Original Article

The effect of simultaneous Superficial and Proprioceptive Stimulations on Dexterity of Educable 6-7 Years Old Children with Down Syndrome

Meisam Mohammadi, PhD
Faculty of Neuroscience, University of Shahid Beheshti, Tehran, Iran
Amir Rahmani Rasa, MSc
Faculty of Rehabilitation Sciences, Hamedan University of Medical Sciences and Hamedan, Iran
Robab Teymouri, PhD, Masoud Gharib*, MSc, Tabassom Matin, MSc
Pediatric Neurorehabilitation Research Center, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran

Background and Objective: Down syndrome is the most common chrosomal disorder in which the fine and gross motor skills due to lack of proper sensory experience are disturbed. The role of dexterity in activity of daily living, interaction with environment and independency is quiet crucial in Down syndrome. Therefore, the aim of this study was to investigate the effects of simultaneous application of superficial and proprioceptive stimuli on the dexterity of 6-7 year-old educable children with Down syndrome.

Methods and Materials: Thirty–three educable children with Down syndrome were assigned in three groups (i.e. superficial, proprioceptive and simultaneous application respectively) and voluntarily participated in the study. In the first group, children received only exteroceptive stimulation for 30 minutes, three times a week. Children in the second group received only proprioceptive stimulation in the same way. In the third group, children received both stimulations simultaneously. Dexterity was evaluated through Purdue Pegbourd Test after 5th, 10th, 15th, 20th, 25th, and 30th sessions.

Results: Dexterity changes were significantly differed in all three groups ($p<0.05$) using repeated measurement test. In order to assess the improvement process of Dexterity, every group was evaluated separately with Purdue Pegboard Test. The third group showed significant improving comparing to other groups ($p<0.05$). There was no significant improvement in dexterity in the first and second groups ($p>0.05$).

Discussion: The findings of current study suggest that simultaneous application of superficial and proprioceptive senses could be used for improvement the dexterity in children with Down syndrome.

Key words: Proprioception, Superficial, Dexterity, Down syndrome, Sensory integration

Introduction

According to the significance of motor skills especially upper limbs in maintaining child's independence and developing other skills such as self-help, play, social and academic achievement and their adaptation to environment, improving gross and fine motor skills of children with Down syndrome is a considerable aspect in functional development. Clumsiness is a marked feature of these groups. Affected children child lack various gross and fine motor skills due to the deficit of appropriate sensory experiences (1, 2).

Hand is the factor of human creativity by which the capacities and thoughts emerge and nonverbal relationships form. Thus related weakness and disability of any grade can affect its role. Efficient use of hand in Activities of Daily Living (ADL) depends on the inter-play of visual perception and fine motor acts (1).

According to Sensory Integration (SI) theory, following the simultaneous stimulation of two or more different senses like tactile and proprioception stimuli, an adaptive response is triggered in the brain, and leads to increased central nervous system efficacy on controlling movements (3, 4).

It could be hypothesized that cortical orientation of upper limbs and transmission of signals from brainstem to the cortex will be enhanced through

* All correspondences to: E-mail: Gharib_Masoud@yahoo.com

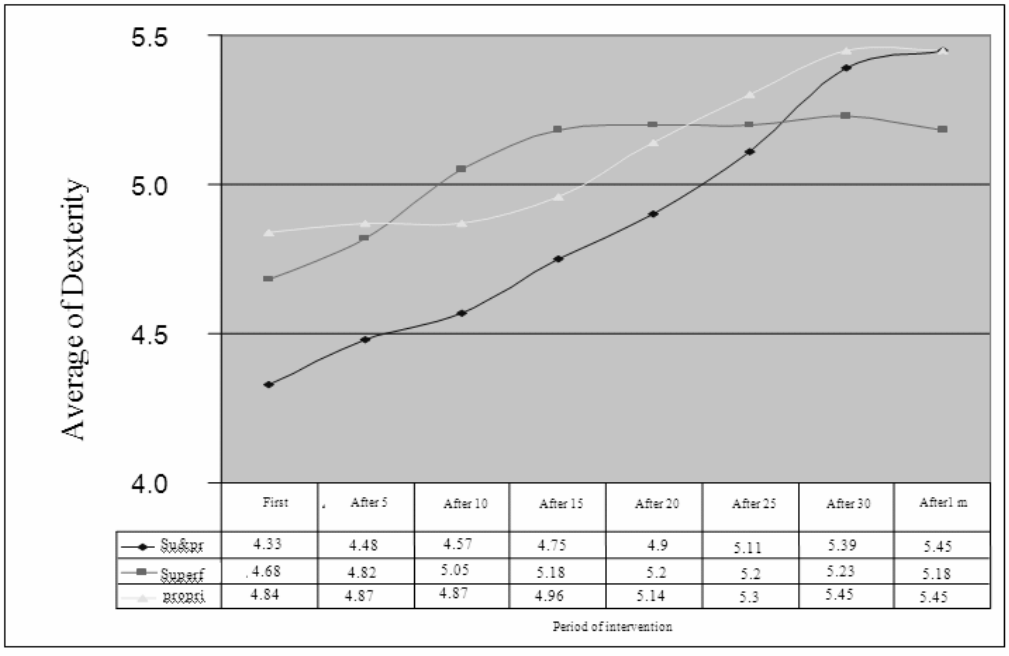
simultaneous superficial and proprioceptive inputs as well as exaggerated sensory stimulations (4).
Likewise it is possible to modify sensory processing and integration defects on account of aforementioned neuropathology which is secondary to the limitation of sensory experiences in the stream of early childhood inefficient motor control (5).
Gross and fine motor skills of children with Down syndrome are usually similar to normal ones, however it occurs with some delay; but many of them have the potential to acquire needed dexterity for independent living (1).

Materials and Methods

Thirty-three educable 6-7 years old children with Down syndrome having the inclusion criteria were compeer-dispensed for variables including weight, gender and lateral dominance in 3 eleven-child groups. The first group received superficial stimulation for 30 minutes three times a week; the dominant upper limb from shoulder to fingertips was covered by sand and stimulated by tuning fork, then intermittently worn by cold and hot putty and dried by a dryer in anatomical position afterwards (safety of the substance was accredited by dermatologists). Next participants were proprioceptively involved with Bobath's weight-bearing techniques in sitting position and placing-holding of various joint angles for the dominant side with the same duration. Weight bearing was scaled and varied with the child's weight.
The extent of weight-bearing was 8%, equal to the weight of each upper limb.
The third group also applied superficial and proprioceptive stimulations simultaneously for 30 minutes as follows: initial covering the whole dominant upper limb with sand, using tuning fork, placing-holding exercise, wearing cold and hot putty, being dried in anatomical position and finally Bobath's weight-bearing for 8% of the body weight respectively.
Every five attempts were assessed by Purdue Pegboard Test and after 30 sessions, final evaluation using the above-mentioned test was accomplished leading to the comparison of the results. Each child was supposed to have 3 opportunities to put pegs into the board in 30 seconds. The mean number of 3 trials was noted down as the test result. To follow up, all subjects implemented Purdue Pegboard Test one month after the intervention and results were analyzed and interpreted.

Results

Binary Factorial Analysis of Variance and Repeated Measurement Test showed significant difference among the three groups ($p \leq 0.05$) (figure 1). Each group was separately tested by Repeated Measurement on dexterity improvement, while the third one indicated significant achievement in this aspect ($p \leq 0.05$) (figure 2). According to the separate Repeated Measurement for the first 2 groups, there was no significant advancement in dexterity ($p>0.05$) (figures 3, 4).



	First	After 5	After 10	After 15	After 20	After 25	After 30	After1 m
Supp	4.33	4.48	4.57	4.75	4.9	5.11	5.39	5.45
Superf	4.68	4.82	5.05	5.18	5.2	5.2	5.23	5.18
propri	4.84	4.87	4.87	4.96	5.14	5.3	5.45	5.45

Figure1: Comparison of advancement dexterity in three groups

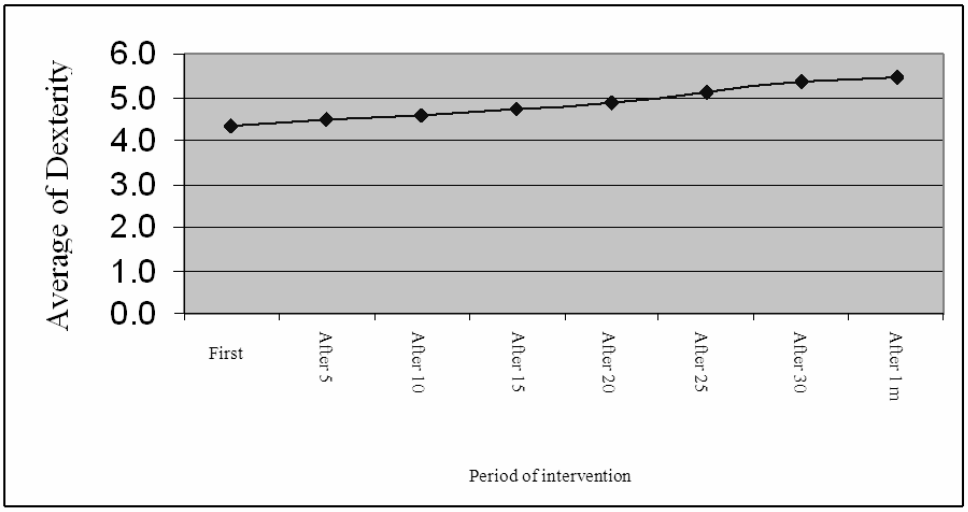


Figure 2: change of dexterity in the third group

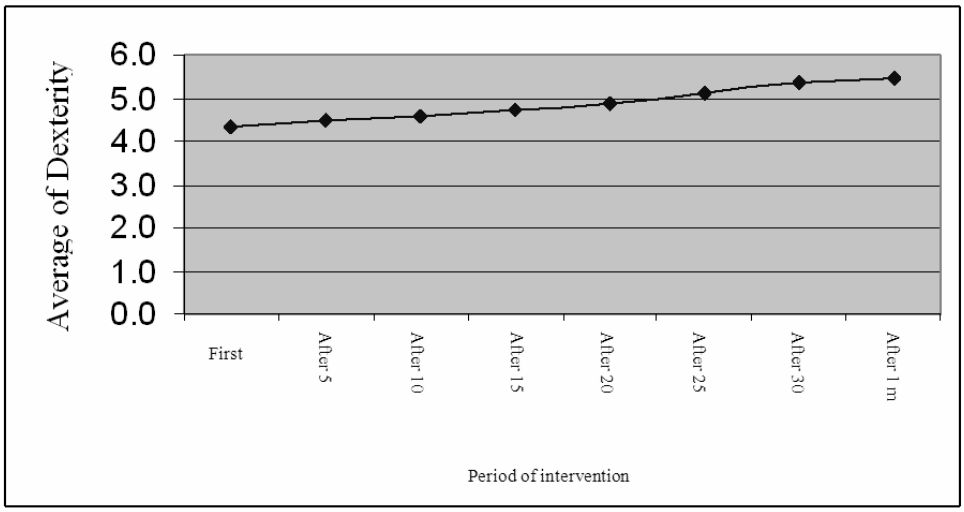


Figure 3: change of dexterity in the second group

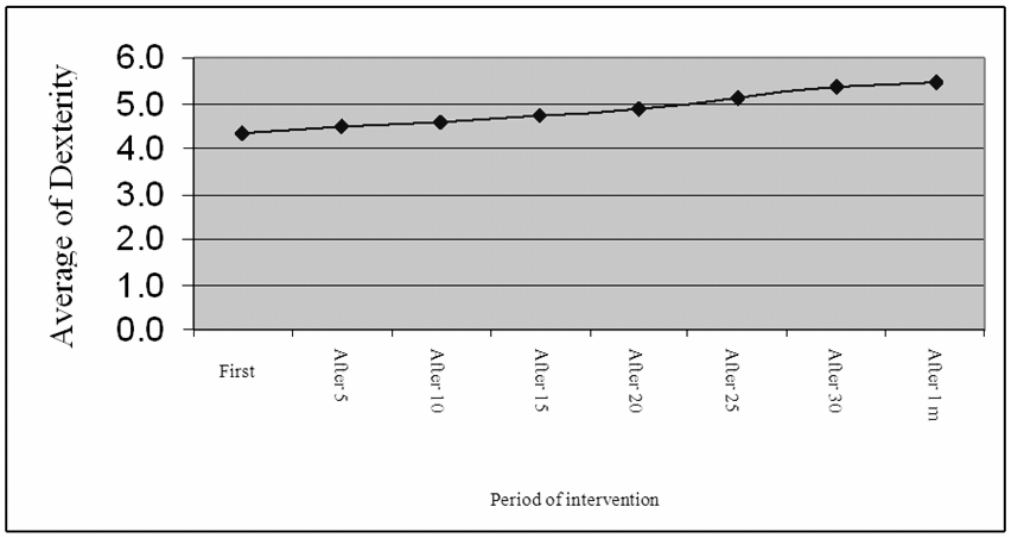


Figure 4: change of dexterity in the first group

Discussion

Based on various theories like Kandel's (2000), it is assigned that simultaneous stimulation of superficial and proprioception as well as greater sensory inputs increasingly activates cortical orientation over upper limbs and also brainstem-cortex pathways (4, 5). According to Hines, repetitive and regular application of this method within rehabilitation program, will hopefully contribute to the upper limb receptors to become more recognizable for brain and affecting more neurons via synapses among various receptors (6), meanwhile we may be able to compensate relevant impairments of sensory processing and integration as a consequence of early sensory experience deprivation following lack of suitable motor control (5, 7, 8).

In a study carried out by Uyanik and colleagues, through comparing three 15-child groups of children with Down syndrome who benefited from different therapeutic services including sensory integration, sensory integration accompanying vestibular stimulation and neurodevelopmental therapy, they indicated that application of a combination of the above mentioned methods have the best effects. Therefore researchers usually recommend providing incorporated programs depending on each child's individual demands and status (5). This study emphasizes the use of numerous sensory stimulations in combination with other various techniques like ours.

In 2004, some researchers of Touch Research Institute considered the effect of massage and superficial stimulation on gross and fine motor functions of children with Down syndrome, which composed of a 30-minute superficial stimulation session, twice a week for 2 months. The results showed that coincidence of the two procedures contributed to reduction of hypotonicity and improving gross and fine motor skills (9). The findings of the former study unlike present one appreciate the application of superficial stimulation in enhancing the hand dexterity.

The relationship among sensory-motor, motor-dexterity and performance components of self-care in 30 mental retarded children with motor delay was conducted by smith *et al.* (1999). Results were indicative of significant link among sensorimotor components, fine motor skills, dexterity and performance of self-care issue. Fine motor skills attended in this study were patterns of grasp, eye-hand coordination, bilateral hand coordination and dexterity (10). Our study with the purpose of improving motor control via sensory inputs has been performed alongside the previous study and puts emphasis on the close tie among sensorimotor components, motor skills and dexterity.

Concerning the findings of present study, it can be concluded that in order to enhance the dexterity of children with Down syndrome and others suffering dysfunction of the upper limb as a result of motor control defect (*e.g.* cerebral palsy, head injury and metabolic disorders) it would be better to apply diverse and simultaneous superficial and proprioceptive stimulations.

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