



## Effect of Sensory Integration-Based Occupational Therapy Intervention on Sensory Functions and Neuromotor Performance of a Baby with Down Syndrome: Case Report\*

### Down Sendromlu Bir Bebeğe Duyu Bütünleme Temelli Ergoterapi Müdahalesinin Duyusal Fonksiyonlar ve Nöromotor Performansa Etkisi: Olgu Sunumu

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#### Abstract:

The aim of this study was to investigate the effects of a sensory integration-based occupational therapy intervention program on the sensory functions and neuromotor performance of a 14-month-old baby with Down syndrome (DS). The study evaluated the baby's sensory functions using the Test of Sensory Functions in Infants (TSFI) and neuromotor performance using the Neuro Sensory Motor Development Assessment (NSMDA) after recording demographic information. The infant participated in a 12-week occupational therapy intervention program, receiving 45-minute sessions once a week, and the family was provided with a home program. Evaluations were conducted before and after the intervention. The results showed positive improvements in the infant's sensory functions and neuromotor performance. The baby's NSMDA functional level score decreased from 17 to 11, while the TSFI total score increased from 29 to 42. The study found that sensory integration-based occupational therapy intervention could be effective in improving sensory functions and neuromotor performance in a baby with DS. These results suggest that clinical management of sensory and neuromotor function may be of benefit to a significant number of babies with DS.

#### Keywords:

Down syndrome, Neuromotor performance, Occupational therapy, Sensory function, Sensory integration.

#### Özet:

Bu çalışmada Down sendromlu (DS) bir bebekte duyu bütünleme temelli ergoterapi müdahale programının duyu fonksiyonlar ve nöromotor performansa etkisini ortaya koymak amaçlanmıştır. Çalışmamıza DS'li 14 aylık bir bebek dahil edildi. Demografik bilgiler kaydedildikten sonra duyu fonksiyonları değerlendirmek için Bebeklerde Duyusal Fonksiyonlar Testi (BDFT) ve nöromotor performansı değerlendirmek için ise Nöro Sensori Motor Değerlendirme Anketi (NSMDA) kullanıldı. 12 hafta boyunca haftada 1 gün 45 dakika boyunca bebek ergoterapi müdahale programına alındı ve aileye ev programı verildi. Değerlendirmeler müdahale öncesi ve sonrası olmak üzere iki kez uygulandı. 12 haftalık ergoterapi müdahale programı sonucunda bebeğin duyu fonksiyonları ve nöromotor performansında olumlu yönde gelişmeler olduğu görüldü. Bebeğin NSMDA fonksiyonel seviye puanı 17'den 11'e düşerken; BDFT toplam puanı ise 29'dan 42'ye yükselmiştir. Sonuç olarak çalışma bulgularımız, DS'li bir bebekte duyu bütünleme temelli ergoterapi müdahalesinin duyu fonksiyonlar ve nöromotor performansı iyileştirmede etkili olabileceğini gösterdi. Bu sonuçlar, duyu fonksiyonlarının klinik yönetiminin, DS'li önemli sayıda bebek için fayda sağlayabileceğini göstermektedir.

#### Anahtar Kelimeler:

Down sendromu, Duyusal fonksiyon, Duyu bütünleme, Ergoterapi, Nöromotor performans.

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## INTRODUCTION

Down syndrome (DS) is a genetic disorder caused by a cellular division error during conception, resulting in an extra copy of chromosome 21 (Brown et al., 2020). According to the National Association for DS in the United States, it is the most common chromosomal abnormality in humans (Presson et al., 2013).

Individuals with DS may experience a range of health issues (Charleton et al., 2010). Individuals with DS commonly exhibit generalised muscle hypotonia, ligamentous laxity, and articular hypermobility. They may also experience difficulties with agonist-antagonist muscle co-contraction. Due to decreased motor proficiency, they may encounter challenges when performing anticipatory postural adjustments and adapting to motor task demands and environmental changes (Hardee & Fetters, 2017). Therefore, it is important to use therapeutic programs that increase the stimulation of postural reactions in the intervention program. Some children, particularly those with Down Syndrome, may require strategies to eliminate unnecessary sensory input. The therapeutic approach should focus on creating postural synergies and sensory integration (Uyanik & Kayihan, 2010).

Children with DS may experience sensory integrative dysfunction due to limited sensory experience resulting from a lack of normal motor control (Uyanik et al., 2003). This can lead to physical, cognitive, and sensory integration problems that can reduce their functional abilities in daily living activities. To improve function in children with DS, neurodevelopmental approaches, sensory integrity treatment, and occupational therapy intervention methods are commonly used (Uyanik & Kayihan, 2010).

The literature suggests that when designing rehabilitation programs for children with DS, it is advisable to apply multiple treatment methods that support each other according to the individual needs of the child (Uyanik et al., 2003). This study aimed to support occupational therapy intervention with a sensory integration approach. The study examined the effect of sensory integration-based occupational therapy intervention on sensory functions and neuromotor performance in a baby with DS.

## MATERIALS AND METHODS

### Design

The study employed a single-subject research design to examine the effectiveness and efficiency of the intervention method applied to a specific patient. This design involves observation and intervention stages to evaluate the intervention's impact (Ottenbacher, 1986).

### Case Report

Our study involved a 14-month-old male baby diagnosed with DS. According to the medical report obtained from Hacettepe University Hospitals İhsan Doğramacı Children's Hospital, the baby's family sought treatment from Hacettepe University Occupational Therapy Department in 2019. Prior to the study, the participant's parent provided informed consent. The baby was delivered via caesarean section at 36+6 weeks gestation, as reported by the family. The physician did not detect the presence of DS during pregnancy; however, the family identified it at birth. The baby's developmental records indicate delays in both motor (crawling, sitting, and walking) and sensory capacities (proprioceptive, vestibular, tactile, and visual). According to the information provided by the family, the baby was cared for by their paternal grandmother while the parents spent evenings with them due to work schedules. From the age of one, the baby received ongoing care from a specialized educator and a speech and language therapist at a rehabilitation and special education center. The family pursued occupational therapy due to the baby's delayed sensory-motor development.

### Outcome Measures

The Sociodemographic Information Form recorded the age and gender of the baby, as well as the educational level, marital status, and employment status of the family. To assess neuromotor performance, we administered the Neuro Sensory Motor Development Assessment (NSMDA), while the Test of Sensory Functions in Infants (TSFI) was used to evaluate sensory functions. Technical term abbreviations were explained upon their first use to ensure proper

comprehension. Both assessments were conducted while the baby was seated on the mother's lap on a cushion placed on the floor. The evaluations took place approximately 2 hours after feeding time, and the baby did not take any medication that could have affected the assessment. Each evaluation lasted for approximately 40 minutes. Additionally, the baby was enrolled in a 12-week (3-month) occupational therapy program, which consisted of 45-minute sessions once a week. Furthermore, a personalised home programme was created to suit the baby's sensory profile and neuromotor performance level, based on feedback and assessments provided by the family. The baby underwent two evaluations, one before and one after the intervention, and the results were subsequently compared.

### **Neuro Sensory Motor Development Assessment (NSMDA)**

NSMDA was used to compare the neuromotor performance of infants with DS before and after intervention. The test assesses infants and children between 1 month and 6 years of age to determine whether their motor development and movement components are within normal limits, suspicious, or abnormal. The parameters of this criterion-referenced test assess age-appropriate motor skills, tone, deep tendon reflexes, movement patterns, postural reactions and balance, tactile, proprioceptive, visual and vestibular sensory system (Burns, 1992).

### **Test of Sensory Functions in Infants (TSFI)**

TSFI was used to compare the sensory functions of DS babies before and after the intervention. The TSFI is a clinician-administered sensory assessment scale that evaluates the sensory functions of babies aged 4-18 months. It assesses five sub-parameters of sensory function: response to tactile deep pressure, adaptive motor functions, visuo-tactile integration, ocular-motor control, and response to vestibular stimuli (Jirikowic et al., 1997).

### **Intervention**

This study examines the application of sensory integration-based occupational therapy intervention by

an occupational therapist. The baby attended 45-minute occupational therapy sessions by the occupational therapist once a week for 12 weeks (3 months) in the sensory integration unit between October 2019 and January 2020 (Uyanik & Kayihan, 2010; Zengin & Akyurek, 2021). The sensory integration unit provided a safe environment with age and gender-appropriate toys for sensorimotor play. To ensure the baby's safety, the parent participated in the first two sessions. The parents were also given a home program consisting of activities that could be done at home to improve the baby's sensory and neuromotor functions by involving them in the game.

A sensory integration-based occupational therapy intervention program was created to improve sensory and motor skills in the family intervention. The program took into consideration the scores obtained from NSMDA and TSFI. The sessions began with games the baby enjoyed gaining their confidence. Positive improvements in sensory and motor skills were observed after 12 weeks, leading to the decision to continue occupational therapy sessions. The 12-week sensory-based occupational therapy intervention was carried out in a safe and playful therapeutic environment. The intervention was collaborative and focused on appropriate challenges to develop the sensory and motor factors that underlie the skills and abilities necessary for the baby's success and participation in daily life (Uyanik & Kayihan, 2010). The occupational therapy sessions aimed to enhance the baby's fine and gross motor skills. The program, comprising of 12 sessions, was designed based on the gross and fine motor indicators of 12-18-month-old babies. Additionally, the sessions focused on developing the baby's sensory skills, including their ability to understand the texture, shape, and weight of various objects. The 12 sessions aimed to develop sensory processing skills through activities that targeted proprioception, vestibular, visual, and tactile senses. Various materials such as therapeutic brushes, sponges, coloured papers, buttons, fabrics of different textures and colours, newspaper papers, mirrors, rattles, and bells were used. The Wilbarger protocol was also applied for 12 sessions, and the family was taught to continue it at home. The protocol involves brushing, approximation, and deep pressure applications.

## Home Program and Family Education

The family was advised to create a secure play area for their baby and to encourage the baby to engage in new activities and experiences. Tips were provided on selecting toys and activities that would aid the baby's skill development. The family was informed about all relevant studies and the Wilbarger protocol, and instructed to apply it at home during specific hours every day, in addition to the sessions (Wuang et al., 2013). The family sent images and made phone calls through communication channels such as WhatsApp after following the home program. The program's effectiveness is evident due to the family's cooperation, resulting in significant progress.

## RESULTS

### Results Related to Neuromotor Performance

Positive improvements were observed in the neuromotor performance of the baby as a result of the intervention program. The NSMDA sub-dimensions of gross motor, fine motor, neurological, postural reactions, tactile, ocular, vestibular and proprioception sub-fields, as well as the total score of NSMDA, showed a decrease, indicating improvements in neuromotor functions (Table 1).

### Results Related to Sensory Functions

The intervention program resulted in positive improvements in the baby's sensory functions. Specifi-

cally, there was a decrease in each of the TSFI sub-dimensions, including response to deep tactile pressure, adaptive motor functions, visual tactile integration, oculomotor control, response to vestibular stimuli, and the total score of TSFI, indicating improvements in neuromotor functions (Table 2).

## DISCUSSION

The objective of this case study was to investigate the impact of sensory integration-based occupational therapy intervention on sensory functions and neuromotor performance in an infant with DS. It was found that the intervention led to an improvement in both sensory functions and neuromotor performance.

Various studies have investigated and confirmed the effectiveness of sensory integration interventions on the sensory functions of children with DS in the literature. (Uyanik et al., 2003; Uyanik & Kayihan, 2010). Uyanik et al. (2003) applied various intervention methods to three groups of DS children. The study results indicated that all treatment methods should be used together when preparing rehabilitation programs for children with DS (Uyanik et al., 2003). In our study, we found that the combination of occupational therapy and sensory integration approaches aligns with the literature. It is crucial to develop personalized occupational therapy intervention programs based on the individual needs of children with DS.

Table 1. NSMDA comparisons of baby with Down Syndrome before and after intervention

	Pre-Intervention (14 month)	Post-Intervention (17 month)
Gross Motor	15	11
Fine Motor	55	35
Neurological	53	50
Postural Reactions	33	22
Tactile	14	11
Ocular	2	1
Vestibular	10	6
Proprioception	11	8
Functional Level	17 (severe motor dysfunction)	12 (fine motor problem)

NSMDA: Neuro Sensory Motor Development Assessment.

Table 2. Comparison of TSFI before and after intervention in baby with Down Syndrome

	Pre-Intervention (14 month)	Post-Intervention (17 month)
Response to Deep Tactile Pressure	6	9
Adaptive Motor Functions	6	13
Visual Tactile Integration	3	7
Ocular Motor Control	1	2
Response to Vestibular Stimulus	7	11
Total Points	29 (Abnormal)	42 (At risk)

TSFI: Test of Sensory Functions in Infants.

Research suggests that children with DS exhibit lower neuromotor performance compared to their neurotypical peers (Moriello et al., 2020; Post et al., 2022). The study demonstrated that an occupational therapy intervention based on sensory integration improved the neuromotor performance of a child with DS. Positive changes in gross and fine motor skills were observed after the intervention. Neuromotor problems can worsen the core symptoms of DS and negatively affect the daily lives of children with DS (Moriello et al., 2020). Further studies are needed to evaluate the direct relationship between neuromotor performance and sensory integration-based occupational therapy intervention outcomes.

The study has limitations, particularly that the intervention was only applied to one baby, preventing generalisation of the findings to all babies with DS. Therefore, it is important to conduct further studies with a larger sample group. Another limitation of the study was the challenge of monitoring homework. To gain a better understanding of the effectiveness and safety of sensory integration-based occupational therapy intervention in infants with DS, well-designed studies are required in this population.

In summary, our study findings indicate that sensory integration-based occupational therapy intervention could be effective in improving sensory functions and neuromotor performance in infants with DS. The study's results support the planning, implementation, and evaluation of educational programs that combine sensory integration and occupational therapy approaches for babies with DS.

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