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The Effect of Sensory Integration Therapy on Improving The Writing Skills of Children with Special Needs

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Abstract. Writing is an important part of language skills in everyone's life, including children with special needs. Poor writing skills can lead to children with special needs experiencing difficulties and obstacles in completing school assignments, thereby negatively impacting academic achievement. This study aimed to examine the effect of sensory integration therapy in improving the writing skills of children with special needs at the N-Ergy Psychology Center. A qualitative experimental method was adopted, specifically a Single Subject Research (SSR) design with an A-B-A' pattern. The sample consisted of 3 children subjected to psychomotor therapy at the center. Data were collected using a tracing test, the Beery VMI, Visual Perception and Motor Coordination subtests, as well as handwriting observation. Analysis was conducted visually and presented in the form of tables and graphs to reflect changes in subjects' behavior before, during, and after the intervention. The results showed an improvement in writing skills across all participants. In addition to improved tracing test scores, enhancements were also observed in the Beery VMI scores, Visual Perception and Motor Coordination subtests, as well as handwriting quality. These results suggest that sensory integration therapy has a positive effect on improving the writing skills of children with special needs. Therapy can be effectively implemented in individualized settings in therapy institutions by providing appropriate sensory stimulation and engaging parents actively to achieve optimal outcomes.

Keywords: children with special needs, sensory integration therapy, single subject research, writing skills

Pengaruh Terapi Sensori Integrasi dalam Meningkatkan Kemampuan Menulis Anak Berkebutuhan Khusus

Abstrak. Menulis merupakan bagian penting dari keterampilan berbahasa dalam kehidupan setiap orang termasuk anak-anak berkebutuhan khusus. Keterampilan menulis yang buruk dapat menyebabkan anak berkebutuhan khusus mengalami kesulitan dan hambatan dalam menyelesaikan tugas sekolah, sehingga berdampak negatif pada prestasi akademik. Tujuan dari penelitian ini adalah untuk mengetahui pengaruh terapi sensori integrasi dalam meningkatkan kemampuan menulis anak berkebutuhan khusus di N-Ergy Psychology Center. Penelitian ini menggunakan pendekatan kuantitatif dengan metode eksperimen, serta menerapkan desain Single Subject Research (SSR) dengan rancangan A-B-A'. Sampel penelitian terdiri dari tiga subjek yang menjalani terapi psikomotorik di N-Ergy Psychology Center. Pengumpulan data dilakukan menggunakan tes tracing, Beery VMI, subtes Visual Perception, subtes Motor Coordination, serta observasi tulisan tangan. Data dianalisis secara visual melalui penyajian dalam bentuk tabel dan grafik untuk menggambarkan perubahan perilaku subjek pada fase sebelum, selama, dan setelah perlakuan diberikan. Hasil analisis menunjukkan peningkatan kemampuan menulis pada ketiga subjek. Selain peningkatan pada frekuensi tes tracing, peningkatan juga terlihat pada skor Beery VMI, subtes Visual Perception, subtes Motor Coordination, serta hasil observasi tulisan tangan. Temuan ini menunjukkan bahwa terapi sensori integrasi berpengaruh dalam meningkatkan kemampuan menulis anak berkebutuhan khusus. Terapi ini dapat diimplementasikan secara individual di lembaga terapi, dengan memperhatikan stimulasi sistem sensorik serta melibatkan peran aktif orang tua untuk memperoleh hasil yang lebih optimal.

Kata Kunci: anak berkebutuhan khusus, kemampuan menulis, *single subject research*, terapi sensori integrasi

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"Children with special needs" are individuals who require specialized education and services to fully develop human potential. The term stems from the necessity to fulfill various aspects of life. These children need support in education, social development, counseling, and other services that differ significantly from the general population (Putra et al., 2021). Stimulation of cognitive, language, physical, motor, and socio-emotional aspects is essential to facilitate continuous development and promote independence. From an Islamic perspective, every individual is encouraged to strive toward developing full potential, as stated in Surah Ar-Ra'd, verse 11 of the Quran: *"Indeed, Allah would never change a people's state (of favor) until they change their own state (of faith)."* This verse directs educators and parents to provide the best education for children, regardless of the circumstances (Akhirin, 2015).

Based on observation, the number of children with special needs continues to increase. A report from the Coordinating Ministry for Human Development and Culture (Kemenko PMK) published in June 2022 stated that 3.3% of children aged 5-19 years, approximately 2,197,833, were identified with disabilities within a total population of 66.6 million (Syarifah, 2023). Data from the Indonesian Child Protection Commission (KPAI), based on the 2024 Indonesian Welfare Survey (SKI), estimated that out of 83 million, approximately 1 million are designated as children with special needs (KPAI, 2025).

Writing is a crucial part of language skills in everyone's life; hence, it should be mastered by school-age children. It is the expression of thoughts, ideas, or feelings through the use of language (Safitri et al., 2022). The skill is required across all school activities, such as composing stories, expressing emotions, copying numbers from the board, completing school assignments, or writing letters (Srivastava, 2016). Writing is a form of expression that should be mastered after developing listening, speaking, and reading skills (Marlena et al., 2024). In addition to academic settings, it is required in several social activities, such as filling out forms and taking important notes. Given the significance, writing should be taught and mastered by every individual, including children with special needs. Poor writing skills can lead to children with special needs experiencing difficulties and obstacles in completing school assignments, thereby negatively impacting academic achievement. These children often fail to advance onto the next grade owing to the inability to complete school assignments (Mangunsong, 2014). Previous study showed that 50-85% of children with special needs repeated a grade once, 30% repeat a grade up to 3 times, and 10% attend special classes, with writing difficulty being a contributing factor (Prasaja & Harumi, 2020).

To enable effective writing, components such as fine motor control, visual perception, visual-motor integration, kinesthesia, sensory modalities, and sustained attention are essential

and should be mastered (Prasaja & Harumi, 2020). Children with special needs require preparation to support writing activities, including maintaining an upright posture, eye-hand coordination (also known as motor coordination), motor planning, as well as endurance and maturity in holding the applicable instrument/tool.

Children with special needs typically have lower visual and auditory acuity, as well as motor activity, compared to children in general (Soendari, 2010). The essential elements of writing readiness are mastered at the start of formal education. However, these elements remain underdeveloped in children with special needs. Writing proficiency depends on auditory and visual acuity as well as coordination between motor movements (Soendari, 2010).

Previous studies have shown that delayed mental development in children with special needs impacts motor skills acquisition (Widiyati, 2015). Central nervous system abnormalities commonly observed among this population contribute to impaired motor skills, leading to difficulties in writing (Raddine & Damayanti, 2023). The impairments are evident in the inability to perform motor activities that require speed, coordination, and complex movement (Wati & Widajati, 2018). Sensory processing disorders occur when children process information from the environment or their bodies in unusual ways. This leads to challenges in recognizing ongoing situations and determining appropriate responses. The sensory input process begins with recognition (awareness of sensations), orientation (paying attention to sensations), interpretation (understanding the meaning of the information received), and organization (responding to the information received). The outcomes from sensory processing are in the form of emotional behavior, motor, or cognitive responses (Waiman et al., 2016).

Observations conducted at the N-Ergy Psychology Center, an agency in Ungaran providing therapy and psychological services, identified several sensory processing challenges among children with special needs. The difficulties included improper pencil grip, inconsistent letter sizing, incorrect letter formation, irregular spacing between letters, and frequent distraction during writing tasks. These sensory processing issues had a direct impact on motor output, including writing performance.

Interviews were conducted with three Sensory Integration therapists at the N-Ergy Psychology Center to strengthen the theoretical foundation of this study and provide a deeper understanding of the problem. Therapists explained that children experiencing writing difficulties were influenced by easily distracted concentration and focus, poor posture, excessive close proximity of the body and head to the table, improper pencil grip, inability to visualize letter shapes, and poor hand-eye coordination during writing tasks. During dictation exercises, some children lacked

optimal auditory skills, which led to difficulties in transcribing spoken information accurately.

Each individual possesses seven sensory categories, namely tactile, auditory, visual, gustatory, olfactory, vestibular, and proprioceptive. When one of the senses is impaired, several bodily functions will be affected, leading to distorted sensory messages. This results in the individual being unable to receive, understand, or respond appropriately to the stimuli received (Tanawali et al., 2018).

Sensory integration is the process of recognizing, transforming, and differentiating sensations received through the environment to provide an adaptive response in the form of emotional behavior, motor, or cognitive responses (Waiman et al., 2016). Some individuals experience discordant responses to received stimuli, a phenomenon known as sensory integration disorder, first described by Dr. Anna Jean Ayres in 1963. It is defined as a problem with the neurological processes that regulate and process stimuli from the environment or the body, leading to the inability to respond optimally. The disorder is caused by problems in the brain's nervous system, which prevent the information received in the form of stimuli from being efficiently processed into an appropriate response (Irvan, 2017).

The rationale for sensory integration intervention is based on the concept of neuroplasticity, which refers to the ability of the nervous system to adapt in response to increased sensory stimulation. Experience and exposure to complex sensory stimuli promote the formation of synaptic connections (synaptogenesis) in the brain, thereby supporting the development of neurological fusion in individuals (Irvan, 2017). As a component of occupational therapy, sensory integration therapy aims to harmonize external environmental impact with internal sensory signals to produce appropriate responses (Waiman et al., 2016) This intervention is designed for children with sensory stimulation difficulties, commonly identified as sensory integration disorders (Komariah, 2018). The therapeutic method emphasizes the development of the visual, vestibular, and proprioceptive systems (Waiman et al., 2016).

As a complex activity, writing requires the synthesis and integration of different sensory systems. The tactile, proprioceptive, and vestibular systems allow the feeling of the paper's surface, estimate the force needed to hold a pencil and write, as well as coordinate bilateral body movement (Srivastava, 2016). The three sensory systems are included in the principles of sensory integration therapy applied at the N-Ergy Psychology Center.

A study conducted by Kasdaniel among autistic children showed that sensory integration was effective in improving early writing skills (Kasdanel, 2013). Prasaja and Linda Harumi proved the positive and significant effect of visual integration activity interventions on writing readiness among children with ADHD (Prasaja & Harumi, 2020).

Assjari and Sopariah (2011) have also conducted a similar study by providing sensorimotor training to children with Autistic Spectrum Disorder. The results showed an improvement in writing skills following the intervention.

This study offers a distinct contribution compared to previous investigations by engaging children with special needs as participants and implementing a unique intervention, sensory integration therapy, throughout the treatment period. Assessment was conducted by calculating tracing accuracy, and during each final baseline session, the Beery-Buktenica Developmental Test of Visual-Motor Integration (Beery™ VMI), Fifth Edition, was administered. The test included the Visual Perception and Motor Coordination subtests, alongside handwriting observation, to evaluate progress comprehensively.

Based on the description above, observations, interviews, and previous studies, this investigation focuses on improving writing skills in children with special needs through sensory integration therapy. Therefore, the objective is to examine the effect of sensory integration therapy on enhancing the writing skills of children with special needs.

This study is expected to provide both theoretical and practical benefits. The theoretical benefits include advancing insight and knowledge, particularly in the field of developmental psychology and in the practice of sensory integration therapy to optimize child growth and development. The results may also serve as a reference for future investigations and contribute to the expansion of existing theory. Practical benefits include providing therapists with understanding and insight into the effect of sensory integration therapy on the writing skills of children with special needs, thereby serving as a reference for improving disability services at the N-Ergy Psychology Center. This study is expected to inform the community about the importance of providing appropriate interventions for children with special needs to optimize their skills.

Method

Population and sample

This study was conducted at the N-Ergy Psychology Center, a facility that typically treated children with special needs and is staffed by competent professionals. The availability of established therapeutic programs enabled easy access to suitable subjects for the intervention. A total of three children were selected using purposive sampling. The subjects were children with special needs who were registered for sensory integration therapy at the center and identified as having difficulties related to writing.

The selection process included evaluating the subjects' writing and consulting with a psychologist. The inclusion criteria were children with writing difficulties, subjected to sensory integration therapy, and not experience severe neurological disorders.

Furthermore, the severity of the disorder was considered to ensure that the intervention provided was tailored to each child, making the results more valid and accountable.

Study design

This study adopted an experimental method with a Single Subject Research (SSR) design, using an A-B-A design framework. This design reflected a causal relationship between writing skills and sensory integration therapy as dependent and independent variables, respectively (Astuti et al., 2015)

Study procedure

SSR design includes taking measurements at each session to compare the same subjects under different conditions, namely, baseline and intervention. The baseline condition, marked with the symbol A, represented the subjects' state before receiving sensory integration therapy intervention, during which the target behavior was measured. Meanwhile, the intervention condition, denoted by the symbol B, represented the period when sensory integration therapy treatment was administered and the target behavior was measured.

The baseline-1 phase (A-1) of this study consisted of 3 sessions. The intervention phase (B) included 13 sessions, while the baseline-2 phase (A-2) comprised 3 sessions. The duration of intervention followed the report presented by (Morikawa et al., 2023).

Table 1

A-B-A Design

Baseline-1	Intervention	Baseline-2
	X X X X X X X X X X X X X	
0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0
	Session	

Data collection

This study adopted three measurement methods, and the first was a tracing test (thickening the pattern), conducted during each session. The correct answers of the subjects were counted within a 2-minute timeframe, and quantitative data were obtained by calculating a success score. This instrument was validated by psychologists at the N-Ergy Psychology Center.

The second was the Berry Buktenica Developmental Test of Visual Motor Integration (Berry™ VMI), a standardized test, which was administered at the end of each baseline phase to measure visual-perceptual-motor skills. This test also consisted of two additional subtests, namely visual perception and motor coordination, both of which have established reliability and validity (Roman-Oyola & Rodriguez, 2009):

Table 2

Validity and Reliability of the Beery VMI Fifth Edition

Test Type	α	Validity
Main Test	.84	.45
Visual Perception Subtest	.87	.46
Motor Coordination Subtest	.88	.37

A standardized psychological test was used to measure the changes in outcomes resulting from the intervention. The test was an assessment tool formalized in terms of content, material, and administration procedures, including scoring and interpretation methods; hence, the scores obtained by different subjects could be compared. It was designed for long-term use and had been validated on a large number of subjects, comprising populations from diverse age groups, cultures, and educational levels (Azwar, 2022).

The third method was handwriting observation, which was used to evaluate children's writing skills. This includes systematic observation and recording of individual behaviors to facilitate accurate interpretation (Kusdiyati & Fahmi, 2022). The Minnesota Handwriting Assessment (MHA) served as a primary tool, assessing legibility, placement, spacing, and letter size. Body posture, pencil grip, writing speed, writing pressure, and behavioral responses while copying the text onto the provided assignment sheets were also observed.

Data analysis technique

This study adopted visual analysis as the primary method in SSR. The method allowed for continuous measurement of data, facilitating the monitoring of subject progress throughout the intervention process. Through graphs, each session was evaluated, and behavioral variations were assessed across individuals.

This study adopted within and between condition analyses. Within-condition analysis aimed to assess the stability and variation of behavior in a single phase. Meanwhile, between-condition analysis measured the effectiveness of the intervention. Visual analysis offered the advantage of speed and practicality in summarizing the data obtained. All data were presented graphically, hence changes in subject behavior during each session were clearly observed over time and analyzed based on specific components of the phases studied (Prahmana, 2021).

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Results

The objective of this study is to examine the effect of sensory integration therapy on enhancing the writing skills of children with special needs. The results showed that sensory integration therapy had an impact on the writing skills of children with special needs, as detailed below:

Subject MAB

Subject MAB was a 5-year-and-1-month-old boy diagnosed with sensory impairment. The following graph shows the tracing test scores of the boy.

Figure 1

Subject MAB's Success Score on the Tracing Test

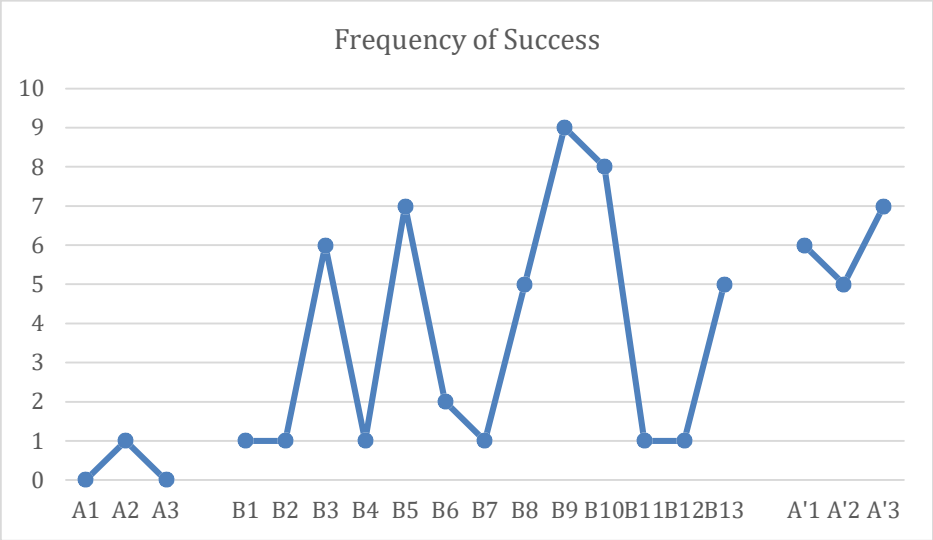


Figure 1 shows that the sensory integration therapy intervention successfully increased the frequency of Subject MAB's success on the tracing test. Although there were fluctuations during the process, the increasing trend was consistent throughout the intervention phase. In Phase A-2, the success scores remained high, signifying that the intervention was effective and sustained even after discontinuation. This is evidenced by the Subject MAB's mean scores of 0.333, 3.692, and 6 in Phase A-1, Phase B, and Phase A-2, respectively. Furthermore, analysis was conducted under the conditions listed in Table 3 to further understand the pattern of changes due to the intervention.

Table 3

Within-Condition Analysis of Subject MAB's Tracing Test Scores

Conditions	A-1	B	A-2
1. Condition length	3	13	3
2. Directional trend	(=)	(+)	(+)
3. Stability trend	Variable (33.33%)	Variable (0%)	Variable (33.33%)
4. Data trace	(=)	(+)	(+)
5. Stability level and range	Variable 0-1	Variable 1-9	Variable 5-7
6. Level change	1-0 (+1)	9-1 (+8)	7-5 (+2)

Table 3 shows that Phase 1 (A-1) was conducted over 3 sessions, with a stable trend in the data. This signified no significant change in tracing performance. Data stability was assessed as quite low at 33.33%, reflecting variability and inconsistency. The trace showed a stable pattern with a change range of +1, suggesting a slight increase during Phase A-1 (baseline-1).

Phase B (intervention) showed a significant change in the data pattern, where the trend reflected an increase. The stability level was very low, with a value of 0%, suggesting that none of the data was within the stable range. The trace showed an upward trend, reflecting an increase, where scores from 1 to 9 signified an improvement due to the intervention.

Phase A-2 (baseline-2) was conducted over 3 sessions, similar to Phase A-1. The data trend showed an increase, but stability was assessed as variable, with a percentage of 33.33%. The data trace reflected a rise of +2 with a score range of 5-7. This suggested that the subject's performance was at a higher level than before the intervention.

Table 4

Between-Condition Analysis of the Subject MAB's Tracing Test Scores

Condition Comparison	B/A	A'/B
1. Number of variables	1	1
1. Directional change and its effect	(=) (+) Positive	(+) (+) Positive
2. Stability change	Variable to variable	Variable to variable
3. Level change	(0-1) +1	(1-6) +5
4. Overlap percentage	(6 : 13) x 100 = 48.15%	(3 : 3) x 100 = 100%

Based on the between-condition analysis in Table 4, there was a positive directional change, from a stable baseline-1 phase to an increase during the intervention phase. This change was considered positive due to an increase in scores from 0 to 1. There was a change between variables within the stability of both phases. The overlap between data A and B was 48.15%, signifying an overlap in conditions A and B. This showed a significant difference in the data resulting from the intervention.

Conditions A-2 (baseline-2) and B (intervention) showed positive directional changes, with a trend toward increasing scores even after the intervention was discontinued.

The change in score from B to A-2 ranged from 1 to 6, signifying a 5-point increase. Data stability was variable, and all A-2 (baseline-2) data overlapped with Phase B (intervention) at 100%. This reflected no further improvement after discontinuation, but the subject remained within the range of scores previously achieved during the intervention.

Improvements in visual-motor integration, visual perception, and motor coordination were discovered through standardized test results. These tests include the Beery VMI test, the Visual Perception subtest, and the Motor Coordination subtest, as described in Table 5.

Table 5

Comparison of Visual-Motor Integration, Visual Perception, and Motor Coordination in Baseline-1 and Baseline-2 Conditions for Subject MAB

Tes	Baseline-1		Baseline-2		Score Change
	Score	Category	Score	Category	
Beery VMI	65	Very low	89	Below average	+24
Visual Perception	83	Below average	99	Average	+16
Motor Coordination	93	Average	114	Above average	+21

The Beery VMI test results in Table 5 showed consistent improvements in visual-motor integration, visual perception, and motor coordination. This improvement in test results was in line with the handwriting observation of Subject MAB.

Through handwriting observation, MAB showed improvement in writing skills. The subject was able to write several letters, such as b, o, r, v, e, a, and y

MAB has only been able to scribble the letters on a worksheet. The subject also wrote while sitting upright in a chair and holding a pencil using the tripod grasp, which includes the thumb, index, and middle fingers. This pattern is the most effective, enabling more stable and efficient control when writing. During the pre-test, MAB refused to sit in a chair and wrote using the pinch grasp, which comprised the index finger and thumb.

Subject AFR

Subject AFR is a 5-year-8-month-old male diagnosed with overactive behavior. The tracing test scores of the subject are shown in Figure 2.

Figure 2

Subject AFR's Success Score in the Tracing Test

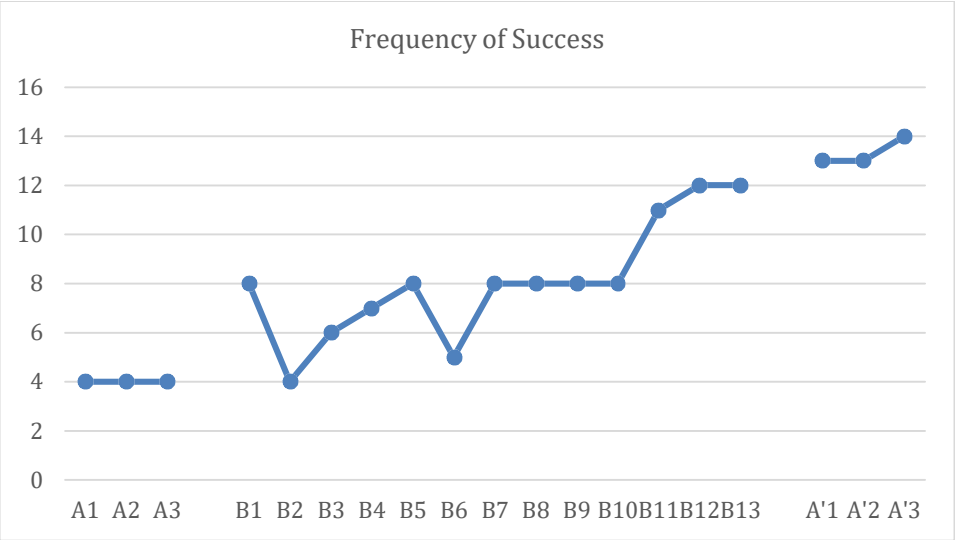


Figure 2 showed a consistent increase in performance from Phases A-1 (baseline-1), B (intervention), and A-2 (baseline-2). Phase A-1 had a stable score of 4, reflecting low initial skills. After the intervention was administered, there was a gradual increase with some fluctuation. Subsequently, subject AFR's scores remained high and continued to increase following discontinuation of the intervention. This is evident in the mean scores of 4, 8.077, and 13.333 in Phase A-1, Phase B, and Phase A-2. The results reflected the effective impact and retention of the intervention toward improving writing skills. Table 6 presents a within-condition analysis to determine the effectiveness of the intervention and the pattern of measurable changes in the writing skills of Subject AFR.

Table 6

Within-Condition Analysis of Subject AFR's Tracing Test Scores

Condition	A-1	B	A-2
1. Condition length	3	13	3
2. Directional trend	(=)	(+)	(+)
3. Stability trend	Stable (100%)	Stable (53.846%)	Stable (100%)
4. Data trace	(=)	(+)	(+)
5. Stability level and range	Stable 4-4	Stable 4-12	Stable 14-13
6. Level change	4-4 (=)	12-8 (+4)	14-13 (+1)

Table 6 shows significant changes in performance across each phase. The performance of Subject AFR stabilized in Phase A-1 at a score of 4, with no change in level. This led to a stability percentage of 100% and no trend in the direction of change. The result showed that the subject experienced no improvement, and writing skills were low before the intervention.

Phase B (intervention) showed significant performance with a positive trend. This reflected a score increase of 4 to 12 and a change in level from 12 to 8, signifying a 4-point increase. The stability achieved was quite good, with a score of 53.846%. Finally, the data showed that the intervention had an impact on the writing skills of Subject AFR.

In Phase A-2 (baseline -2), the performance of Subject AFR continued to improve with a positive trend and scores in the 13-14 range. A stability of 100% showed the level of consistency of the subject after the intervention was discontinued. The change in level from the final intervention phase to baseline-2 increased by 1 point. This result suggests that the effect was sustained for Subject AFR.

Table 7

Between-Condition Analysis of Subject AFR's Tracing Test Scores

Condition Comparison	B/A	A'/B
1. Number of variables	1	1
2. Directional change and its effect	(=) —— (+) Positive	(+) / (+) Positive
3. Stability change	Stable to stable	Stable to stable
4. Level change	(4-8) +4	(8-14) +6
5. Overlap percentage	(1 : 13) x 100 = 7.69%	(0 : 3) x 100 = 0%

The between-condition analysis in Table 7 showed that Phases A-1 (baseline-1) and B (intervention) had a positive directional change in the skills of Subject AFR. The intervention effect was categorized as positive because the score increased from 4 to 8, with consistent data stability. Based on observation, the overlap between data from A-1 and B was 7.69%. Most of the data from the intervention phase did not overlap with the baseline-1 phase. This signified that the intervention had a significant impact on the writing skills of the subject.

Comparison between conditions A-2 (baseline-2) and B (intervention) showed a positive change in the score direction. Scores tended to increase even without intervention, reflecting the continuity of the previous results. The change in score from A-1 and B was 8 to 14, a 6-point increase. Based on observation, data stability was maintained, with no overlapping. This signified that the intervention not only had a positive effect but also persisted even after discontinuation.

Improvements in visual-motor integration, visual perception, and motor coordination were observed, as evidenced by the standardized test results. These include the Beery VMI test, the Visual Perception subtest, and the Motor Coordination subtest. The test results are shown in Table 8.

Table 8

Comparison of Visual-Motor Integration, Visual Perception, and Motor Coordination in Baseline-1 and Baseline-2 Conditions for Subject AFR

Test	Baseline-1		Baseline-2		Score Change
	Score	Category	Score	Category	
Beery VMI	97	Average	120	High	+23
Visual Perception	97	Average	120	High	+23
Motor Coordination	109	Above average	140	Very High	+31

Table 8 showed significant improvements in visual-motor integration, visual perception, and motor coordination. These improved scores signified that Subject AFR experienced development in visual and motor integration skills, as a factor in writing.

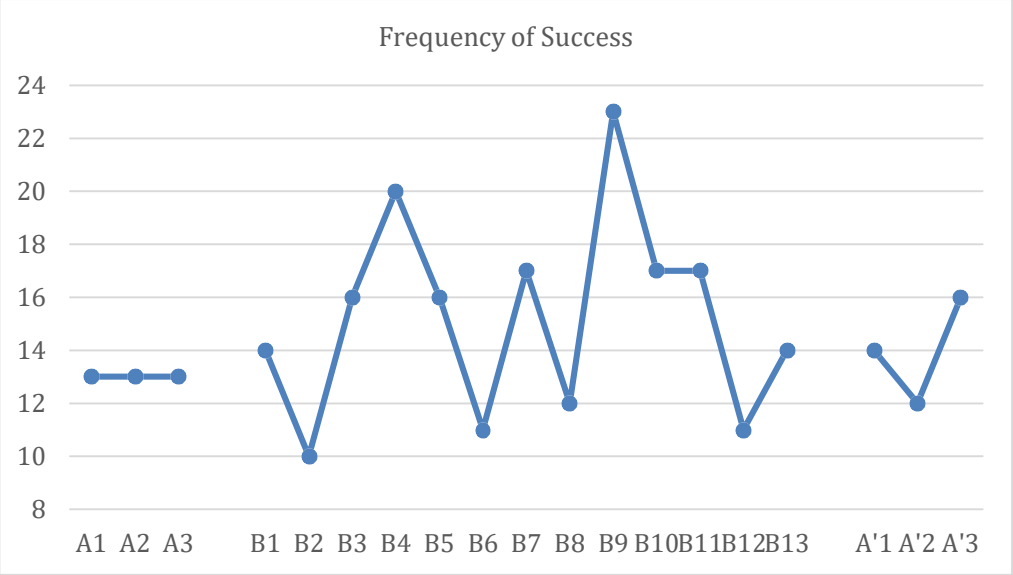
Handwriting observation of Subject AFR presented positive changes, with increased legibility and proper lettering. During the baseline-1 phase, several letters were written unclearly, including f, q, a, and w, resembling r, a, Q, as well as r and n, respectively. Writing speed also improved, with completion time reduced from 8 minutes and 27 seconds in Baseline-1 to 3 minutes in Baseline-2. Positive changes were observed in body posture and pencil grip. Following sensory integration therapy, the subject maintained an upright posture and adopted the tripod grasp, which comprised the thumb, index, and middle fingers, allowing for more stable and flexible finger movement. Previously, writing was performed with the head resting on a table or hand, and the pencil was held using a four-point grasp, including the thumb, index, middle, and ring fingers. This grip pattern resulted in instability, reduced fluency, and hand fatigue.

Subject SANA

Subject SANA was a 7-year-2-month-old girl diagnosed with Attention Deficit Disorder (ADD). The tracing test results of the subject are summarized in Figure 3.

Figure 3

Subject SANA's Success Score on the Tracing Test



Based on Figure 3, the score in Phase A-1 (baseline-1) was consistent and stable at 13, but Phase B (intervention) had significant fluctuation. This suggests that Subject SANA needed time to adjust to the intervention, but there was a general, inconsistent improvement in the tracing test score. Phase A-2 (baseline-2) showed a decrease in score, but still featured improvement compared to A-1 (baseline-1). This is evidenced by the mean scores of 13, 15.231, and 14 for SANA in Phase A-1, Phase B, and Phase A-2. Although there was a decrease after the intervention, the effect was partially maintained.

Table 9

Within-Condition Analysis of Subject SANA's Tracing Test Scores

Condition	A-1	B	A-2
1. Condition length	3	13	3
2. Directional trend	(=)	(+)	(+)
3. Stability trend	Stable (100%)	Variable (30.769%)	Variable (33.333%)
4. Data trace	(=)	(+)	(+)
5. Stability level and range	Stable 13-13	Variable 10-23	Variable 16-12
6. Level change	13-13 (=)	23-10 (+13)	16-12 (+4)

Based on Table 9, Phase A-1 (baseline-1) had a steady trend, with a consistent score of 13 and 100% data stability. The data trace showed no change and remained stable, signifying that Phase A-1 (baseline-1) allowed for a clear comparison with B (intervention).

Phase B (intervention) showed a positive trend, with a general increase in scores compared to A-1 (baseline-1). However, data stability was variable at a percentage of 30.769%, reflecting significant fluctuations. The score range in this phase increased by +13 from the previous, and the data trace showed a positive trend. This signified that the intervention had an impact on improving writing skills, but the results were not consistent across phases.

Phase A-2 (baseline-2) had a positive trend, but the data showed a variable pattern with a stability percentage of 33.333%. The level change occurred by +4 compared to the final session in Phase B (intervention). This signified that the effect of the intervention persisted even after the administration was stopped, as evidenced by the higher score obtained in Phase A-1 (baseline-1). The data trace showed an increase, although not completely stable. This result supports that the intervention had a temporary, lasting impact on the writing skills of Subject SANA.

Table 10

Between-Condition Analysis of Subject SANA's Tracing Test Scores

Condition Comparison	B/A	A'/B
1. Number of variables	1	1
2. Directional change and its effect	(=) —— (+) Positive	(+) / (+) Positive
3. Stability change	Stable to variable	Variable to variable
4. Level change	(13-14) +1	(14-16) +2
5. Overlap percentage	(4 : 13) x 100 = 30.769%	(3 : 3) x 100 = 100%

Table 10 presents a comparison of Phases A-1 (baseline-1) and B (intervention), showing a positive directional change. The success score increased from 13 to 14 with a level change of +1. The data stability shifted from a stable condition in Phase A-1 (baseline-1) to a variable condition in Phase B (intervention). The percentage of 30.769% reflected some overlap, but the difference between Phases A-1 and B was significant enough. This showed the effect of sensory integration therapy intervention on improving writing skills in Subject SANA.

Improvements were observed in visual-motor integration, visual perception, and motor coordination, as evidenced by standardized test results. These included the Beery VMI test, the Visual Perception subtest, and the Motor Coordination subtest. A comparison of test scores before and after the intervention is presented in Table 11.

Table 11

Comparison of Visual-Motor Integration, Visual Perception, and Motor Coordination at Baseline-1 and Baseline-2 for Subject SANA

Test	Baseline-1		Baseline-2		Score Change
	Score	Category	Score	Category	
Beery VMI	90	Average	94	Average	+4
Visual Perception	94	Average	104	Average	+10
Motor Coordination	107	Average	155	Very High	+48

Table 11 shows the positive developments in visual-motor integration, visual perception, and motor coordination that follow sensory integration therapy. The most significant change occurred in Subject SANA's motor coordination, reflecting substantial progress in motor skills.

The results were supported by handwriting observation of Subject SANA. Positive changes were observed, with legible writing, clear shapes, and appropriate size, as shown in the provided example. During baseline-1, several letters were unclear, including q resembling O and z written with an incomplete structure, alongside inconsistent letter sizes. After receiving sensory integration therapy, SANA was seen sitting upright while writing, in contrast to the earlier habit of leaning on one hand. Writing speed also improved, with the subject completing the copying task in 2 minutes during Baseline-2, compared to 2 minutes and 26 seconds in Baseline-1.

Discussion

Writing is an important language skill that every individual should acquire, particularly during school age. As the final stage of language development, writing has the highest level of difficulty. It is a written activity used to express thoughts, ideas, or feelings to others through language skills (Rachmawati et al., 2022).

Producing written work demands fine motor control, visual perception, visual-motor integration, kinesthesia, sensory modalities, and sustained attention (Prasaja & Harumi, 2020). Other contributing factors include maintaining an upright sitting posture, hand-eye coordination, motor planning, as well as maturity and endurance in holding a writing instrument. This complex process not only comprises fine motor skills but also depends on the full readiness of both sensory and motor systems, fine and gross.

Children with special needs have central nervous system disorders that affect mental development and result in lower motor skills than typically developing peers (Raddine & Damayanti, 2023). This is evident in motor activities that require speed of movement and reaction time, thereby requiring more complex motor coordination and competence. Obstacles in motor and cognitive responses are caused by disruptions in sensory processing, which can occur in various ways, affecting both sensory input from the environment and within the body. As a result, understanding environmental stimuli and determining appropriate actions becomes more difficult.

Obstacles in sensory processing can result in inappropriate motor and cognitive responses, including those observed in writing activities. This study used sensory integration therapy, which aims to stimulate sensory systems, focusing on the tactile, vestibular, and proprioceptive systems (Waiman et al., 2016). As a complex activity, writing requires synthesis and integration across sensory systems. The tactile system enables awareness of the paper's surface, the vestibular system supports coordination between both sides of the body, and the proprioceptive system regulates the force needed to hold a pencil and form letters. Furthermore, visual-motor and visual-spatial skills are essential for producing legible writing (Srivastava, 2016). All of these needs will be stimulated in sensory integration therapy.

Sensory integration therapy has been shown to improve fine motor skills, gross

motor skills, visual-motor skills, upper limb coordination, postural skills, vestibular function, language development, as well as handwriting and reading skills (Reynolds & Reynolds, 2010). This study showed improved writing in children with special needs who used the therapy, as analyzed using the SSR design with 3 subjects, MAB, AFR, and SANA. Based on the within and between-condition visual analysis, a positive trend was observed across all subjects after the intervention.

In Subject MAB, there was consistent improvement in tracing skills and other visual-motor components. The graph shows that the intervention significantly increased the frequency of successes, and even after the intervention was discontinued, performance remained at a high level. This data is supported by the Beery VMI test results, which showed improved scores in all aspects (visual-motor integration, visual perception, and motor coordination), as well as positive changes in handwriting observation and body position while writing. The result confirms that sensory integration therapy can improve the readiness and fine motor control required for writing activities. The data of Subject MAB varied due to not having started school, resulting in no exposure to writing tasks or opportunities for practice. This differed from the other two, who had already entered school.

Subject AFR showed a very positive response to the intervention. Tracing scores increased consistently, with minimal overlap between the baseline and intervention phases, reflecting a meaningful effect of the therapy. Even after the intervention was discontinued, writing skills continued to improve. This was supported by the Beery VMI standardized test results, with scores increasing to the high and very high categories, particularly in motor coordination. Observation showed improved writing quality, more stable posture, and the use of a more functional pencil grip. This suggests that the intervention not only had a short-term effect but also developed long-term motor skills. The success of Subject AFR in improving writing skills was influenced by other factors, such as parental guidance, discipline, consistency in exercises provided by teachers at school, as well as motivation and competitive spirit. This motivation enhanced the subject's drive to make positive changes from previous test results.

Subject SANA showed more fluctuating results, specifically during the intervention phase. Although there was a general increase in tracing scores, data stability remained relatively variable. This may be due to the characteristics of the subject diagnosed with ADD, generally characterized by difficulty maintaining attention and self-regulation (Ridwan & Koestieni, 2017). Variation in scores among ADD subjects also occurred in a study conducted by Iffa and Erny. The results were in line with the proposed hypothesis, but not systematically (Hikmawati & Hidayati, 2014). The easily distracted attention of the subject may have been due to therapy

being conducted collaboratively with others. Post-intervention phase (A-2) still showed higher scores than the initial baseline, signifying that the effect of the intervention remained partially maintained. The Beery VMI test results showed improvement, particularly in motor coordination. Handwriting observation also presented improvements in letter shape and clarity, although not as optimal compared to the other 2 subjects.

The results showed that sensory integration therapy is effective in improving writing skills of children with special needs, both in terms of tracing performance, handwriting observation results, and Beery VMI standardized test scores. This improvement can be attributed to the principle of neuroplasticity. The principle stated that children's brains had a high capacity to form new neural connections in response to consistent sensory and motor stimulation (Irvan, 2017). Structured interventions through sensory activities help children integrate information from the environment and body, thereby translating it into functional motor skills such as writing.

Visual analysis in this study showed that patterns of change in each subject can vary significantly depending on individual characteristics, such as diagnosis, age, and emotional stability or attention (Komariah, 2018). Therefore, even when the intervention is the same, the effectiveness may vary depending on the readiness of the nervous system and other factors. These results are in line with the study conducted by Kasdanel (2013), who proved the effectiveness of sensory integration therapy in improving the early writing skills of children with autism.

Conclusions

This study aimed to examine the effect of sensory integration therapy in improving the writing skills of children with special needs at the N-Ergy Psychology Center. In conclusion, sensory integration therapy can improve the writing skills of children with special needs. This was evident from the increase in tracing scores between the initial (baseline-1) and the final tests (baseline-2). Furthermore, the Beery VMI test, Visual Perception subtest, and Motor Coordination subtest showed increases in standard scores and category changes. Handwriting observation presented changes in legibility, placement, spacing between letters and words, writing speed, improved writing pressure, posture, and pencil grip.

Suggestion

Based on the results, sensory integration therapy can be a strategic method for improving the writing skills of children with special needs. Therapy should be implemented individually to minimize external distractions that could affect the focus of children during sessions. Psychological service centers, inclusive schools, and special education institutions can incorporate this therapy into routine intervention programs, specifically in cases of difficulties with fine motor coordination

and writing skills. Therapy activities should be designed to systematically include stimulation of the tactile, vestibular, and proprioceptive systems. Parental engagement plays a key role, especially in supporting home practice to promote lasting and effective outcomes.

Based on the study process and results, the following suggestions are provided to relevant parties. For N-Ergy Psychology Center, each client should receive individualized intervention to minimize external distractions, enabling the sensory integration therapy process to be effectively internalized. This study was conducted using an SSR design, thereby having limited generalizability. Future investigations could use a larger sample size or a group design to enhance generalizability. Furthermore, identical subjects with the same disorder categorization could be adopted to obtain more in-depth data.

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