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ORIGINAL ARTICLE

The Effects of a Sensory Integration Programme with Applied Interactive Metronome Training for Children with Developmental Disabilities: A Pilot Study

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KEYWORDS
children with developmental disabilities;
interactive metronome training;
sensory integration

Summary *Objective:* To assess the effects of a sensory integration programme involving applied interactive metronome training in a group of children with developmental disabilities.
Methods: Ten children with various developmental disabilities participated in this study. Participants received sensory integration treatment in a group programme with applied interactive metronome training for 45 minutes a day for 4 weeks, exclusive of Saturday and Sunday. The treatments consisted of stimulations of the vestibular and tactile senses, and proprioceptive applied metronome training.
Results: The effects of the programme were evaluated via measurements of short sensory profile, Corner's teacher rating scale, and DeGangi-Berk test. The data obtained before and after the treatment were analyzed using Wilcoxon's test. The findings of this study were that there were significantly positive effects on sensory processing, concentration, motor control, bilateral coordination, and reflex integration in the study group.
Conclusion: Our results indicated that the sensory integration programme with applied interactive metronome training might be useful and improved the performance of the children with developmental disabilities. The results demonstrated the efficacy of this new approach. This pilot study provides new insights into the effective treatment of children with developmental disabilities.

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Introduction

Children with developmental disabilities cannot act effectively and efficiently within their environments; this is especially true of children with sensory processing disorders, who may experience profound difficulty in carrying out activities of daily living. Children with developmental disabilities generally evidence problems in at least two areas of development, such as gross motor skills, fine motor skills, language, cognition, social skills, and activities of daily living. Children with sensory integration disorders may experience problems in the areas of attention, arousal, or movement, and these behaviours may result in anxiety, or may negatively affect age-appropriate learning and ultimately damage family relationships (Dunn, 2001).

For these reasons, sensory integration intervention may help to explain, as well as alleviate, the problems experienced by children with developmental disabilities (Lai et al., 1996). The theory behind this suggests the possibility of a relationship among concentration, activity, and nervous system function. Sensory integration (SI) therapy was developed by A. Jean Ayres to focus on the neurological processing of sensory information (Ayres, 1963). This concept of intervention is targeted towards understanding the sensory and praxis functions for many aspects of development (Ayres, 1991). The objective of SI treatment is to improve sensory modulation related to behaviour and attention and to increase social interaction ability, academic skills, and independence, by helping the nervous system modulate, organize, and integrate information from the environment (Ayres, 1991). In particular, SI treatment emphasizes SI of the tactile, vestibular, and proprioceptive senses (Ayres, 1989).

Interactive metronome was invented in 1969 by Etiennen Loulie from France as a noninteractive metronome for temporal teaching of music (Greenspan, 1992). Instead of users having to rely on their own mental estimations for their temporal accuracy, the interactive metronome provides accurate real-time guide sounds to indicate users' temporal accuracy during performance in a series of prescribed movements. The tonally and spatially changing guide sounds enable users to correct their rhythms and timing errors deliberately (Robert et al., 2000). However, the interactive metronome technique, which generally uses a personal computer, has one profound disadvantage, which is that it is quite expensive. Therefore, the theoretical concept of interactive metronome was used in this study in order to improve the motor timing, performance, attention and auditory ability of children with developmental disabilities. Unlike the traditional SI based on three senses - tactile, proprioceptive, and vestibular senses, in this study, the auditory sense was additionally integrated into the intervention. A previous study for attention deficits hyperactivity disorder (ADHD), based on the interactive metronome, needed personal computer and sensor device (Shaffer et al., 2001). However, the present study was to ascertain the effects of auditory clue on motor timing, performance and attention ability without personal computer and sensor device.

In general, cognitive rehabilitation employs a "bottom-up" approach. On the contrary, the interactive metronome training is a "top-down" approach (Toglia, 1998). These two approaches can be used to complement one another (Jane et al., 2001). There are not many studies combining both SI and the interactive metronome treatments. In addition, most of the SI studies were based on individual interventions and they rarely had any sort of group programme. The programme of this study was developed in a group format based on SI theory. Unlike individual therapy, the therapist in a group environment can promote more features (Gartland, 2001, pp. 731–755). With the help of other therapists, children in a group can get along with each other or interact with a variety of activities while their abilities are evolving.

The objective of this study was to evaluate the effects of a SI group intervention programme involving interactive metronome training. This study not only focussed on the three traditional senses, tactile, vestibular, and proprioceptive, but additionally on the auditory sense from interactive metronome.

Methods

Participants

A total of 10 children aged 5 to 9 years old, with developmental disabilities, who attended the Doumte Preschool Institute for Children with Disabilities in Korea, participated in this study. The mean age of the children was 7.2 years. The male-to-female ratio was 9:1. The inclusion criteria were as follows: (a) 5 to 9 years of age; (b) diagnosed developmental disability by a child psychologist; (c) the absence of other medical or developmental diseases which would affect physical and cognitive performances; (d) not undergoing SI therapy elsewhere during the study period; and (e) parents willing and committed to carrying out the home programme. The contents of the programme which used the SI applied metronome are summarized in Table 1. In addition, the children were selected based on the criteria that their auditory senses were adequate to take action according to the sound given in the training.

Instruments

Short sensory profile (SSP)

The SSP (McIntosh, Miller, Shyu, & Dunn, 1999, pp. 59–73) is a parent-reported scale which screens functional behaviours related to sensory responsivity. Norms were obtained from the Sensory Profile (Ermer & Dunn, 1998) and standardized on 1,200 children. Reliability of the SSP was .90, and discriminant validity was $<$95% (McIntosh, Miller, Shyu, & Hagerman, 1999).

Corner's teacher rating scale (CTRS)

The Corner's teacher rating scale (Conners, 1969), a 39-item checklist rated on a four-point scale, assesses the behaviours of children such as inattentiveness, anxiety, hyperactivity and conduct problems, who have been determined by teachers in a classroom setting. The scale is validated for children from 3 years to 17 years of age.

Table 1 Summary of Treatment.

	Contents of treatment	Duration time (min)
Introduction	Activities before treatment	5
	- greeting	
	- calling name	
	- acting motion along with sounding of drum	
	- pointing out body parts	
	- practicing freehand exercise	
Intervention	Metronome training	10
	1. drum sound	
	①right hand up	
	②left hand up	
	③right leg front	
	④left leg front	
	2. triangle sound	
	- hands up and down	
	3. tambourine	
	- clapping	
	4. piano	
	Do: right foot stamping	
	Mi: left foot stamping	
	Treatment of sensory integration	25
	1. Intervention for tactile sensitivity	
	- scrubbing with shower towel	
	- brushing with Wilberger brush	
	- stimulus with vacuum	
	- stimulus with hair drier	
	2. Taste/smell sensibility stimulation	
	- smelling various aromas	
	- smelling the scent of flowers	
	- tasting flavours (sourness, sweetness, bitterness, saltiness)	
	3. Intervention for proprioception sense	
	- forward rolling	
	- crawling on hands and knees	
	- crawling on hands and feet	
	- crawling on hands and feet while turning over	
	4. Intervention for equilibrium sense	
	- riding bidual swing	
	- riding rotation plate	
	- riding bar swing	
	- riding netting swing	
	- riding circle swing	
Closing	Evaluation and assessment	5
	Greeting	

DeGangi-Berk Test

The DeGangi-Berk Test (DeGangi & Berk, 1983) is used for the clinical evaluation of preschooler's sensory motor ability, which was devised by DeGangi and Berk in 1983. The DeGangi-Berk Test provides an assessment of motor control, bilateral coordination, and reflex integration.

Intervention

Intervention was provided to 10 children with developmental disabilities by an occupational therapist professionally trained in SI (Fig. 1). All children received the intervention on a session schedule of 45 minutes/day, 5 days/week. The duration of intervention was from May 30, 2011 to July 1, 2011. Preliminary examinations were conducted on the first and last days of treatment. The SI treatment intervention is based on the theory and interventions of Ayres (1991). The treatment is designed to: (a) maintain arousal levels; (b) ensure that activities are successful; (c) guide self-regulation; and (d) ensure physical safety.

The interactive metronome training used in this study had a hypothesis that auditory stimulation was closely connected with praxis, motor timing, motor planning, and attention. On this hypothesis, children could have the chance to think themselves about a promised action depending on the sound. Therefore, the trainers of the interactive metronome training had to put emphasis on motor timing as well as accuracy of movement in this study.

Figure 1 Sensory Integration Instrument and Metronome Activity.

The intervention time of interactive metronome training was 10 minutes during the SI treatment. After watching the movement, the therapist covered the children's eyes with eye patches and they were asked to perform the movement. Before that, the children had to think for a maximum of 2 minutes about the pre-promised movement which was tuned on the sound. If the children performed the movement with success, they were reinforced by the therapist and at the same time the practice movement speed was increased to a certain level according to their abilities (Table 1).

Statistical analysis

A non-parametric statistical method using SPSS statistical software version 12.0 (SPSS Inc., Chicago, IL, USA) was used to assess the pre-/post-treatment differences within the study group. The level of significance (p) was set at .05.

Results

Ten children in this study attended the Doumte Preschool Institute for Children with Disability in Korea. They were diagnosed with delayed development (20%), autism (10%), mental retardation (10%), speech delay (30%), ADHD (20%), and Down's syndrome (10%). The ages of the participants were 5 (10%), 6 (20%), 7 (20%), 8 (40%), and 9 (10%). The genders were 9 males and 1 female (Table 2). The results of pre-/post-treatment comparisons are listed in Table 3.

The SSP was performed in this study to evaluate sensory processing both pre-test and post-test. The results showed significant differences after treatment in terms of tactile sensitivity, gustatory/olfactory sensitivity, motor sensitivity, high/low response, hearing filtering, low endurance, visual/auditory sensitivity, and the total score ($p < .05$).

The Corner's Teacher Rating Scale (CTRS) was assessed in this study to evaluate sensory processing pre-test and post-test. The results showed significant differences in attention and hyperactivity after treatment ($p < .05$).

The DeGangi-Berk test was conducted in this study to evaluate sensory processing pre-test and post-test. The results showed significant differences after treatment in postural control, bilateral integration, reflex integration, and the total score ($p < .05$).

Discussion

This study demonstrated the effects of a SI programme, involving applied interactive metronome training, in a group of children with developmental disabilities. The results of this study support the hypothesis that a SI treatment programme involving applied interactive metronome training may help to improve attention, sensory processing, praxis, posture control, and so forth.

Interactive metronome training promotes auditory memory, attention, and praxis. Especially, auditory metronome training assists children in practicing fast and accurate motions. Therefore, the SI programme, with applied interactive metronome training, can improve executive function as well as sensory processing. In recent years, the studies of children with developmental disabilities have outlined some general trends in brain sciences. These studies, based on nervous system theories, have provided significant insights into the problems children with developmental disabilities experienced.

In this study, the results of SSP for the evaluation of sensory processing represented the effects of the nervous system in relation to tactile sense, gustatory/olfactory

Table 2 Characteristics of Participants.

Item	Characteristic	N	%
Gender (M/F)	Male	9	90
	Female	1	10
	Sum	10	100.0
Age (y)	5	1	10
	6	2	20
	7	2	20
	8	4	40
	9	1	10
	Sum	10	100.0
Diagnosis	Delayed development	2	20
	Autism	1	10
	Mental retardation	1	10
	Speech delay	3	30
	ADHD	2	20
	Down's syndrome	1	10
	Sum	10	100.0

ADHD = attention deficit hyperactivity disorder.

Table 3 Results of the SSP, the CTRS and the Degangi-Berk Tests on Experimental Variables.

Item		Mean ± SD		Z	*p*
		Pre-test	Post-test		
SSP	Tactile sensitivity	27.90 ± 2.13	30.40 ± 2.27	−15.000	< .001*
	Gustatory/olfactory sensitivity	15.20 ± 3.80	16.20 ± 3.55	−4.743	.001*
	Motor sensitivity	11.90 ± 1.79	13.20 ± 1.48	−4.993	.001*
	High/low response	20.70 ± 7.18	27.20 ± 6.30	−7.144	< .001*
	Hearing filtering	22.50 ± 4.81	27.40 ± 4.88	−4.299	.002*
	Low endurance	21.90 ± 4.07	25.40 ± 3.72	−4.134	.003*
	Visual/auditory sensitivity	9.10 ± 4.80	15.30 ± 4.55	−7.262	< .001*
	Total score	129.5 ± 21.54	156.10 ± 17.45	−12.838	< .001*
CTRS	Attention	13.50 ± 6.29	18.40 ± 5.23	−7.097	< .001*
	Hyperactivity	20.20 ± 4.13	15.70 ± 4.00	12.075	< .001*
DeGangi-Berk	Posture control	16.80 ± 2.04	18.50 ± 2.22	−11.129	.002*
	Bilateral integration	26.20 ± 1.23	27.70 ± 1.42	−4.392	.002*
	Reflex integration	11.50 ± 1.27	14.70 ± 3.77	−3.138	.012
	Total score	54.50 ± 4.28	61.20 ± 5.59	−6.230	< .001*

* $p \leq .05$.

sensitivity, motor sensitivity, suitable response, hearing filtering ability, endurance, and visual/auditory sensitivity. The results of CTRS for the evaluation of concentration, demonstrated its positive effects on attention and reducing hyperactivity. Praxis capacity plays a key part in the frontal lobe of the brain, and involves the cognitive control of thoughts and actions in human. The frontal lobe of the brain has a key part in praxis and cognitively controls thoughts and actions in humans. However, most children with developmental disabilities experience the problems with praxis and concentration. In our study, as the SI programme with interactive metronome training raised the self-controlling functions, attention capabilities of all participants also improved and their hyperactivities were decreased. The results of the DeGangi-Berk test for the evaluation of posture control, bilateral integration, and reflex integration, represented the effects of neurological maturity in this study. In general, children with developmental disabilities experience neurological deficiencies, characteristics of a premature nervous system. Therefore, they may experience troubles with posture control, bilateral integration, and reflex integration. In our study, the SI programme with interactive metronome training helped to ameliorate neurological deficiencies; participants then showed an improvement in these aspects.

In future, the detailed effects of auditory and various additional sensory stimulations for children with developmental disabilities have to be investigated. Further studies about applications of SI programmes in the form of group intervention are also needed.

However, this pilot study was subjected to a number of limitations: the study was a single group programme evaluation only, the sample size was small, and the study period was relatively short. There was no follow-up after the programme.

Conclusion

This study demonstrated positive effects of the SI interventions with interactive metronome training used in children with developmental disabilities. We found positive improvements in sensory processing, nervous system functions, and concentration after treatment.

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