

A SENSORY INTEGRATION INTERVENTION FOR CHILDREN WITH AUTISM SPECTRUM DISORDERS (ASD): DEVELOPMENT AND TRIAL

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Abstract

Sensory integration theory was developed to explain neurological processing of sensory information. The theory is based on the understanding that interferences in neurological processing of sensory information interrupt the construction of appropriate behaviours. Children with particular conditions, including Autism Spectrum Disorder (ASD), can have difficulties generating appropriate behaviours in response to the sensory stimuli they perceive and their environment. These difficulties impact on the educational experiences of these children. The aim of this study is to develop a sensory integration intervention programme to address behavioural problems for children with ASD and to report on the practicality of the programme with an aim for implementing it in a randomised controlled trial. The intervention programme was developed through a comprehensive literature review and expert panel review. Three children diagnosed with ASD aged between 6-12 years old with normal to moderate intellectual quotient received the intervention. Six outcome measures were administered before and after the intervention. The outcomes included parent self-rated and therapist-assessed behaviour, school function, daily living skills and social participation. Interview with parents were also conducted after the intervention to collect their feedback on the programme. All participants reported an improvement after post intervention mostly in communication, socialization, reduction of behaviour problems and reduction of sensory problems. The result of this study supported the use of Sensory Integration intervention to enhance

children with ASD's positive behaviours to allow them to learn, socialise and engage into appropriate daily functioning.

Keywords: Sensory Integration, Autism Spectrum Disorders, Sensory-Based

Introduction

Children with ASD have impairments in two common areas: i) problems in social interactions and social communication; and ii) restrictive and repetitive patterns of behaviours, interests or activities (American Psychiatric Association, 2013). These impairments may lead to the manifestation of behavioural problems which negatively impact children's participation in school, activities of daily living and social engagement (Baghdadli, 2003; Herring et al., 2006; Murphy et al., 2005). In order to minimise the impact on the daily functioning of these children, overcoming behavioural problems is essential.

Sensory Integration Intervention

Sensory integration (SI) intervention is widely used among occupational therapist. The interest in applying SI is increasing dramatically. SI makes use of the principles in neuroscience, developmental psychology and occupational therapy in explaining the concept of sensory perception and integration in development and functional behaviour (Ayres, 1979; Parham & Mailloux, 2005; Schaaf, Benevides, Kelly, & Mailloux-Maggio, 2012). Reports from the Interactive Autism Network indicated SI is the fifth common type of intervention received among children with Autism Spectrum Disorders (ASD) (Autism Speaks, 2104). Researches have been addressing on the effectiveness of SI intervention for decades; however, findings are still inconclusive.

Since 2007, therapists using SI are advised to follow the ten specific principles stated by Parham et al. (2007). They are i) providing sensory opportunities (present of various sensory experiences); ii) offering just-right challenges (activities that are neither too difficult nor too easy to evoke adaptive responses); iii) collaboration on activity (allowing children to actively exert control over activity choice); iv) guiding on self-organization (supporting and guiding children to make own choices and plan own behaviour, encouraging them to initiate and develop ideas); v) supporting for optimal arousal (ensuring the activities support's attention, engagement and comfort); vi) creating play context (building intrinsic motivation and enjoyment, facilitate or expand on social, motor, imaginative or object play); vii) maximizing success; viii) ensuring physical safety (physical safety is ensured throughout the activities); ix) room arrangement (room is arranged attractively to engage participation in activities); and x) therapeutic alliances (respecting emotions, conveying positive regards, building connection and creating climate of trust and emotional safety). These ten specific fidelity measures must also be applied with the structural features of SI intervention which include i) environmental design including room setup and type of equipment

used and ii) therapist qualification including professional background, education, clinical experiences, training, supervision and certification in SI. Many therapists and researchers are still confused with SI intervention and sensory-based intervention.

Sensory-Based Intervention

Sensory-based intervention uses discrete sensory experiences or environmental modifications to facilitate regulation of behaviours, addressing specific difficulties in sensory modulation or sensory discrimination (Tomchek & Case-Smith, 2009; Watling, Koenig, Schaaf, & Davies, 2011). Sensory-based intervention focus more on the environmental modifications to assist a child rather than the lasting effect of sensory input (ie: providing weighted vests to increase attention in class). It may not include all the ten fidelity measures and the structural features described as the SI intervention and, therefore, may not tackle children's problems using the theoretical framework used in SI. Effectiveness of such programmes may vary.

The aim of this study was to develop a sensory integration intervention programme including the ten fidelity measures of SI intervention to address behavioural problems for children with ASD and report on the practicality of the programme which could then be implemented in a randomised controlled trial.

Table 1 - Differences of SI Intervention and Sensory-Based Intervention from (Watling & Clark, 2011)

Sensory Integration Intervention	Sensory-Based Intervention
Aims for a lasting impact on neurophysiological processing sensation	Aims to modify regulatory state of behaviour without lasting effect
Applies the ten fidelity measures of SI intervention	Uses sensation to support function but does not apply the ten fidelity measures of SI
Requires active engagement and adaptive responses	Sensation may be applied passively with or without adaptive response
Used of specialized SI equipment	Minimal use of equipment needed
Needs specialized environmental affordances	Can easily be implemented in everyday environments
Provides in a context of play and fun activity	May or may not be playful and fun
Individualize intervention (one-on-one)	May be individual or group
Advance training with certification of SI consistence with Ayres SI theory	Recommended for advance training only

Method

Participants

Three children with ASD (*mean age* = 8.2 years) were recruited from a private children centre in Malaysia. Children were invited if they were aged 6-12 years old, diagnosed with ASD, attained an overall score greater than 10 in the Maladaptive Behavioural Index of Vineland Adaptive Behaviour Scales (2nd edition), and had an intellectual quotient greater than 50 (normal to moderate grade of intellectual disabilities).

Table 2 - Participant demographic information

Participant	Age (years)	Ethnicity	VABS-II Screening Score	IQ	Interventions
Ian	8.0	Malay	10	Mild	OT: 1 hour per month
Alex	8.6	Malay	13	Mild	OT: 1 hour per month
Shawn	8.1	Chinese	53	Moderate	OT- 1 hour per week ST- 1 hour per week

OT: Occupational Therapy

ST: Speech Therapy

VABS-II: Vineland Adaptive Behaviour Scale, Second Edition

IQ: Intelligence quotient

Ethical Approval

Ethical approval was obtain form the University of Western Sydney Human Ethics Committee and the Economic planning unit, Prime Minister's Department to conduct a study in Malaysia. A permission letter was obtained from the private centre in Malaysia as an agreement to conduct the study at the centre. Informed consent from the parents was obtained on behalf of their children prior to the initiation of the pilot study.

Research Design

The study used a pre-post design to report on the practicality of the SI programme developed based on the ten fidelity measures (Parham et al., 2007). The intervention was developed as a pilot study and the development of the SI intervention programme to assess the effectiveness of the SI intervention on each participant. Any errors occur on the practicality of the intervention and the outcome measures used will be reported.

Programme Development

The intervention programme was developed through a comprehensive literature review and expert panel review with four experienced occupational therapists from Malaysia (N=4) of more than three years' experience in paediatric occupational therapy. Comments made by the expert panels were corrected first before applying the SI intervention pilot study.

Intervention

A one-week SI intervention applying the ten fidelity measures of SI was used in this study. The children underwent one hour SI intervention everyday. The programme consisted of a ten minute warm-up session for the children to explore the SI equipment. Eight stations of SI intervention (trampoline, balance beam, ball pool, therapy ball, tunnel, swing, stairs and table) were to be completed as one cycle (Figure 1). The

participants would play as many cycles as possible within 30 minutes. Afterwards, specific stimulations were given for another ten minutes. Cool down activities were given at the end of the session. All the interventions were monitored and observed by the therapist to ensure no injury occurred during the one hour session for each child. An upgrade and downgrade of each intervention was given by the therapist to ensure that the activity performed in the SI intervention was suitable (just-right-challenge) for the participant's need.

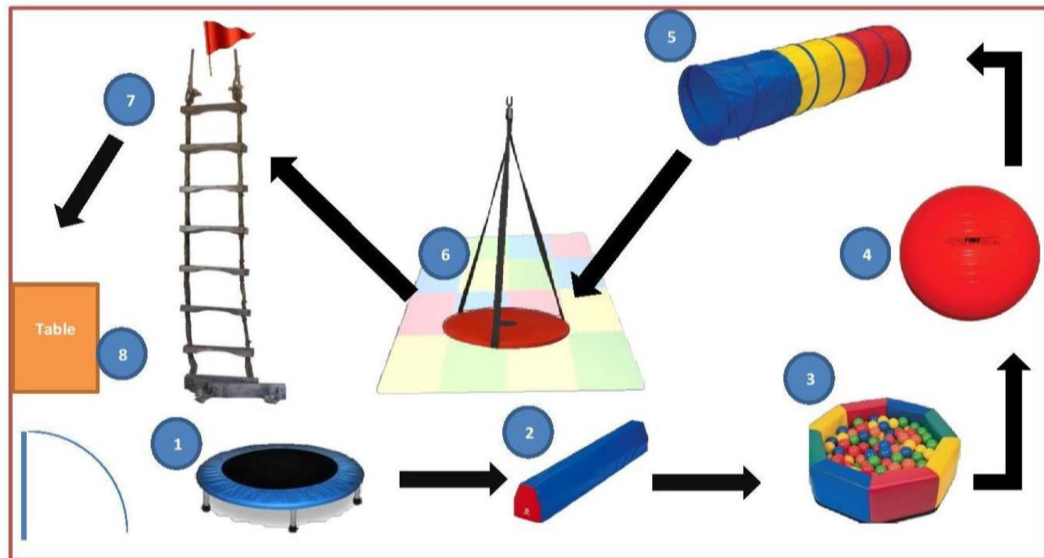


Figure 1 - Settings of SI intervention room

Outcome measures

Six outcome measures were used in this study. Three outcome measures were rated by occupational therapist. They were the: i) Vineland Adaptive Behaviour Scale, Second Edition (VABS-II); ii) School Function Assessment (SFA); and iii) Walker McConnell Scale (WMS). Another three were self-rated by the parents. They were the: i) Behaviour Rating Inventory of Executive Function (BRIEF), ii) Sensory Profile (SP) and iii) Sensory Processing Measures (SPM). All assessments were rated before and after the intervention.

Results

The results of the study were measured using the six outcome measures and parents interview (Table 3). Since a small sample size of participants was involve in a short duration, statistical analyses could not be conducted. In addition, the main aim of the pilot study was to report on the practicality of the SI intervention development programme.

Ian

Results from the VABS-II indicated a slight improvement in the communication and socialization domains after the SI intervention. For the behavioural issues, only the internalizing behaviours were reduced while the maladaptive behaviours and externalizing behaviours remained the same after the SI intervention. Results in BRIEF indicated an improvement in both behavioural regulation index and the metacognitive index. The SFA reported no improvements in all the tasks after a one week of SI intervention. Results from the WMS indicated an improvement in social competence with an increment of 13 points. In the SP, the client showed a slight improvement in seven out of fourteen sensory domains). Results of the SPM indicated a reduction in the total of all the sensory domains. The interview with his parents after the SI intervention suggested Ian appeared to be more focused in class and seemed to sleep well at night.

Alex

Results from the VABS-II indicated a slight improvement in communication and socialization domains after the SI intervention were conducted. Behavioural issues were only reduced in the maladaptive behaviours domain. Results of the BRIEF indicated an improvement in both behavioural regulation index and the metacognitive index. The SFA reported no improvements in all the tasks after a one week of SI intervention. Results from the WMS indicated an improvement in social competence with an increment of 2 points. Results of the SP indicated no improvement in all the sensory domains after a one week SI intervention programme. In SPM, results reported a slight decrease of the total score. According to his mother, Alex was more alert and his attention level had increased. Academic achievement was also improved.

Shawn

Results from the VABS-II indicated an increment in all domains after the SI intervention programme. Behavioural issues were all reduced after the SI intervention. Results of the Behaviour Rating Inventory Executive Function (BRIEF) also indicated an improvement in both behavioural regulation index and the metacognitive index. Results from the SFA indicated an improvement in seven domains. Results from the WMS indicated an improvement in social competence with an increment of 18 points. Results of the SP indicated improvement in ten of the sensory domain. In the SPM, results reported a decrease of the total score. The interview with his parents indicated that Shawn had reduced behaviour in pinching and crying after the third session. His mother also reported that the Shawn was more alert at home.

Table 3 - Outcome Measure Results

Ian				
Vineland Adaptive Behaviour Scale-II (VABS-II)				
Domain	Pre-Standard Score	Pre-Adaptive Level	Post-Standard Score	Post-Adaptive Level
Communication	65	Low	69	Low
Daily Living Skills	65	Low	65	Low
Socialization	64	Low	68	Low
Domain	Pre V-Scale Score	Pre-Adaptive Level	Post V-Scale Score	Post-Adaptive Level
Maladaptive Behavior Index	15	Average	15	Average
Internalizing	19	Elevated	17	Average
Externalizing	14	Average	14	Average
Sensory Profile (SP)				
Sensory Processing	Pre-Scoring	Pre-Indications	Post-Scoring	Post-Indications
A. Auditory Processing	26/40	Definite Difference	28/40	Probable Difference
B. Visual Processing	36/45	Typical Performance	36/45	Typical Performance
C. Vestibular Processing	54/55	Typical Performance	58/55	Typical Performance
D. Touch Processing	85/90	Typical Performance	85/90	Typical Performance
E. Multisensory Processing	32/35	Typical Performance	32/35	Typical Performance
F. Oral Sensory Processing	48/60	Typical Performance	50/60	Typical Performance
Modulation				
G. Sensory Processing Related to Endurance/Tone	33/45	Definite Difference	36/45	Probable Difference
H. Modulation Related to Body Position and Movement	41/50	Typical Performance	43/50	Typical Performance
I. Modulation of Movement Affecting Activity Level	23/35	Typical Performance	23/35	Typical Performance
J. Modulation of Sensory Input Affecting Emotional Responses	11/20	Typical Performance	11/20	Typical Performance
K. Modulation of Visual Input	16/20	Typical Performance	17/20	Typical Performance

Affecting Emotional Responses and Activity Level				
Behavior and Emotional Responses				
L. Emotional/Social Responses	64/85	Typical Performance	64/85	Typical Performance
M. Behavioral Outcomes of Sensory Processing	23/30	Typical Performance	23/30	Typical Performance
N. Items Indicating Thresholds for Responses	11/15	Probable Difference	12/15	Typical Performance
Sensory Processing Measures (SPM)				
Domain	Pre-T-Score	Pre-Interpretive	Post-T-Score	Post-Interpretive
Social	58	Typical	58	Typical
Visual	61	Some Problems	59	Typical
Hearing	66	Some Problems	63	Some Problems
Touch	61	Some Problems	57	Typical
Body	59	Typical	59	Typical
Balance	57	Typical	57	Typical
Planning and ideas	58	Typical	58	Typical
Total	62	Some Problems	53	Typical
School Function Assessment (SFA)				
Tasks	Pre-Criterion Score		Post-Criterion Score	
Part I: Participation				
Special Education Classroom+ 5 Settings	85/100		85/100	
Part II: Task Supports				
Physical Tasks-Assistance	73/100		73/100	
Cognitive Tasks-Assistance	69/77		69/77	
Part III: Activity Performance				
Physical Tasks				
Travel	72/100		72/100	
Maintaining and Changing Positions	83/100		83/100	
Recreational Movements	82/83		83/83	
Manipulation with Movements	65/93		65/93	
Using Materials	65/83		65/83	
Setup and Clean-up	72/87		72/87	
Eating and Drinking	65/100		65/100	
Hygiene	60/92		60/92	
Clothing Management	70/93		70/93	

Up/Down Stairs	100/100	100/100
Written Work	64/73	64/73
Computer Equipment Use	43/65	43/65
Cognitive/Behavioral Tasks		
Functional Communication	60/91	60/91
Memory and Understanding	70/79	70/79
Following Social Conversations	56/73	56/73
Compliance with Adult	70/76	70/76
Directives and School Rules		
Task Behavior/Completion	70/72	70/72
Positive Interaction	60/81	60/81
Behavior Regulation	60/74	60/74
Personal Care Awareness	63/92	63/92
Safety	62/91	62/91
Behaviour Rating Inventory of Executive Function (BRIEF)		
Scale/Index	Pre-T-Score	Post-T-Score
Behavioural Regulation Index	50	59
Metacognitive Index	53	64
Walker-McConnell Scale (WMS)		
Pre-Total Score	Post-Total Score	
105	118	

Alex**Vineland Adaptive Behaviour Scale-II (VABS-II)**

Domain	Pre-Standard Score	Pre-Adaptive Level	Post-Standard Score	Post-Adaptive Level
Communication	72	Moderately Low	77	Moderately Low
Daily Living Skills	78	Moderately Low	78	Moderately Low
Socialization	69	Low	73	Moderately Low
Domain	Pre V-Scale Score	Pre-Adaptive Level	Post V-Scale Score	Post-Adaptive Level
Maladaptive Behavior Index	17	Average	16	Average
Internalizing	15	Average	15	Average
Externalizing	16	Average	16	Average
Sensory Profile (SP)				
Sensory Processing	Pre-Scoring	Pre-Indications	Post-Scoring	Post-Indications
A. Auditory Processing	40/40	Typical Performances	40/40	Typical Performances
B. Visual Processing	45/45	Typical Performances	45/45	Typical Performances
C. Vestibular Processing	54/55	Typical Performances	54/55	Typical Performances
D. Touch Processing	87/90	Typical Performances	87/90	Typical Performances

E. Multisensory Processing	33/35	Typical Performances	33/35	Typical Performances
F. Oral Sensory Processing	60/60	Typical Performances	60/60	Typical Performances
Modulation				
G. Sensory Processing Related to Endurance/Tone	45/45	Typical Performances	45/45	Typical Performances
H. Modulation Related to Body Position and Movement	50/50	Typical Performances	50/50	Typical Performances
I. Modulation of Movement Affecting Activity Level	35/35	Typical Performances	35/35	Typical Performances
J. Modulation of Sensory Input Affecting Emotional Responses	20/20	Typical Performances	20/20	Typical Performances
K. Modulation of Visual Input Affecting Emotional Responses and Activity Level	18/20	Typical Performances	18/20	Typical Performances
Behavior and Emotional Responses				
L. Emotional/Social Responses	83/85	Typical Performances	83/85	Typical Performances
M. Behavioral Outcomes of Sensory Processing	27/30	Typical Performances	27/30	Typical Performances
N. Items Indicating Thresholds for Responses	15/15	Typical Performances	15/15	Typical Performances
Sensory Processing Measures (SPM)				
Domain	Pre-T-Score	Pre-Interpretive	Post-T-Score	Post-Interpretive
Social	65	Some Problems	58	Some Problems
Visual	54	Typical	54	Typical
Hearing	43	Typical	43	Typical
Touch	52	Typical	52	Typical
Body	55	Typical	55	Typical
Balance	54	Typical	54	Typical
Planning and ideas	61	Some Problems	58	Some Problems

Total	67	Some Problems	65	Some Problems
School Function Assessment (SFA)				
Tasks		Pre-Criterion Score		Post-Criterion Score
Part I: Participation				
Special Education Classroom+ 5 Settings		85/100		85/100
Part II: Task Supports				
Physical Tasks-Assistance		83/100		83/100
Cognitive Tasks-Assistance		76/77		76/77
Part III: Activity Performance				
Physical Tasks				
Travel		81/100		81/100
Maintaining and Changing Positions		100/100		100/100
Recreational Movements		83/83		83/83
Manipulation with Movements		75/93		75/93
Using Materials		68/83		68/83
Setup and Clean-up		83/87		83/87
Eating and Drinking		72/100		72/100
Hygiene		78/92		78/92
Clothing Management		86/93		86/93
Up/Down Stairs		100/100		100/100
Written Work		62/73		62/73
Computer Equipment Use		47/65		47/65
Cognitive/Behavioral Tasks				
Functional Communication		66/91		66/91
Memory and Understanding		74/79		74/79
Following Social Conversations		58/73		58/73
Compliance with Adult		71/76		71/76
Directives and School Rules				
Task Behavior/Completion		66/72		66/72
Positive Interaction		64/81		64/81
Behavior Regulation		63/74		63/74
Personal Care Awareness		67/92		67/92
Safety		63/91		63/91
Behaviour Rating Inventory of Executive Function (BRIEF)				
Scale/Index		Pre-T-Score		Post-T-Score
Behavioural Regulation Index		62		68
Metacognitive Index		60		65
Walker-McConnell Scale (WMS)				
Pre-Total Score			Post-Total Score	
135			137	
Shawn				
Vineland Adaptive Behaviour Scale-II (VABS-II)				
Domain	Pre-Standard Score	Pre- Adaptive Level	Post-Standard Score	Post-Adaptive Level

Communication	48	Low	62	Low
Daily Living Skills	58	Low	59	Low
Socialization	40	Low	69	Low
Domain	Pre V- Scale Score	Pre-Adaptive Level	Post V-Scale Score	Post-Adaptive Level
Maladaptive Behavior Index	22	Clinically Significant	15	Average
Internalizing	21	Clinically Significant	17	Average
Externalizing	20	Elevated	17	Average
Sensory Profile (SP)				
Sensory Processing	Pre- Scoring	Pre- Indications	Post-Scoring	Post- Indications
A. Auditory Processing	24/40	Definite Difference	26/40	Probable Difference
B. Visual Processing	39/45	Typical Performance	39/45	Typical Performance
C. Vestibular Processing	38/55	Definite Difference	39/55	Definite Difference
D. Touch Processing	68/90	Probable Difference	69/90	Probable Difference
E. Multisensory Processing	13/35	Definite Difference	14/35	Definite Difference
F. Oral Sensory Processing	32/60	Definite Difference	33/60	Definite Difference
Modulation				
G. Sensory Processing Related to Endurance/Tone	41/45	Typical Performance	41/45	Typical Performance
H. Modulation Related to Body Position and Movement	16/50	Definite Difference	37/50	Probable Difference
I. Modulation of Movement Affecting Activity Level	20/35	Probable Difference	23/35	Typical Performance
J. Modulation of Sensory Input Affecting Emotional Responses	4/20	Definite Difference	8/20	Definite Difference
K. Modulation of Visual Input Affecting Emotional Responses and Activity Level	12/20	Probable Difference	12/20	Probable Difference
Behavior and Emotional Responses				

L. Emotional/Social Responses	44/85	Definite Difference	55/85	Probable Difference
M. Behavioral Outcomes of Sensory Processing	14/30	Definite Difference	14/30	Definite Difference
N. Items Indicating Thresholds for Responses	3/15	Definite Difference	9/15	Definite Difference
Sensory Processing Measures (SPM)				
Domain	Pre-T-Score	Pre-Interpretive	Post-T-Score	Post-Interpretive
Social	80	Definite Dysfunction	75	Definite Dysfunction
Visual	79	Definite Dysfunction	54	Typical
Hearing	43	Typical	43	Typical
Touch	74	Definite Dysfunction	47	Typical
Body	75	Definite Dysfunction	64	Some Problems
Balance	57	Typical	40	Typical
Planning and ideas	80	Definite Dysfunction	53	Typical
Total	74	Definite Dysfunction	54	Typical
School Function Assessment (SFA)				
Tasks	Pre-Criterion Score		Post-Criterion Score	
Part I: Participation				
Special Education Classroom+ 5 Settings	77/100		77/100	
Part II: Task Supports				
Physical Tasks-Assistance	48/100		64/100	
Cognitive Tasks-Assistance	57/77		57/77	
Part III: Activity Performance				
Physical Tasks				
Travel	0/100		72/100	
Maintaining and Changing Positions	50/100		60/100	
Recreational Movements	83/83		83/83	
Manipulation with Movements	61/93		69/93	
Using Materials	61/83		61/83	
Setup and Clean-up	45/87		45/87	
Eating and Drinking	61/100		100/100	
Hygiene	53/92		58/92	
Clothing Management	64/93		64/93	
Up/Down Stairs	100/100		100/100	
Written Work	0/73		0/73	
Computer Equipment Use	0/65		0/65	

Cognitive/Behavioral Tasks		
Functional Communication	0/91	0/91
Memory and Understanding	27/79	34/79
Following Social Conversations	0/73	0/73
Compliance with Adult	0/76	0/76
Directives and School Rules		
Task Behavior/Completion	0/72	0/72
Positive Interaction	0/81	0/81
Behavior Regulation	0/74	0/74
Personal Care Awareness	92/92	92/92
Safety	0/91	0/91
Behaviour Rating Inventory of Executive Function (BRIEF)		
Scale/Index	Pre-T-Score	Post-T-Score
Behavioural Regulation Index	54	83
Metacognitive Index	55	80
Walker-McConnell Scale (WMS)		
Pre-Total Score	Post-Total Score	
46	64	

Discussion

Analyses of the results of the six outcome measures yielded an improvement in some of the areas after (post) one week of SI intervention programme. All participants improved mostly in communication, socialization skills, reduction of behaviours and reduction of sensory problems. Reduction of sensory problems leading to a reduction of behavioural problems seems to increase the participants' learning abilities, communication and socialization. The reduction in behavioural problems in addition may be indicative of the children's better ability to process sensory stimuli around them (Preiffer, Koenig, Kinnealey, Sheppard, Henderson, 2011). Shawn improved mostly in all the areas compared to Ian and Alex. This may be due to the fact that Shawn has higher sensory and behavioural problems and was more responsive to the SI intervention. Overall, all three participants reported an increase attention and alertness at home and in school. Previous studies found similar outcomes when assessing the behavioural issues in ASD children. Watling and Dietz (2007) studied four children with ASD where the result after SI intervention indicated an improvement in engagement behaviours. Smith, Press, Koenig, and Kinnealey (2005) compared SI intervention with table-top intervention; the results reported a reduction of self-stimulatory behaviours in the SI group compared to the table-top groups. SI intervention was found to be an effective intervention in this study which specifically helps children with ASD in their learning. This case study is insufficient to conclude the effectiveness of the SI intervention with only one week duration, However, the results can highlight the importance of applying the ten fidelity measures when developing the SI intervention.

Conclusion

The main aim of this study was to test the practicality of the newly developed sensory integration programme to address the behavioural problems of children with ASD. The

SI intervention designed was a success and can be tested in the future randomised controlled trial.

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