

The effects of musical sensorimotor integrative therapy on a child with speech delay: Case report

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Sensorimotor integrative therapy (SMITH) is a Czech therapeutic approach used for the rehabilitation of children with developmental and communication problems. Its potential for children for special needs started to be explored by a series of research studies recently. This is the first case report investigating the effect of a musical modification of SMITH on speech production and development of a boy with speech delay. Data from technological measurements (speech production of the child, parent, and their conversation turns) collected by Language ENvironment Analysis (LENA) Digital Language Processor, pre-test and post-test speech therapy examination, self-reported data from parents, and textual analysis of each session's audio recordings has shown considerable progress of the boy in speech, attention, cooperation, and time perception. The results show potential of SMITH for the intervention in children with speech delay and other communication and developmental problems. Considering the limits of this case study, we recommend further investigation of SMITH and other sensory-based approaches in children with speech delay.

Keywords: communication; speech delay; music; sensorimotor integration; case report; DLP LENA.

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Сенсомоторная интегративная терапия (Sensorimotor integrative therapy, SMITh) — это терапевтический подход, используемый для реабилитации детей с проблемами в развитии и общении в Чехии. В ряде недавних научных исследований был изучен ее потенциал в работе с детьми с особыми потребностями. В этой статье описан кейс, в котором впервые исследуется влияние музыкальной модификации СМИТ на общее и речевое развитие ребенка с задержкой речи. Данные, полученные с помощью технологии цифрового языкового процессора LENA (речевая продукция ребенка и его родителей, ход разговора между ними), логопедическое обследование до и после тестирования, информация от родителей, а также текстовый анализ аудиозаписей каждого сеанса терапии показали значительный прогресс в развитии речи, внимания, навыков кооперации, а также восприятия времени у ребенка. Результаты применения СМИТ показали потенциал этого

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подхода к работе с детьми с задержкой речи и другими проблемами в общении и развитии. Учитывая ограничения этого исследования, авторы рекомендуют продолжить исследование СМИТ и других сенсорных методов для развития детей с задержкой речи.

Ключевые слова: коммуникация, задержка речи, музыка, сенсомоторная интеграция, кейс-исследование, DLP LENA

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Introduction

The aim of this case report was to investigate the effect of a musical modification of the sensorimotor integrative therapy (SMITh) on the speech development of a boy with speech delay. Speech and language delay is defined as the child's failure to show the language development expected at the chronological age [16]. The prevalence of isolated speech and language delays (without associated developmental delays, autism spectrum disorder, or intellectual disability) was estimated at 6% among children aged 2–5 years [14; 16] in the United States. In the Czech Republic, these children are often forced to wait until after the 36th month of life to be diagnosed, but the current recommendation in the Czech Republic is to start the intervention earlier [2]. Internationally, various approaches were found to be effective for intervention in children with speech delay [4; 5; 15].

In this paper, the potential of SMITh for intervention in speech delay is explored. SMITh is a Czech neurorehabilitation approach created in clinical practice by phoniatician M. Kučera and speech therapist K. Fritzlova, when working with children with developmental and communication problems. This approach belongs to the category of sensory-based interventions [8], as it is based on and the creation of conditions for the integrated activity of individual sensory subsystems and the integration of motor and sensory perception, where motor determines the quality of sensory perception, and vice versa. The training includes stimulating the cerebellar functions (using balance exercises that shape postural reflexes), the ability to perceive the contours and basic axes of the body, training of time perception, and formation of reflexes that allow one to capture, retain, filter, and integrate external signals. According to the knowledge of the authors, there is no evidence about the effect of sensory-based approaches on speech delays, and the evidence concerning the effect of sensory-based approaches on speech development is rare [7; 10–13]. However, based on the empirical experience from clinical practice, children with speech delay could benefit from sensory-based intervention and the theory of sensorimotor integration may explain the therapeutic mechanisms that enable the therapeutic change in these cases. Therefore, we conducted this pilot case study with the aim to investigate the impact of SMITh intervention on the speech of a boy with speech delay. For this study, we used a musical modification of SMITh described by R. Harvánek [6].

Methods

Research with a single-case study design was realised to answer these research questions:

- What are the effects of musical SMITH on the frequency of speech production of a child with speech delay?
- What are the effects of musical SMITH on the frequency of conversation between parents and child with speech delay?

In addition, we observed the quality of speech, comprehension, cooperation with therapist/parent, concentration, fine and gross motor skills, self-care, and perception of time (understanding parts of the day and the concepts of yesterday, today, and tomorrow).

The participant was selected from the first author's private therapy practice based on meeting inclusion criteria:

- The child has a diagnosis of speech delay without other serious developmental problems, namely autism or disorders of intellectual development.
- Preschool age (2–5 years).
- Parent cooperates well with therapy and does exercises at least three times a week in the home environment.

Based on these criteria, we have selected a boy that will be named Václav here. He lives with his parents in a complete and functional family with no other sibling. Both parents have a very nice relationship with him. Václav started the intervention at age 3 years and 4 months because of the speech delay diagnosed by the speech therapist. He was born premature (one month early) and manifested small delays in his movement development. He started to crawl in the 8th month, sit in 12th month, and then he started walking around the furniture. His first words occurred in the 12th month.

In the pre-test examination, parents reported a slight delay in gross motor functions (changes legs only when climbing upstairs, intermittent support by hands needed) and in self-care activities. He understood the sequence of activities, but he did not understand the concepts of yesterday, today, tomorrow. A speech-therapist's examination reports noticeable attention deficit, impulsivity and hyperactivity, and low level of cooperation. Expressive communication included 15–20 words and occasional two-word sentences. His speech understanding is within norm limits (but the examination was challenged by the low level of cooperation of Václav), he is socially very skilled, and is happy among children.

Intervention

The protocol for musical modification of SMITH included procedures stimulating the tactile sensation of the feet, proprioception with perception of the surface and circumference of the body, perception of the basic vertical axis and other horizontal axes given by paired body parts (inducing postural reflexes) and stimulating connected perception of time and space. In practice, this was done with 11 types of exercises — foot stimulation, body massage with a soft gymnastic ball, outlining the figure of a child, proprioceptive exercises, placing objects on

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the drawn figure, swinging on a balance board with viewing one-point / pointing to one point / playing a drum, maintaining visual attention on a moving object, spatial hearing, and perception of time with a planning calendar. A detailed description of each activity is attached in supplementary materials (Appendix).

Intervention with the child was conducted for three months, four times a week (once during the music therapy session, and three times at home). One session lasted approximately 45 minutes. All the activities had to be taught continuously and in a playful way, in order of protocol. Throughout the research, we were in contact with the mother at least once a week, either in person or by phone in case of illness and tried to motivate them continuously. As support material, the parents were given a precise description of the individual activities of the sensorimotor integration exercises, a diagram of the exercises on the drum balance board and the necessary equipment. The implementation of the exercises throughout the study was supervised by the author of SMITH.

Outcomes and outcome measures

Primary outcomes (frequency of verbal expressions of child and frequency of communication exchanges between child and parent) were collected during the SMITH exercises using the DLP LENA device (Figure 1), which was placed on the child's chest. The application evaluates the recording and assigns individual sounds into four categories: child vocalizations, adult words, conversational turns of phrase, and environmental sounds. For the research, we looked at two categories — communicative utterances and communicative exchanges between child and parent.



Figure 1. Digital Language Processor LENA

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Secondary outcomes were observed using:

- parent interview (once in a week during all the intervention with goals to reflect the course of intervention),
- questionnaire (parents rated on a 0–3 scale the level of gross and fine motor skills, psychomotor restlessness, speech/communication, and perception of time; each item also included an open-ended response option for comments), speech therapist reports from pre-test and post-test phases (comprehension, quality of speech). The questionnaire was filled out before the start of each exercise and then after the end of the exercise,
- parents' diary — written reflection of each exercise (narratively assessing the course of the exercise and the child's willingness to cooperate, shifts in the quality of verbal communication, understanding, attention and improvement in time orientation, and any other significant changes or events),
- textual analysis of audio recordings of the exercises (quality of speech and content of communication exchanges).

The data analysis was conducted through descriptive statistics and through narrative analysis of textual data. The primary outcomes (data collected through LENA DLP) were graphically processed, assessing the child vocalizations, adult words, conversational turns of phrase. The y-axis of the linear line graph (Figure 2) is based on arithmetic averages of words per minute and captures the progression of 34 measurements (x-axis).

Results

Václav's average verbal expression during the training period ranged from an average of two to fifteen vocalizations per minute, with his mother's frequency between two and ten words per minute and conversational turns of one to five per minute. From the first week of recording, Václav's word count increased, and his mother's word count decreased. By the third month of recording, the child's word count began to clearly outnumber the adult's count. Based on the textual analysis of the audio recordings and the interview with the mother, it was evident that the mother gradually became very tired from the exercises. Therefore, her verbal expression intentionally decreased. She gradually gave the child more space for verbal expression; she deliberately reduced her verbal expression. However, this was not reflected in a change in the number of conversational turns.

The speech therapist's examination confirmed a growing active vocabulary, as Václav started to speak in longer sentences (combining up to five words). Still, there is worse intelligibility of speech comparing to norm and suspected verbal dyspraxia. Significant progress was reported also in cooperation and longer attention (for more than 30 minutes) by speech therapists. Václav had no tendency to run away from the chair and works well also without his mother's close presence. According to the parents' post-post-test report, there is better concentration of attention generally during all activities. He improved in time perception and time orientation — understands the terms yesterday, morning, afternoon, evening, tomorrow and recalls what activities have been planned. According to the parents' diary, the most

significant progress in verbal communication occurred after eight weeks of training. Václav's mother noted: "Significant shift in speech with speech therapist, repeated words after her. He said more than fifty words on his own. He is already beginning to tell what he did, what he is going to do. He understands the timeline very well in terms of 'we will go out and have a treat in the afternoon', he remembers the idea himself and then points it out to me that I promised him."

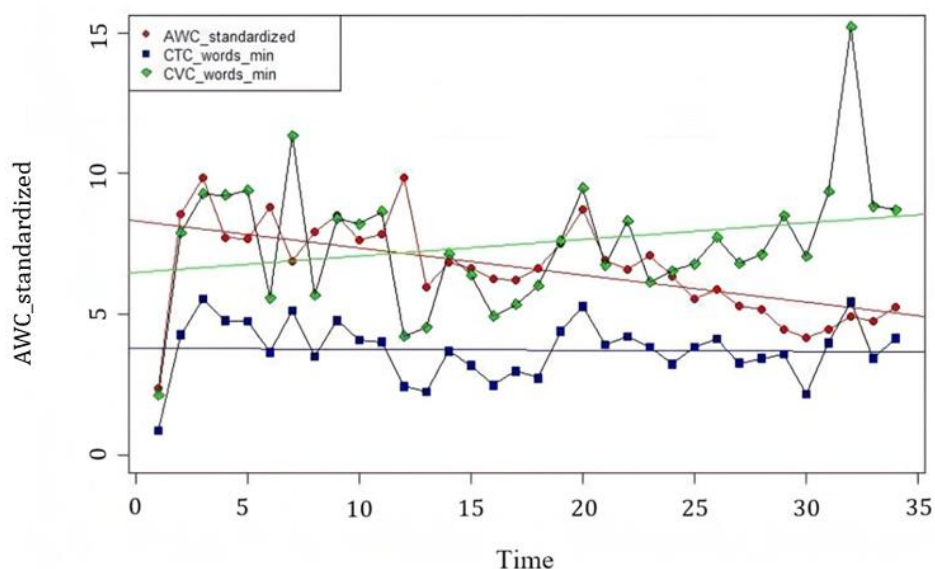


Figure 2. Measurement results of parameters detected by LENA DLP (CVC — child vocalizations, AWG — adult words, CTC — conversational turns of phrase)

Discussion

This first case study exploring the impact of SMITH on the speech of a boy with speech delay found significant improvement of speech production, increase of active vocabulary and creation of longer sentences. The increase of Václav's speech production compensated a decreased mother's activity during the conversational turns. Also, progress in attention, cooperation, and time perception was reported by the mother / speech therapists.

These results are easy to explain by the theory of sensorimotor integration. Slight development delays in different areas in Václav prior to intervention signalled immaturity of sensory processing functions [1; 3] that negatively influenced also motor reactions and development. This case study's findings correspond to empirical findings from clinical practice of the authors of SMITH, however there was less severe pathology in Václav in comparison to most of the current recipients of SMITH intervention.

Considering short time-period that was needed for gaining such progress of the boy, SMITH could be considered as a therapeutic approach for preschool children with speech delay, especially in case of accompanying developmental problems. The findings of this case study are worthy in the context of international research focused on the impact of sensory-based interventions on speech and communication. There are only rare case studies that explored the

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impact of sensory-based interventions on spontaneous speech, percentage of vocalisations and other parameters of speech production, mostly in the population of children with autism spectrum disorder or other developmental disabilities [10; 12; 13]. Furthermore, these studies reported mixed results. We found no studies focused on children with speech delay that could benefit from these interventions as well. Sensory-based interventions are mostly applied by occupational therapists, who usually don't intervene in children with speech delay. Our findings support the idea that speech therapists could be trained in some sensory-based interventions or could cooperate with professionals using these approaches [9]. In the Czech Republic, the intervention could be applied by specially trained music therapists, or special teachers, being one of the innovative approaches in rehabilitation [17].

However, the findings must be considered in context of this case study's limitations. The results could be biased by various factors, e.g., speech therapy intervention that took place during the study, or by spontaneous maturation of the child. Therefore, a trial with a sufficient sample size is needed to prove the effectiveness of SMITH for intervention in speech delays.

Conclusion

This first case study exploring the impact of SMITH on speech delay found positive results in speech production, attention, cooperation, and time perception in a preschool boy with speech delay and slight other developmental problems. There is rationale to consider the usage of this intervention in clinical practice, but future research (optimally a trial with sufficient sample size) is needed to prove the effectiveness of SMITH and its potential for the population of children with speech delay.

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APPENDIX

Description of musical modification of sensorimotor integration therapy

The procedure included 11 activities.

1. Foot stimulation — the feet are an important sensory organ for foot motor skills and perception of terrain and body stability. We created a sensory pathway for the child using massage pads that had different textures, stepping stones of different heights and bells that the child tinkled on using his feet and a balance board. The child traversed the track on his/her own or with the support of a guiding hand. The parent or therapist motivates the child verbally — stomp, stomp, hop or by singing a descriptive song of what the child is doing.

2. Massaging the body with a soft gymnastic balloon — we stimulate the child's perception of his own body. The child lies on his back and then on his stomach. Squeeze a soft gymnastic balloon on the child's body and comment on what part of the body is currently being massaged.

3. Drawing the child's figure — the child lies down on the paper and with a marker we draw his figure, so that the marker touches his body. As we draw, we comment on which part of the body we are currently tracing. In this way, the child gradually becomes aware of the limits of his body.

4. Proprioceptive exercise — the child lies down on his back, and we gradually place on his body axis a pebble, a bell, a rattling egg, a small car. The objects are taken down and placed next to each other. In the next step, the child feels the objects and places them next to each other on the body axis alternately with the right and left hand.

5. Placing objects on the outlined figure — the child lies down on the outlined figure, a pebble, a bell or a small motivational toy is placed on his body. The child feels the object, takes it off, stands up and places the object on the traced figure where the object was on his/her body. The child reinforces his/her body perception.

6. Swinging on the balance board one point view — the child swings side to side on the balance board, stands straight, does not bend, does not fall. The swinging is rhythmic, the rhythm of the swinging can be supported with the rhyme "Hoop, hoop" or a simple rhythmic song. At an angle of 45°, at the child's eye level, we place an object that the child watches while swinging. The object is chosen so that the child is motivated to follow the object. For example, a bell, a squeaky toy, a light toy, a cell phone with a video on. The parent stands behind the child and stimulates the rocking by touching, holding on the child's shoulders.

7. Swinging on the balance board — view with pointing to one point — the child swings rhythmically, slowly on the balance board sideways, standing straight, not bending, not falling. At an angle of 45°, at the child's eye level, we place the object to which the child now points when prompted. The object is chosen so that the child is motivated to point to the object, e.g. a bell, a toy. The parent stands behind the child and stimulates the swinging by touching, holding onto the child's shoulders.

8. Swinging on the balance board with playing the drum — the child swings slowly and rhythmically on the balance board sideways, standing straight, not bending, not falling. The parent stands behind the child, one hand stimulates the swinging at the child's shoulder and

the other hand holds the drum at height of the child's eyes. One distinctive dot is painted on the drum. The child is holding a drumstick and when swung on the call of now or boom, plays the dot on the drum. Swinging the drum has a total of eight variations of alternating where the foot goes down and the hand plays the drum and the placement drum on the right or left (Figure A).

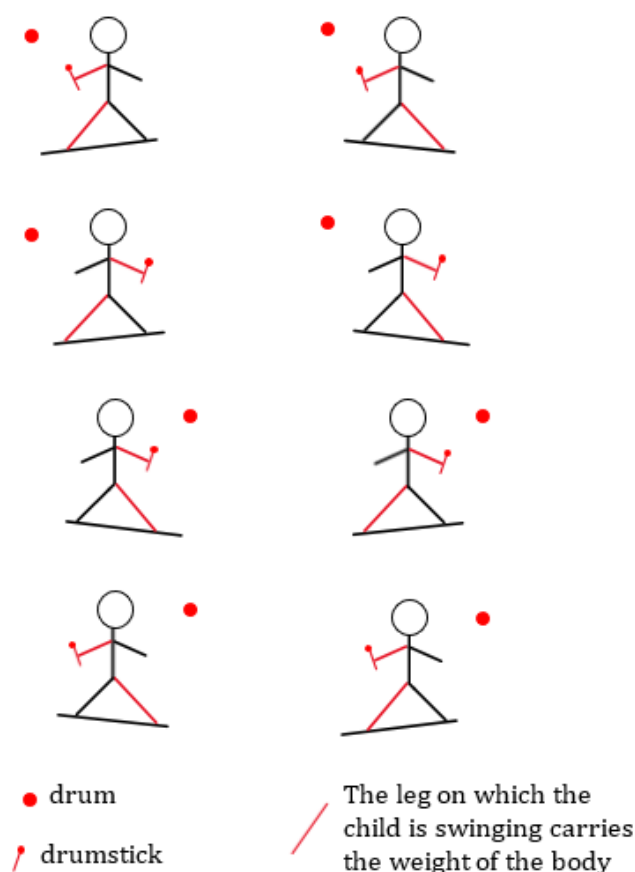


Figure A. Swinging on the balance board with playing the drum – variants

9. Maintaining visual attention — the child sits on a chair, we place a pendulum at eye level or a bell, which is slowly swung from right to left across the body axis. The child follows the object with his eyes, to maintain attention he can point his finger at the object and watch it swing the swinging motion.

10. Spatial hearing — the child sits on a chair and has his eyes closed, the parent plays right, left, front or back, either by ringing a bell or a bright sounding object and the child always points to where the sound is coming from. If he makes a mistake, he opens his eyes and points with his eyes open.

11. Time perception with a planning calendar — each evening the child, with the parent's help, places the activities on the calendar. Preferably three activities in the morning and three activities in the afternoon. After completing the activity, the child, with the parent's help, removes the pictogram and reminds himself what the next activity is planned. For pre-school children we have used a time scheme one day (Figure B).

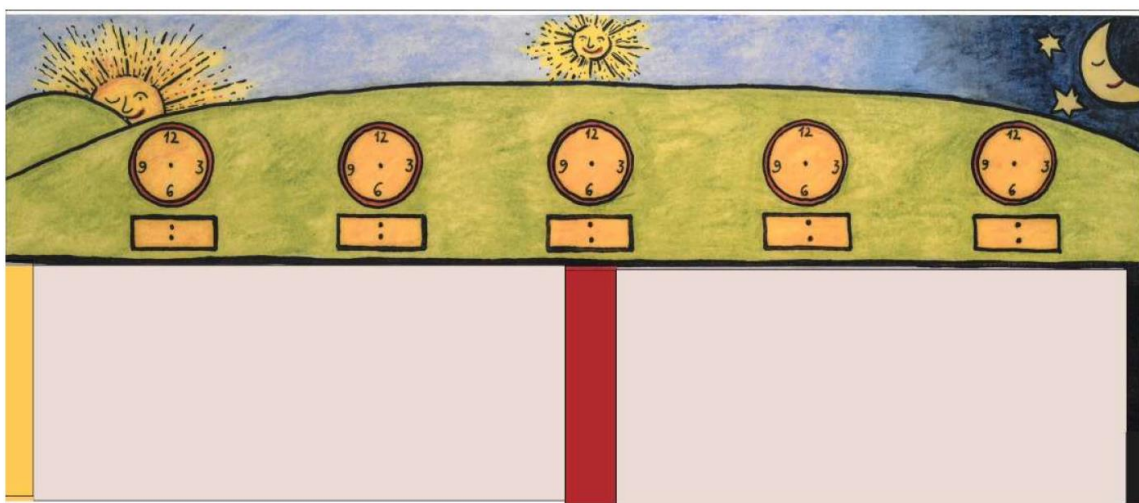


Figure B. A planning calendar

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