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Gamification Does Not Replace Sensory Integration Training in Autistic Children

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Abstract

Background: Autistic children had various behavior limitations. These limitations result from defects in interaction and integration of perceptual and sensory processing.

Aim: Our study aimed to determine whether gamification replace sensory integration training in autistic children or not.

Methods: Thirty children (nineteen boys and eleven girls) suffering from autism spectrum disorders (ASDs) conducted to this study. They were divided randomly into two age and sex matched groups. Each child in group I applied Wii training for (30 min, three sessions per week for 6 months). Each child in group II conducted to sensory integration program (30 min, three sessions per week for 6 months).

Results: Post treatment mean values of the calculated variables were compared and revealed significant promotion in fine motor skills for both groups with favor of sensory integration group.

Conclusion: Virtual reality games do not replace sensory integration and open environment training in autistic children.

Keywords: Sensory integration; Virtual reality; Gamification, Autistic; Peabody; Fine motor

Introduction

Autism Spectrum Disorder (ASD) is a disorder which affects children development resulting in their impairment [1]. The impairment changes considerably and ranged from mild to severe. It includes communication, somatosensory, mood, concentration and typical developmental patterns defects [2]. Zikl et al. stated that autistic children had delayed fine motor skills as compared with gross motor skills and balance [3].

As a result of these defects, these children suffering from limited functional behaviors [4]. Also, their capabilities to join in activities become restricted [2].

Sensory-based activities are widely applied to manage the developmental delay in pediatric rehabilitation. It provides different sensory inputs (vestibular, proprioceptive, auditory and tactile) which act to control sensory system. These inputs were supplied by using specific equipment, e.g. brushes, swings and balls [5,6]. Recently, pediatric rehabilitation therapies use various virtual reality (VR) technologies such as Wii and Fit. It provides a safe and ecologically valid environment and being enjoyable and motivating to be participant focus on the task rather than painful or unpleasant medical procedures [7,8]. Our study aimed to determine whether gamification replaces sensory integration training in autistic children or not.

Subjects, Instrumentations and Procedures

Subjects

Children (n=30 child) diagnosed as mild to moderate autistic features according to the Childhood Autism Rating Scale (CARS) conducted to this study [6,9,10]. They selected from the schools of special needs and some clinics according to the following criteria:

1. They had borderline intelligent quotient (IQ) according to Stanford-Binet Test.
2. They were able to track simple verbal instructions.
3. They had no history of other disorders (cerebral palsy or epilepsy) or associated disorders (visual and auditory).
4. Their age ranged from 40 to 65 months.

They were divided randomly into two groups: Group I: virtual reality group: included 15 children (10 boys and 5 girls) with mean age ranged from 57.73 ±7.29 months. Group II: sensory integration group: included 15 children (9 boys and 6 girls) with mean age ranged from 54.67 ± 9.45 months. The study was approved by an Ethics Committee of the Cairo University. Written consent and Volunteer Information Sheet were authorized to Child's parents. All information about the aim of the study, its benefits and risks and their committee with regard to time and money were mentioned in these forms.

Instrumentations

For evaluation: Fine motor skills were evaluated pre and post interventions for each child in both groups using Peabody Developmental Motor Scale (PDMS-2) [6].

For treatment: Group I (Virtual reality group):

All children in this group received Nintendo Wii Sports intervention to provide virtual reality. Each child applied Wii training for 30 min, 3 times per week for 6 months.

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- Group II (Sensory Integration group):

All children in this group received sensory integration program for 30 min, 3 times per week for 6 months.

Procedures

For evaluation: Each child in both groups was examined individually, using the Peabody Developmental Motor Scale (PDMS-2). The fine motor skills include assessment subsets for grasping and visual-motor integration [6].

Scoring the PDMS-2: The PDMS-2 norms, each item of subsets scored as 2, 1 or 0. After administration of all tests in each subtest, raw and standard scores were intended for each one. Finally, the fine motor quotient (FMQ) was determined. The FMQ was converted into a description included in the PDMS-2 manual. This description reflected the child relative strengths and weakness to motor development.

For treatment: Group I (Virtual reality group): All children who participated in this group conducted to Nintendo Wii Sports. It focused on the children's hand-eye coordination and timing of movements. The selection of games and activities were individualized for each child based on their interests, functional limitations and abilities [11]. Nintendo Wii Sports includes five games: boxing, bowling, golf, tennis and baseball.

Group II (Sensory integration group): Various Sensory integration materials were used for this child to provide tactile input (e.g. touchable bubbles and a mist spray fan), vestibular input (e.g. swings, balancing boards, trampolines and see-saws) and proprioceptive input (e.g. hand weights, modeling clay and weighted blankets). The fine motor skill activities were also included [6].

Item	Virtual reality group	Sensory integration group
	$\bar{x}$ ± SD	$\bar{x}$ ± SD
Age	57.73 ± 7.29	54.67 ± 9.45
IQ	79. 07 ± 5.06	78.27 ± 5.30
CARS	28.93 ± 2.96	29.33 ± 2.77

$\bar{x}$: Mean; SD: Standard Deviation

Table 1: Descriptive data of both groups.

Statistical analysis

The mean value and standard deviation were calculated for each variable measured during the study for both groups. Comparing mean values of each parameter were be done by nonparametric statistics independent t-test. The differences in the mean values revealed that there were significant differences between both groups as ($p<0.05$).

Results

Descriptive data of both groups (the virtual reality and the sensory integration)

The ages, degree of Childhood Autism Rating Scale (CARS) and intelligent quotient (IQ) (mean ± standard deviation) of virtual reality and the sensory group were summarized in Table 1.

Pre- and post-treatment values of raw scores

Comparing the pre-treatment mean values of the measured subtests in both groups revealed no significant difference as ($p>0.05$) (Table 2). Comparing the post-treatment mean values of the measured subtests in both groups revealed significant difference as ($p<0.05$) (Table 2).

Pre and post-treatment values of standard scores

Comparing the pre-treatment mean values of the measured subtests in both groups revealed no significant difference as ($p>0.05$) (Table 3). Comparing the post-treatment mean values of the measured subtests in both groups revealed significant difference as ($p<0.05$) (Table 3).

Pre and post-treatment values of fine motor quotient

Comparing the pre-treatment mean values of the fine quotient in

Items		Group	$\bar{x}$ ± SD	MD	t-value	P-Value
Pre treatment	Grasping	Virtual reality	44.27 ± 3.56	1.467	1.324	0.196
		Sensory integration	42.80 ± 2.40			
	Visual motor integration	Virtual reality	117.53 ± 12.81	0.533	0.136	0.893
		Sensory integration	117.00 ± 8.08			
Post treatment	Grasping	Virtual reality	44.733 ± 3.59	-4.867	-5.005	0.000*
		Sensory integration	49.60 ± 1.12			
	Visual motor integration	Virtual reality	118.93 ± 12.88	-15.000	-4.379	0.000*
		Sensory integration	133.93 ± 3.20			

$\bar{x}$: Mean; SD: Standard Deviation; MD: Mean Difference; t-value: Paired t-value; P-value: Probability Value; *: Significant

Table 2: Pre- and post-treatment mean values of raw score's subsets for both groups.

Items		Group	$\bar{x}$ ± SD	MD	t value	P Value
Pre treatment	Grasping	Virtual reality	5.133 ± 2.875	1.133	1.342	0.190
		Sensory integration	4.00 ± 1.558			
	Visual motor integration	Virtual reality	6.533± 2.825	0.267	0.315	0.755
		Sensory integration	6.267 ± 1.668			
Post treatment	Grasping	Virtual reality	5.400 ± 3.043	-4.667	-5.476	0.000*
		Sensory integration	10.067 ± 1.280			
	Visual motor integration	Virtual reality	6.800 ± 3.144	-3.400	-3.838	0.000*
		Sensory integration	10.200 ± 1.373			

$\bar{x}$: Mean; SD: Standard Deviation; MD: Mean Difference; t-value: Paired t-value; P-value: Probability value; *: Significant

Table 3: Pre- and post-treatment mean values of standard score's subsets for both groups.

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both groups revealed no significant difference as (p>0.05) (Table 4). Comparing the post-treatment mean values of the fine quotient in both groups revealed significant difference as (p<0.05) (Table 4).

Pre and post-treatment values of age equivalence in months for the sub motor tests

Comparing the pre-treatment mean values of the age equivalence in months for the sub motor tests in both groups revealed no significant difference as (p>0.05) (Table 5). Comparing the post-treatment mean values of the measured subtests in both groups revealed significant difference as (p<0.05) (Table 5).

The interpretation of the composite quotients in terms of diagnosing strengths and weaknesses in motor development

Based on the fine motor quotient classifications, the pre and post treatment quotients in both groups were compared and revealed that the fine motor skills were improved post treatment in both groups (Table 6).

Discussion

This study was participated to compare the effect of virtual reality versus sensory integration program on fine motor skills rehabilitation in autistic children. It was conducted to autistic children who are highly increased in last decades [12]. Pre-school age children with ASD had a significant developmental delay in fine motor skills when compared with normal children matched for chronological and mental age [13,14].

The Peabody Developmental Motor Scale is considered as a reliable and valid tool used to evaluate fine motor skills performed by preschool children [15]. Sensory integration approach is one of the interventions that commonly and positively affect the rehabilitation of autistic children [16,17]. Virtual reality (VR) is recently used as a talented method in pediatric rehabilitation [18].

The pre-treatment results obtained from both groups (virtual reality and sensory integration respectively) regarding the measuring variables showed no significant difference. While the pretreatment mean values of age equivalence in months for the children in both groups showed a decrease in their values as compared with their chronological age in months, which mean that these children had a developmental delay in fine motor skills. These results were consistent with those reported previously by several studies on children with ASD [19-22]. In this study early detection of the problem in children with ASD is important for early intervention; the findings of this study can be explained by Noterdaeme et al. [23], who concluded that detection of motor problems in developmentally impaired children was particularly relevant for two reasons: Firstly, motor problems added burden on the development of children. These deficits had a considerable impact on activities of daily living and impaired the social integration of the child

Items	Group	$\bar{x}$ ± SD	MD	t value	P Value
Pre treatment	Virtual reality	75.786 ± 16.025	4.586	0.969	0.341
	Sensory integration	71.200 ± 8.621			
Post treatment	Virtual reality	77.286 ± 17.081	-23.514	-4.832	0.000*
	Sensory integration	100.800 ± 7.7293			

$\bar{x}$: Mean; SD: Standard Deviation; MD: Mean Difference; t-value: Paired t-value; P-value: Probability Value; *: Significant

Table 4: Pre and post treatment values of fine motor quotient.

Items		Group	$\bar{x}$ ± SD	MD	t Value	P Value
Pre treatment	Grasping	Virtual reality	30.600 ± 14.618	4.333	0.919	0.366
		Sensory integration	26.267 ± 10.938			
	Visual motor integration	Virtual reality	40.600 ± 11.861	1.533	0.423	0.675
		Sensory integration	39.067 ± 7.497			
Post treatment	Grasping	Virtual reality	33.333 ± 14.603	-20.267	-4.952	0.000*
		Sensory integration	53.600 ± 6.1621			
	Visual motor integration	Virtual reality	42.067 ± 12.584	-14.000	-3.949	0.001*
		Sensory integration	56.067 ± 5.496			

$\bar{x}$: Mean; SD: Standard Deviation; MD: Mean Difference; t-value: Paired t-value; P-value: Probability Value; *: Significant

Table 5: Pre and post treatment mean values of age equivalence in months for both groups.

Item			Fine motor quotient classifications						
			Very poor	Poor	Below average	Average	Above average	Superior	Very superior
Group	Group I (Virtual reality)	Pre treatment	7 children	1 child	4 children	3 children	0	0	0
		Post treatment	7 children	1 child	2 children	5 children	0	0	0
	Group II (sensory integration)	Pre treatment	6 children	7 children	2 children	0	0	0	0
		Post treatment	0	1 child	0	14 children	0	0	0

Table 6: The interpretation of the composite quotients.

in his peer group. Secondly, those children with problems in fine motor functions and coordination had a higher risk of developing learning and behavioral problems when they reached school age [23].

Our results indicated post-treatment improvements in fine motor skills in both groups. It also showed that the improvements in motor skills were highly significant in sensory integration group when compared with virtual reality group. These results consistent with these reported by Abdel Karim and Mohammed who emphasized that sensory integration therapy improves fine motor skills in children with ASD [6]. Sensory integration intervention conducted to children with ASD showed advancement in their individualized goals ability and reduce their mannerism [24]. Also, it has a direct effect on a child's nervous system functioning and capitalizing on plasticity within his or her nervous system [25].

The use of sensory activity schedule intervention improves the classroom task performance which assessed by the task analysis [26].

Anderson et al. reported that virtual Wiihab offer augmented feedback and motivation to patients through recording performance and behavioral measurements, allowing for activity customization and using auditory, visual, and haptic elements [27]. Also, Muneer et al. stated that virtual reality games provide a useful platform for building interventions for children with developmental disabilities in motor, cognitive and social/emotional domains [28]. The virtual reality interventions provide concentrated sensory-motor stimuli that act to evoke neurons and allow brain reorganization. This reorganization allows the children to interrelate the three-dimensional scenario and the captured movement on the screen at the same time. Detection the source of error and corrections are allowed through the augmented feedback provided by Wii games. So, tasks are practiced with timely feedback control. It also provides feed forward preparatory control that is required for achieving balance, especially in standing position. It also improves the regulation of movement amplitude, speed and precision which are necessary for achieving balance. Wii games training provide active participation from the children in a fun, enjoyable and play environment which helps to keep the children motivated during therapeutic rehabilitation [29].

Conclusion

It was concluded that both sensory integration therapy and virtual reality were effective interventions for autistic children as it promotes their motor development. Also, it was concluded that the sensory integration therapy has a highly significant impact as compared with virtual reality in the autistic children rehabilitation.

Conflict of Interest

We declare that there were no conflicts of interest in the entire journey of the study.

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