. Also, in the ASD group, about half of the child's participants are adults, and this might relate to being less optimistic because it's harder to get improvement in the core symptoms when autistic people are older. In the control group, the ratio of males to females is 1.7 to 1, and this is not consistent with the overall ratio of males and females in Beijing. Additionally, because of the voluntary nature of the questionnaire, most of the ASD parent participants are relatively highly motivated to help their children to get improved and are more open to the new treatment. Regarding the attitude toward VR intervention, only the benefits of VR are shown to the participants, so the level of optimism might be slightly overestimated.

5. Conclusion

Despite some limitations, this study still clearly indicates the autistic children parent's concerns, rating of symptoms, and most importantly, the difference in the level of optimism between the ASD group and control group, and provides some insights for future VR intervention development. Those information are of great importance for us to learn what it is really like to be the parents of autistic parents, how challenging their and their children's lives are, and how urgent the new treatment modalities are. Virtual Reality, as one of the most promising interventions, has the great potential to subvert the old paradigm, dramatically increase the effectiveness, and improve the quality of lives of people with autism. Even though the use of VR for treating ASD is only in its infancy, because it has the potential to change the lives of 750,000 people worldwide with autism and their family members and friends affected by it, it is important that we develop VR and bring it to the attention and support of more people.

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