Living in Silence: A Learning Guide for a Deaf and Autistic Student

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ABSTRACT:

In this study, the impact of employing sensory integration techniques on the use of hearing aids, attentional capacity, and conceptual instruction for a second-grade student diagnosed with hearing impairment and autism was examined. The child's progress was evaluated after 12 weeks of intervention, which consisted of three class sessions per week. The implemented educational program was designed to foster the development of the child's anticipated skills by engaging multiple sensory modalities concurrently. A single-subject experimental design was utilized for the investigation. It was observed that the student who initially used the hearing aid for 30 seconds to one minute before the study progressively increased the duration of its use each week. By the conclusion of the study, the student was able to complete lessons without removing the hearing aid. Significant improvements were noted in conceptual teaching, particularly regarding color identification and the distinction between large and small concepts. Additionally, the student demonstrated markedly enhanced performance in attentional activities. These findings suggest that sensory integration-based education can effectively support the developmental needs of children with hearing impairments and autism.

Keywords: Sensory Integration, Hearing Impaired, Autism, Attention, Concept Teaching, Hearing Aid.

INTRODUCTION

According to the Regulation on Special Education Services (2018), individuals with special needs are categorized as students experiencing speech and language disorders, attention deficits, intellectual disabilities, autism spectrum disorders, hearing impairments, orthopedic disabilities, behavioral disorders, hyperactivity, and those identified as gifted. It is a fundamental right of all individuals to receive education, and this right extends to those in need of special education, regardless of age, gender, or specific disabilities. Support services for individuals requiring special education are designed to facilitate their integration with peers without disabilities within the same educational settings, thereby maximizing their potential to achieve educational objectives. Special education aims to mitigate all forms of discrimination and enhance student participation by addressing their specific educational needs (DePauw & Doll-Tepper, 2000). In Turkey, recent years have seen an increase in the use of special education services to ensure that students with disabilities can learn alongside their peers. Data from the 2022-2023 academic year reveal a 35,118 increase in the number of students benefiting from special education services within formal education, bringing the total to 507,804 (MEB, 2023).

Individuals requiring special education have the option to engage in full-time education alongside peers without disabilities or to attend specialized special education classes. Although individualized education programs (IEPs) are widely recognized as the most effective approach for addressing the needs of students with special needs, various challenges and difficulties often arise in practice. These issues can hinder the implementation of education for special students at the desired level and efficacy. A critical factor in addressing these challenges is the teacher's role. Nevertheless, teachers may be hesitant to engage with these courses due to factors such as a lack of self-confidence, insufficient expertise in individualized teaching strategies, and concerns about meeting curriculum deadlines (Morgan & Bourke, 2004).

It is essential for teachers to understand and classify students with special needs thoroughly. When classifying students with special needs, it is crucial to consider that classification issues may arise in cases where multiple disabilities are present rather than just a single disability. In this regard, it is imperative to observe students with autism more deeply. Autism is known to be a neurodevelopmental disorder characterized by deficiencies in social interaction and communication skills, along with restricted interests and stereotypical behaviors (APP, 2013). In addition to these symptoms, individuals with autism often experience issues with language skills (Tager-Flusberg & Joseph, 2003; Cacciari, 2014; Kalandadze et al., 2018; Lampri et al., 2023), learning difficulties (Martínez-Vérez et al., 2024), and other similar effects. Moreover, it is known that hearing impairment can cause autism (Smith et al., 1988; Collins & Carney, 2007; Szymanski et al., 2012) or that individuals with autism require auditory support (Smith et al., 1985). As seen, the classification processes of individuals with multiple disabilities, such as autism, require teachers to determine appropriate teaching methods and create guidelines for their development after the classification.

Personnel involved in the special education process are expected to exhibit a strong willingness to learn and teach, demonstrate innovation and openness to change, and possess high levels of empathy, patience, sensitivity, and impartiality. Additionally, these professionals should be adept at collaborating effectively with affiliated institutions and the families of their students. Consequently, teachers play a pivotal role in applying the knowledge outlined in educational programs, facilitating the development of students with special needs, and supporting the integration of these students within their peer groups in the classroom environment (Saydam, 2003; Orhan et al., 2021).

Despite advancements in special education methodologies in recent years, many students with special needs continue to be subjected to traditional educational practices that lack innovative approaches. There is a need for alternative methods to assess individuals with special needs accurately and to identify instructional challenges arising from their disabilities. Traditional strategies are criticized for imposing limitations on the development of cognitive, sensory, and social skills in children (Benfatto et al., 2016). These methods are also said to inadequately reflect natural learning processes, instead providing students with an artificial educational environment. In response, researchers have developed various innovative techniques for special learners by utilizing diverse data sets and observing natural learning processes. One such progressive approach is the sensory integration technique.

The sensory integration technique is particularly prevalent in the education of young children and is a critical approach for enhancing sensory information processing and integration skills. This technique, increasingly utilized in the education of children with special needs, focuses on the effective processing and organization of diverse sensory inputs—such as touch, sight, hearing, smell, taste, vestibular, proprioceptive, and interoceptive

stimuli—by the brain. The primary objective is for individuals to receive sensory stimuli from both their external environment and their bodies and for their brains to process these inputs in a way that results in meaningful and coherent behavior.

Recent research on brain function reveals that sensory processing plays a fundamental role in how the brain operates. The structure of neurons in the human brain is dynamic, capable of forming new connections or severing redundant ones in response to external stimuli. The stability of these connections is influenced by the frequency and utility of the information received, with sensory experiences playing a crucial role in this process (Lane et al., 2019). Studies indicate that sensory input processing is an intrinsic aspect of brain function, and even when an individual concentrates on information from a single sense, such as vision, other sensory modalities are concurrently engaged and processed by the brain (Farrell & Sherman, 2011). The brain's operational principle relies on the integrated activity of all senses. Therefore, it is essential to incorporate this sensory integration aspect into educational settings, providing sensory-based learning approaches to enhance learning efficacy and retention.

In sensory integration therapy, the three primary sensory systems—tactile, vestibular, and proprioceptive—are systematically and deliberately stimulated using various methods to elicit adaptive motor responses that are appropriate to the sensory experience, goals, and context (Williamson & Anzalone, 2001). Sensory-based therapies involve activities designed to regulate the sensory system through vestibular, proprioceptive, auditory, and tactile inputs. These therapies employ tools such as brushes, swings, balls, and other specialized therapeutic or recreational equipment to provide these inputs. Improvements in these sensory systems are often associated with advancements in higher developmental stages (Yana, 2021). The literature indicates that sensory integration therapy has beneficial effects on a range of mental and neurodevelopmental disorders, including autism, cerebral palsy, and attention deficit hyperactivity disorder (Lang et al., 2012; Shamsoddini & Hollisaz, 2009).

For individuals with multiple disabilities, particularly those with auditory impairments and autism spectrum disorder, sensory integration interventions are conducted not only to address the effects of autism but also to mitigate the impacts of auditory impairments. It is known that individuals with auditory impairments tend to focus on the faces of people they communicate with (Megreya & Bindemann, 2017), thereby emphasizing the importance of visual communication and paying more attention to facial movements (Denmark et al., 2019). When combined with autism, the tendency for individuals to avoid eye contact during communication may make it difficult for them to focus on sign language or facial expressions. Additionally, individuals with sensorineural hearing loss often experience sensory sensitivities due to the use of cochlear implants or hearing aids (Pollick et al., 2024). These sensory sensitivities can negatively affect the student's educational process. In sensory integration interventions for individuals with autism, it has been found that students' learning develops through therapy (Camino-Alarcón, 2024; Fangwi, 2024). However, sensory integration studies specifically targeting individuals with both hearing impairments and autism are pretty limited. This study aimed to enhance the use of hearing aids, attentional capacity, and concept acquisition in a student with both autism and hearing impairment by applying sensory integration techniques. Given the scarcity of research in this area, particularly within Turkey, the study sought to demonstrate the significance and effectiveness of sensory integration methods for students with special needs.

METHODS

This section describes the research model, the characteristics of the study group, the data collection tools employed, the data collection process, and the methods of data analysis used in the research. This study was conducted in accordance with ethical guidelines for research involving human participants. Prior to data collection, ethical approval was obtained from the Ethics Committee of Alanya Alaaddin Keykubat University (Approval No: 6853 E). Written informed consent was obtained from the child's parents, and all procedures were explained in detail to ensure transparency and voluntary participation. All identifiable personal data were anonymized and handled confidentially.

Research Model

In this study, a single-subject experimental design was employed to assess the impact of sensory integration techniques on a student diagnosed with both hearing impairment and autism, specifically focusing on the student's use of hearing aids, attentional capacity, and concept acquisition at the primary school level. Single-subject research is a quantitative methodology characterized by the researcher's complete control over the independent variable, placing it within the realm of experimental research. However, due to the lack of random assignment

of participants, it is sometimes categorized as a quasi-experimental research model. Single-subject research is particularly effective in demonstrating the impact of behavioral changes or teaching interventions through repeated measurements that allow for self-control by each participant (Tekin-İftar, 2012a).

Study Group

The research was conducted with a 7-year-old second-grade student, identified as A., who attended a primary school in Antalya, Turkey, during the 2023–2024 academic year. A. had been previously diagnosed with both autism spectrum disorder and complete (100%) hearing impairment, based on formal medical documentation. All necessary permissions for A.'s participation were obtained from the family. In addition to medical records, detailed information regarding A.'s developmental history and current condition was gathered through interviews and reports from A.'s parents and teachers.

The family reported that they had previously sought treatment and educational support in other cities, but these efforts had not yielded noticeable improvement. Despite enrollment in a special education school, A. expressed a strong aversion to the school environment, often coming home distressed and refusing to participate in classroom activities. The family also reported difficulties with school travel and expressed concerns regarding the adequacy of both the educational services and the personnel involved.

The condition of the child was assessed through both parental and teacher reports. The student exhibited resistance to using the hearing aid due to discomfort from the amplified sounds. The child's parents reported that he initially found the device uncomfortable and would avoid using it. This observation was also confirmed by the teacher, who noted that the child showed reluctance to use the hearing aid during school activities. Both the parents and teacher provided valuable insights into the child's interaction with the hearing aid, helping to understand the challenges faced in adapting to its use. These observations were taken into account when planning and implementing the intervention. However, once he became accustomed to the hearing aid, he began to engage in learning activities when presented with stimuli that captured his interest. Despite this, his attention span was notably short. A.'s strong affinity for colors and painting was leveraged in the study, with initial educational activities centered around painting and colorful games to attract and maintain his attention. The primary challenge identified was A.'s reluctance to use the hearing aid, which significantly hindered his learning and disrupted his educational progress. Consequently, the study aimed first to extend the duration of hearing aid use and subsequently to enhance A.'s attention span and facilitate concept teaching (Table 1.).

Data Collection Tools

The significance and value of scientific research increase with higher levels of internal and external validity (Baştürk, 2009). In this study, the following data collection tools were utilized: the 'Hearing Aid Use Form,' the 'Frankfurter Attention Test (FDT),' and the 'Concept Teaching Form.' Details regarding these measurement tools are provided below.

Hearing Aid Use Form: The Hearing Aid Use Form was used to systematically record the individual's daily usage time of their hearing aid. The researcher documented this data to ensure objective measurement of hearing aid usage. The hearing aids were connected to specialized software on a computer, which retrieved daily usage times without altering the hearing aid programs. Data were then recorded, with average daily usage times noted in minutes.

Table1. **Participant Information**

	Characteristics of the Participant
Age	7
Gender	Male
Who does he live with	Mother, father, brother
Medicine	Does not use
Hearing Aid Device	Refuses to use hearing aids
Accompanying Problems	Hearing Impaired (100%) Autism (Atypical)

Frankfurter Attention Test (FDT): The Frankfurter Attention Test, developed by Raatz and Möhling (1971), underwent reliability and validity studies in Germany. This test is designed to assess children's attention skills by requiring them to differentiate between apples and pears mixed together within a 90-second timeframe. The child's raw score is determined by counting the correctly identified pears, and the standard score is then calculated based on this raw score and the child's chronological age (Seçer & Kaymak-Özmen, 2015).

Concept Teaching Evaluation Form: The "Concept Teaching Evaluation Form," developed by the researchers, was analyzed using a document analysis approach. The development process of the form involved the following steps:

a. Preparation of Draft Form: A preliminary version of the evaluation form was created based on a review of relevant literature.

b. Expert Review: The draft form was then submitted for expert evaluation. An information note was created for the experts, providing a brief introduction and examples of the units within the Concept Teaching Evaluation Form. The experts were asked to review and assess the draft form in light of this information note.

c. Revision Based on Expert Feedback: The form was revised according to the feedback provided by three experts who have expertise in the field of concept teaching.

In the Concept Teaching Evaluation Form, both the primary and secondary concepts within each section were recorded along with their frequency levels. To assess the reliability of the form, the "inter-rater agreement" level was determined (Büyüköztürk et al., 2013). In this process, two researchers independently coded the data. The level of inter-coder reliability was assessed using the formula developed by Miles and Huberman (1994):

$$\text{Reliability} = \frac{\text{Agreement}}{\text{Agreement}+\text{Disagreement}}$$

A reliability calculation of .70 or above is considered acceptable for research purposes. The analysis yielded a reliability level of .93, indicating a high degree of agreement and confirming the reliability of the form (Miles & Huberman, 1994).

To assess the student's understanding of the concepts, the authors designed the Concept Teaching Evaluation Form. This form includes specific criteria to evaluate the student's ability to recognize and correctly use the introduced concepts, as well as their participation in the learning activities. The evaluation was conducted by the teacher during each session, and feedback was also collected from parents regarding the child's progress.

The reliability of the Concept Teaching Evaluation Form was tested through a pilot study. In this pilot study, the form's accuracy and practicality were evaluated to ensure it provided consistent results across different evaluators. Feedback from the pilot study confirmed that the form was effective and easy to understand, validating its use in the current study.

Data Collection Process

The program was implemented for 3 hours per week over 12 weeks. Sessions were conducted regularly on Mondays, Wednesdays, and Fridays, at times coordinated with the family. The intervention took place in the child's home to enhance comfort and facilitate better progress. Throughout the study, frequent meetings were held with the student's family to ensure collaborative involvement between the family and the teacher.

Each week, adjustments were made to the hearing aid to ensure it was used at a volume that would not distress the child while gradually approaching normal levels. Weekly instruction focused on concepts tailored to the student's learning pace, and attention-building activities were incorporated into the sessions.

Due to the initial information that A consistently removed the hearing aid and the family's efforts to address this issue being insufficient, a gradual acclimatization process to the hearing aid was initiated from the first week. In this process, considering A's auditory sensitivity, a low sound output of -15 dB was set. Melodies containing frequencies between 220 Hz and 587.33 Hz were played before each lesson in a quiet environment to support focus and reduce anxiety. Although the use of the hearing aid was limited in the first week, training exercises were conducted outside of the regular sessions with the support of the family. In the second week, after adjusting the sound output to -12 dB, trials were repeated. In the third and fourth weeks, the sound output was set at -9 dB, followed by -6 dB in the fifth and sixth weeks. Starting from the seventh week, the sound output was set at -3 dB.

In addition to hearing aid exercises, visual materials designed for sensory integration were prepared and displayed in the working environment on a weekly basis. During the first week, small-sized yellow materials were used, followed by the addition of small-sized yellow and

blue materials in the second week and small-sized yellow, blue, and green materials in the third week. Each week, an additional color was introduced, and small-sized colors were taught. In the fourth week, large-sized yellow materials were added to those from the previous three weeks. The fifth week saw the addition of large-sized blue materials, followed by the use of both small and large-sized materials of all colors in the sixth week. Starting from the seventh week, the same cycle was applied using medium-sized materials. By the ninth week, materials in all intended colors and sizes were displayed in the environment. The materials used each week remained displayed in the environment throughout the respective week.

Data Analysis

To evaluate the effectiveness of the implementation, the baseline and implementation phases were compared. Baseline data, which reflects the state of the dependent variable before the experimental process begins, were collected over a minimum of three consecutive sessions until stability was achieved. Data stability is indicated when at least 80% of the data points do not deviate from the mean by more than 15% (Kırcaali-İftar & Tekin, 1997).

In this study, baseline data were first gathered during the initial phase, with six measurements taken. Once it was confirmed that the baseline level was stable—falling between X = 3.97 and X = 5.35, which is within +/- 15% of the mean values, and with no significant deviations from these values—the training program was initiated. During the implementation phase of the training program, 30 additional measurements were collected. Follow-up measurements were taken three weeks after the last training session, with three additional measurements collected at that time.

To ensure consistency and reliability, training sessions were regularly conducted and completed on Mondays, Wednesdays, and Fridays, and the completed forms were systematically collected from the participants. Tekin-İftar (2012b) indicates that in single-subject studies, the functional relationship can be assessed primarily through graphical analysis, although statistical or qualitative analysis techniques may also be employed. In the inter-subject multiple probe model, comparing the curves from baseline, implementation, and follow-up phases with previous curves helps determine the effectiveness of the applied method. To address the research objectives and adhere to single-subject research methods, graphs were used in this study. The analysis included phases for establishing performance levels before teaching, assessing the impact of the teaching intervention, and evaluating whether the effects persisted during monitoring. The evaluation focused on data stability and trends.

- ***Stability Analysis:*** This examines the variability of data points within a phase. Variability is assessed by observing fluctuations in the data points on the graph, with lower variability indicating higher stability.
- ***Trend Analysis:*** This involves analyzing the direction of the data path. Trends can be flat, increasing, or decreasing:
  - ***Increasing Trend***: Data values on the y-axis rise during the sessions.
  - ***Decreasing Trend:*** The data values on the y-axis decrease during the sessions.
  - ***Flat Trend:*** Data values remain constant on the y-axis, and the trend line is parallel to the x-axis (Tekin-İftar, 2012b).

In this study, the data related to hearing aid use, attention, and concept teaching—resulting from the embedded instruction using the gradual reduction of prompt methods within activities designed according to the Sensory Integration Approach—were analyzed graphically. The line graph technique, a method of graphical analysis, was utilized to analyze these data. In this study, to quantitatively analyze the impact of the experimental procedure, the mean scores of the baseline data were compared with those obtained during the training process and follow-up measurements. Effect size was utilized to assess the magnitude of differences between these mean scores.

Effect size indicates the proportion of total variance in the dependent variable that is attributable to the independent variable or factor. Cohen's "d" statistic was used to calculate the effect size in this study. Cohen's "d" Calculation:

- **Baseline to During Training:** The effect size is calculated to determine the impact of the training by comparing the mean scores between these two phases:

$$\text{Cohen's d} = \frac{\bar{X}_2 - \bar{X}_1}{SD_1}$$

- **During Training to Follow-Up:** The effect size measures how attention levels changed from the training phase to the follow-up phase:

$$\text{Cohen's d} = \frac{\bar{X}_3 - \bar{X}_2}{SD_2}$$

Cohen's "d" quantifies the difference between means in terms of standard deviations, with the values interpreted as follows:

Small effect size: *d*=0.2
Medium effect size: d=0.5
Large effect size: d=0.8
(Büyüköztürk, 2010; Büyüköztürk et al., 2009).

To determine the effect size, the mean and standard deviation values of the baseline, training program implementation, and follow-up measurement data were calculated. Each set of data was compared to the baseline data to evaluate the impact of the intervention.

RESULTS

In this section, the results and interpretations derived from the statistical analysis of the data collected through the application of the scales are presented. The findings related to each research problem are displayed and discussed in detail through tables and figures.

Duration of Device Use in Sensory Integration Education of Hearing Impaired and Autistic Students

The researcher's observation form was used to measure the duration of hearing aid use among students with hearing impairment and autism. The primary objective of the test was to enhance the student's hearing aid usage by gradually increasing the duration through sensory integration training. The results from the observation phase, as depicted in Figure 1, were recorded every week in minutes.

According to Lauth and Fellner (2004), in single-subject studies, a significant improvement in behaviors compared to baseline data on a line graph can indicate the effectiveness of the training phase. Analyzing Graph 1 reveals that before the training, the student did not use the hearing aid. However, with the implementation of sensory integration training, there was a notable increase in the student's use of their hearing aid each week. The graph shows a continuous upward trend in usage until the 10th week. In the final three weeks, it was observed that the student consistently wore the hearing aid throughout the entire lesson.

Development Level of Concept Teaching Skills in Sensory Integration Education of Hearing Impaired and Autistic Students

The test developed by the researcher aimed to assess the level of concept teaching for students with hearing impairment and autism. The test evaluated the students' understanding of color concepts ("Yellow," "Blue," and "Green") and size concepts ("Small," "Large," and "Medium"). Table 2 presents the results of the test phase, where:

A "+" symbol indicates a correct answer provided by the student.

A "-" symbol denotes an incorrect answer.

Table 2 confirms the effectiveness of the concept teaching process and helps determine students' proficiency in mastering the targeted concepts.

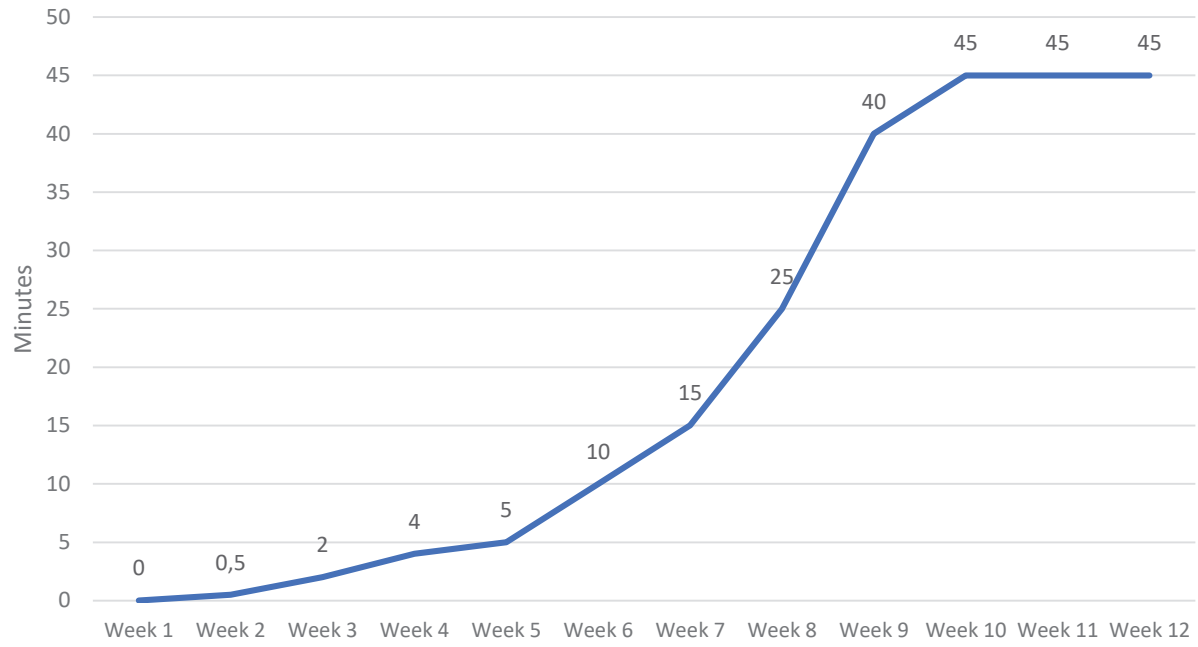

Figure 1. Duration of Hearing Aid Use

Table 2. **Development of Concept Teaching in Sensory Integration Education of Hearing Impaired and Autistic Students**

Week	Student/Concepts	
	Color Concepts (Yellow, Blue, Green)	Size Concepts (Small, Large, Medium)
Week 1	-,-,-	-,-,-
Week 2	+,-,-	-,-,-
Week 3	+,-,-	-,-,-
Week 4	+,+,-	-,-,-
Week 5	+,+,+	-,-,-
Week 6	+,+,+	-,-,-
Week 7	+,+,+	+,-,-
Week 8	+,+,+	+,-,-
Week 9	+,+,+	+,+,-
Week 10	+,+,+	+,+,-
Week 11	+,+,+	+,+,+
Week 12	+,+,+	+,+,+

As indicated in Table 2, the concept teaching assessment test—one of the primary objectives of sensory integration education for students with hearing impairments and autism—was completed successfully. The process involved a structured approach where color concepts were taught in the first six weeks. Once proficiency in color concepts was achieved, the instruction extended to include both color and size concepts starting from the seventh week.

The student successfully learned the color concepts within the first five weeks, with color teaching concluded by the 12th week. The introduction of size concepts began in the seventh week and showed progressive improvement. By the last two weeks, the student had mastered both color and size concepts without any issues.

Initially, the student was unable to correctly identify any of the targeted concepts. However, by the end of the 12th week, the student was able to answer all questions related to the taught concepts correctly. The student's progress is illustrated in Figure 3, which displays the weekly concept acquisition. Overall, the test results demonstrate that sensory integration education effectively supports concept learning in students requiring special education.

Examining Figure 2 reveals that the student initially had no knowledge of the color and size concepts before the training. However, due to the Sensory Integration Training, significant progress was made:

Color Concepts: The student's understanding of color concepts began to improve within the first few weeks. By the fifth week, the student had mastered all three target colors ("Yellow," "Blue," and "Green") and maintained this proficiency throughout the remaining weeks of the study.

Size Concepts: Initially, there was no improvement in the understanding of size concepts during the first six weeks. This lack of progress can be attributed to the focused emphasis on color concepts during this period. In this study, the introduction of the size concept was planned to begin only after the child had sufficiently mastered the color concepts. However, if the child had not achieved mastery in the color concepts by the 12th week, the researcher would have adjusted the teaching process to provide additional support. The goal was to ensure that each concept was fully understood before progressing to the next. Starting from the seventh week, instruction on size concepts commenced, as the child had successfully learned the color concepts by that time. The introduction of the size concepts was carefully planned to match the child's individual learning pace, with the flexibility to adjust the timeline based on the child's responses and needs. By the end of the 12th week, the student had successfully learned all three size concepts ("Small," "Large," and "Medium").

Overall, the data indicate that the sensory integration education positively supported the student's development of concept skills, as evidenced by the significant gains in understanding both color and size concepts by the end of the training.

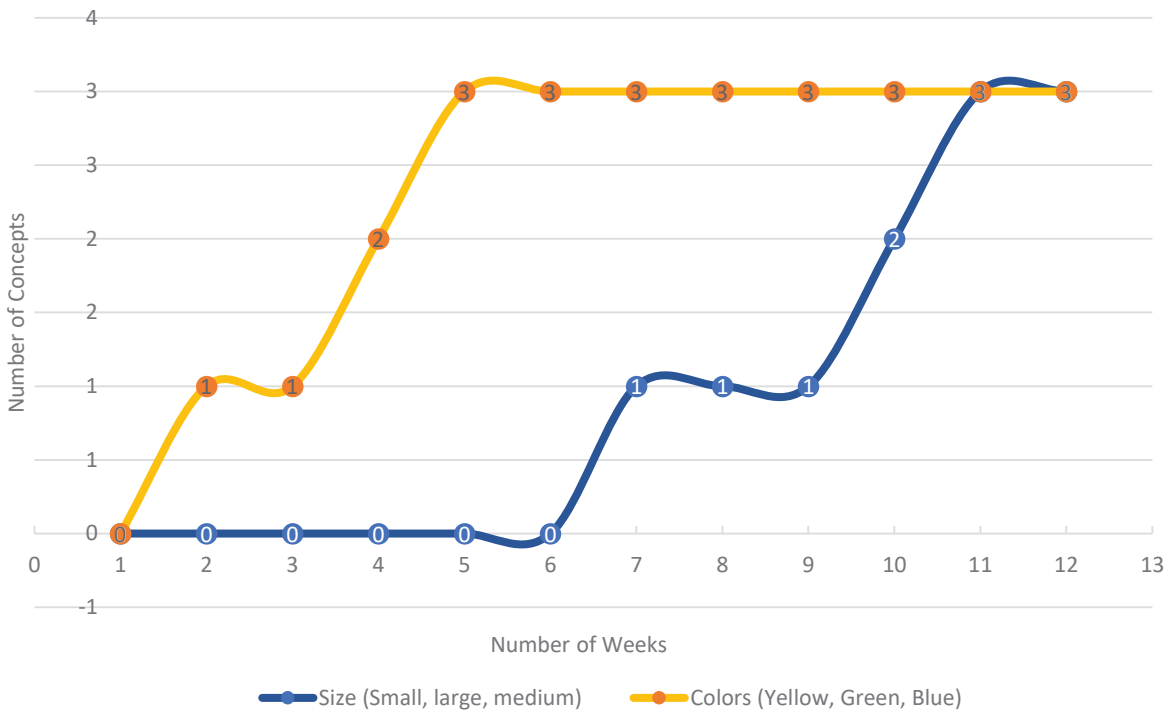

Figure 2. Weekly Development of Concept Teaching Level of Hearing Impaired and Autistic Students

Level of Development of Attention Teaching Skill in Sensory Integration Education of Hearing Impaired and Autistic Students

Data were collected using the Frankfurter Attention Test to assess the attention level of students with hearing impairments and autism. Table 3 presents the descriptive statistics and Cohen's d values for the attention skills of the special student before, during, and after sensory integration education.

Upon examining Table 3, it is evident that the average attention level of students with hearing impairments and autism was X=0 at baseline. Following the sensory integration training, the average attention level increased to X=4,76. The follow-up measurement revealed that this improvement was sustained and further increased to X=7,14. The participant's evaluation demonstrates a significant positive change in attention skills, as indicated by a substantial effect size of *d*=1,41 during the sensory integration training phase. This medium effect size was also observed in the follow-up measurement data, with an effect size of *d*=0,47, reflecting that the gains in attention were maintained and enhanced post-training. Weekly measurements of the student's attention level improvement are presented in Figure 3.

Upon analyzing Figure 3, it is evident that the student had no measurable attention level prior to the training and maintained this baseline level for the first three weeks. Beginning in the fourth week, a gradual improvement in the student's attention level was observed. The Frankfurter Attention Test categorizes scores into three levels: below average (0-22), average (23-32), and above average (33-43). Although the student's attention scores remained below average even after the training, it is essential to note that there was a significant improvement from an initial attention level that was almost nonexistent. This indicates a gradual development in the child's attention span, demonstrating the positive impact of the intervention over time. Considering the participant's au-

Table 3. **Descriptive Statistics and Cohen's d Values of Attention Scores of Students with Hearing Impairment and Autism at Baseline, During the Implementation of the Sensory Integration Education Program and in Follow-up Measurements**

	Beginning Level X (S)	Sensory Integration Education X (S) *d*	Follow-up Measurement X (S) *d*
Attention of the Participant	0 (0)	4.76 (3,36) *d=1,41*	7.14 (5,04) *d=0,47*

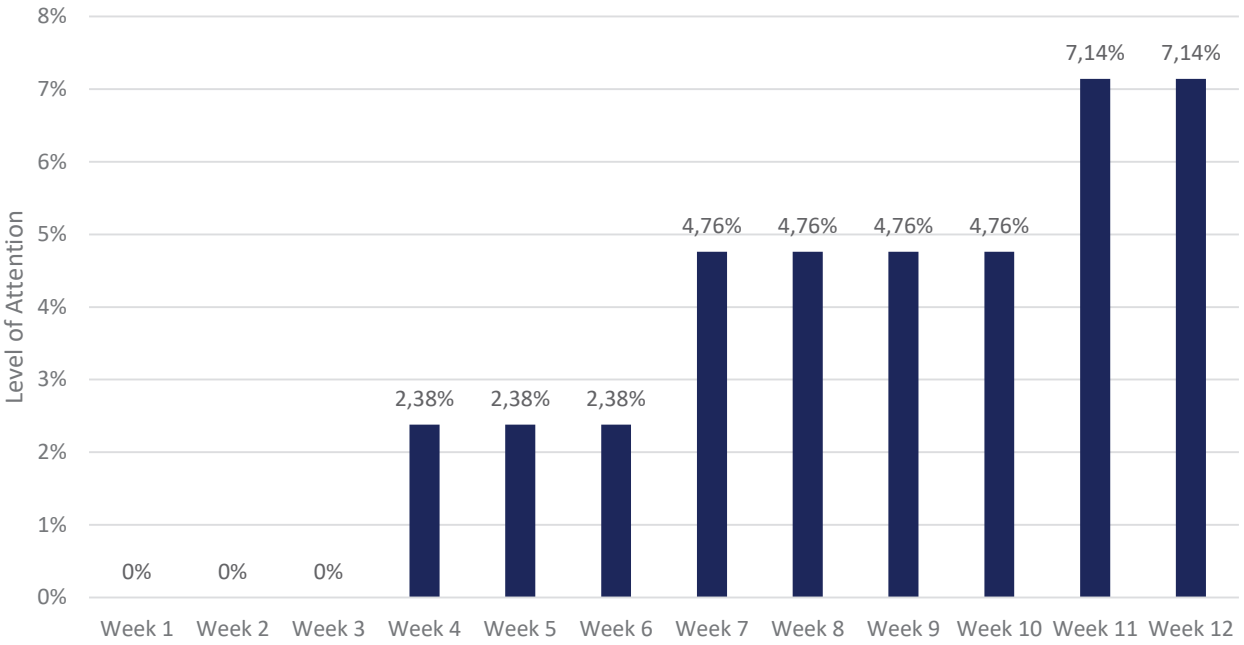

Figure 3. Weekly Development of Attention Level of Hearing Impaired and Autistic Students

tistic characteristics, it is essential to recognize that attention levels may differ from neurotypical individuals, and the observed improvements reflect ongoing support and adaptation tailored to the child's unique learning needs.

DISCUSSION AND CONCLUSION

Based on the research findings, it can be concluded that the sensory integration method makes a positive contribution to the educational processes of students requiring special education. The analysis of the autism and hearing-impaired students within the study sample revealed that training employing the sensory integration approach had beneficial effects on concept teaching, enhanced attention span, and increased the duration of hearing aid use.

In the education of students with special needs, teaching basic concepts is of paramount importance, as these concepts are fundamental to their academic development (Gürsel, 2003). However, children with special needs often require distinct teaching methods and adaptations compared to their typically developing peers to effectively learn concepts (Çelik, 2007; Çiftçi, 2021). In this study, we employed a sensory-based intervention that integrated multiple sensory stimuli to enhance learning outcomes for children with autism and hearing impairments. The approach was tailored to meet the individual sensory needs of the participant and to support effective concept acquisition.

The sensory integration method employed in this intervention is rooted in the work of Ayres (1972), who developed sensory integration therapy to address sensory processing challenges, particularly for children with developmental disorders, such as autism. Research indicates that sensory integration therapy can improve attention, behavior, and learning by providing children with structured sensory experiences that enhance their ability to process sensory input (Case-Smith & O'Brien, 2015).

For this study, the sensory-based intervention utilized visual, auditory, and tactile stimuli. For example, we used colored objects to teach the color concepts (yellow, blue, green), and various textures were introduced to teach the size concepts (small, medium, large). These sensory stimuli were chosen based on the child's preferences and sensory sensitivities, as research suggests that children with autism often have unique sensory processing patterns (Tomchek & Dunn, 2007).

However, children with special needs often require distinct teaching methods and adaptations compared to their typically developing peers to learn concepts effectively. The child's response to sensory stimuli was carefully monitored throughout the study, and adjustments were made based on the child's comfort level and ability to engage with the stimuli. For example, while the child initially exhibited resistance to wearing the hearing aid due to discomfort from the amplified sound, visual stimuli were prioritized to maintain the child's engagement. This adaptation is consistent with findings in the litera-

ture suggesting that visual and tactile stimuli can be more effective for children with autism, especially when they have sensory sensitivities (Pfeifer & Mitra, 2009).

These adaptations to the sensory-based intervention, along with the personalized approach, were crucial in helping the child engage with and master the targeted concepts. The improvements in the child's attention and conceptual understanding further support the effectiveness of this individualized sensory-based approach (Miller et al., 2007).

Çeken (2021) highlighted that diverse activities are crucial in addressing the needs of special education students, and individual-specific strategies are essential for engaging these students and enhancing learning effectiveness (Akmanoğlu-Uludağ & Batu, 2005; Bandyopadhyay & Rathod, 2017; Hwang & Hughes, 2000; Odom et al., 2003; Sazak Pınar & Merdan, 2016). This study found that the sensory integration method, among various teaching techniques designed for special education, is particularly effective for individuals with autism and hearing impairment in the context of concept teaching.

The development of attention skills is another crucial aspect addressed in this study, particularly for students with special needs. Special students, especially those with autism spectrum disorder (ASD), often face substantial limitations in attention compared to their typically developing peers (Charman et al., 1997; Mundy et al., 1990; Swettenham et al., 1998). In the case of the participant in this study, attention issues may be linked to both their hearing challenges and the characteristics specific to autism. Deaf children often struggle to pay attention because they may not be able to fully grasp auditory sensory input, which is essential for maintaining attention (Pfeifer & Mitra, 2009). Additionally, autistic children may be perceived as inattentive by neurotypical individuals due to unique social behaviors, such as avoiding eye contact, which does not necessarily mean they are not paying attention (Klin et al., 2002).

Thus, it is essential to consider that a combination of these factors likely influences the participant's attention difficulties. The challenges related to both the hearing impairment and the social communication behaviors associated with autism likely contribute to the overall attention issues observed. These complexities underscore the need for a multifaceted approach when assessing and addressing attention in children with dual diagnoses, as it involves not only sensory processing issues but also social and behavioral factors that may influence the participant's attention in different ways.

These students require teaching methods and techniques tailored to their individual needs to develop attention skills effectively. Studies by Grimwood and Rutherford (1980), Karim and Mohammed (2015) have demonstrated that sensory integration programs have a positive impact on the educational outcomes of children with autism.

Children who exhibit resistance to wearing hearing aids often have various underlying reasons for their reluctance to do so. Observations on the factors influencing the participant's motivation to use the hearing aid suggest that both the content of the learning topic and the intervention methods have worked together effectively. As mentioned in the study, the learning topic focused on colors particularly attracted the participant's interest, and this visual approach likely enhanced the engagement. However, it is essential to emphasize that the motivation to use the hearing aid was not solely dependent on the visual content. The sensory-based intervention, which integrated auditory, visual, and tactile stimuli, enriched the participant's overall sensory experience and likely increased their willingness to use the hearing aid.

Sensory integration therapy played a significant role in harmonizing the participant's sensory system by effectively integrating sensory inputs. This may have made the experience of using the hearing aid more acceptable and effective. As sensory integration therapies aim to improve the processing and response to sensory input, they could have contributed to the participant developing a more positive attitude toward the hearing aid.

Furthermore, the participant's interest in visually stimulating topics, such as colors, may have helped create a positive association with the use of the hearing aid during the learning process. While the visual approach likely played an important role in motivating the participant to use the hearing aid, the comprehensive sensory integration approach was a key factor in the increased usage of the device. Therefore, the increase in the use of the hearing aid can be explained by both the visual appeal of the learning topic and the holistic impact of the sensory-based intervention.

According to Turan et al. (2012) and Tomblin et al. (2015) emphasize the importance of regular hearing aid use for effective speech and language development. The success of interventions for these children is significantly influenced by their consistent use of hearing aids, as noted by DesJardin (2006) and Jackson, Traub, and Turnbull (2008).

In this study, sensory integration training was specifically designed for a student with autism spectrum

disorder who initially resisted using a hearing aid. The objective was to enhance the student's engagement in educational activities and increase the duration of hearing aid use. The results demonstrated that, as a consequence of the sensory integration interventions, the student's hearing aid use progressively increased over time. By the final week of the study, the student consistently wore the device throughout the lesson, marking a significant improvement in adherence.

A review of the literature reveals that the low academic achievement observed in students with special needs, such as those with autism and hearing impairments, is often attributed to several factors. These include insufficient knowledge and skills among teachers regarding the education of these students, a lack of expertise in making appropriate accommodations, and inadequate use of adaptive materials and tools (Anılan & Kayacan, 2015; Demir, 2015; Kargın et al., 2003; Can et al., 2012; Uyanık & Sarı, 2021). In alignment with these findings, Metin and Altunay (2020) and Balcı (2015) further emphasize that deficiencies in lesson planning for students with special needs, a failure to tailor adaptations to individual student characteristics, and a general lack of professional expertise in special education contribute to these challenges.

To ensure that students utilize all their senses effectively in their learning processes, it is crucial to provide materials and tools that align with their characteristics and needs. Additionally, applying teaching methods and techniques tailored to the subject matter's nature can significantly support educators. Organizing activities that stimulate the senses and support sensory organization in students with special needs is essential for enhancing their learning processes and fostering the development of daily living skills. Therefore, the sensory integration method is highly recommended for teachers as an effective approach to enriching students' educational experiences.

When applying the same sensory-based intervention in other studies or classrooms, researchers and practitioners need to consider several key factors to ensure its effectiveness and adaptability to different contexts:

1. *Individualization of the Intervention:* It is crucial to tailor the intervention to meet the unique needs of each child, particularly when working with children with autism spectrum disorder (ASD) or hearing impairments. Adjustments should be made based on the child's specific sensory sensitivities, interests, and learning pace. This can involve adapting the sensory stimuli (visual, auditory, tactile) to the child's preferences and needs.
2. *Collaboration with Families and Educators:* Effective communication and collaboration with families and educators are essential for supporting the child's progress. Insights from family and teachers into the child's behavior and responses can guide the adaptation of the intervention, ensuring that it aligns with the child's everyday experiences and learning environment.
3. *Consistency and Routine:* Regular and consistent implementation of the intervention is key. A structured routine that incorporates sensory-based activities in various contexts (such as at home, in the classroom, or during playtime) can help reinforce learning and encourage the child's engagement with the intervention.
4. *Monitoring and Evaluation:* Continuous monitoring of the child's progress is essential. Practitioners should regularly assess the child's response to the intervention and make necessary adjustments based on the child's development. This includes tracking attention levels, engagement, and the use of assistive devices (such as hearing aids) over time.
5. *Multisensory Approaches:* Given the benefits of sensory integration, incorporating a multisensory approach that combines visual, auditory, and tactile inputs can enhance the effectiveness of the intervention. It is vital to ensure that these inputs are balanced and appropriately matched to the child's sensory needs.

By considering these aspects, researchers and practitioners can better adapt the sensory-based intervention to suit a wide range of children with special needs, facilitating their learning and development in a more holistic and supportive manner.

ETHICAL APPROVAL STATEMENT

The ethical approval required for conducting this research was obtained from the Social and Humanities Ethics Committee of Alanya Alaaddin Keykubat University (Approval Number: 6853 E.; Document Date and Number: 29.05.2024-185197). To avoid any ethical violations, informed consent was obtained from both the children and their parents through a written consent form.

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