Chapter #30

AUDITORY AND LANGUAGE PROCESSING DISORDER: A CASE STUDY

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ABSTRACT
This chapter describes a psychoeducational intervention for supporting language learning. It concerns a child that lost about 80% of hearing functioning at 11 months age, caused by an occlusive otitis. Despite successful surgery, the child didn't learn to talk. Chapter objective consists of presenting the psychoeducational intervention adopted. This was based on inclusive practices aimed to develop language skills and carried out by an interdisciplinary team in collaboration with primary school teachers. The methodology used for describing the intervention consisted of a naturalistic observation that allowed collecting information on changes as result of the intervention. This permitted the analysis of the insights generated through practical experiences, and to find evidence in research on language learning. Also, the results emerged through the observation of this intervention provided useful elements for encouraging the exploration of intervention's potentiality and inspire future trajectories of research.

Keywords: case study, auditory processing disorder, psychoeducational intervention, language learning, inclusive practices.

1. INTRODUCTION

Language has unique characteristics that distinguish it from other forms of communication. It is *creative*, and like vision it is not a simple set of images or sensations, it is the product of a transformative process of physical stimuli operated by brain. We learn to speak understanding the necessary rules for creating meaningful expressions, and not simply repeating memorized phrases. Also, language has a *form*, composed by a limited number of sounds that follow a predictable order. All languages in the world use a limited number of sounds respect to the potentially available range. Sounds are represented by the "phonemes", the smallest part that form language. Finally, language has *content*, distinct in *morphology* (combination of different phonemes to form words), and *grammar* (combination of several words to form sentences). Unlike communication systems based on signs, in which meaning is strictly connected to specific situations, vocal language consists of depicting and communicating abstract ideas. Moreover, it has an *emotional content*, often amplified by different linguistic expressions, such as gestures, voice tone, facial expressions and posture. These elements allow language to be the main tool of social communication and interactions. Through language we can organize our sensory experiences and express thoughts, feelings and expectations (Mayeux, 1991). Based on such premises, this chapter presents the case of a child who became temporarily deaf due to an occlusive otitis that caused the loss of about 80% of hearing functioning. It happened from 11 months to 2nd year of age, an important phase for language development. Initially, the family noted many differences in relationship and behavior if compared to his twin brother. In fact, this child developed closures and stereotypies that compromised his relational and cognitive development. After some surgical

interventions, the follow-up tests (such as immittance testing, auditory evoked potentials, cortical magnetic resonance, etc.) confirmed a normal typical structure. Despite this, at the age of 3 years the child did not speak, had no eye contact, demonstrated mannerisms and motor stereotypes, as well as developed marked hyperacusis, screams and cries. In addition, he usually played alone (as stereotypical behavior), did not respond to verbal stimuli, was attracted by distant noises rather than the nearby ones, and did not produce any words (only stereotyped vowel sounds). At the age of 40 months, the family requested the support of an interdisciplinary team composed of neuropsychiatrist, psychomotor therapist, speech therapist, music therapist, psychologist, and pedagogist. The request focused on motor and sensory rehabilitation as well as support the inclusion in the school environment, because the child was often isolated from the peer group, and not even the teachers knew how to approach him effectively.

1.1. Language Development

Speech recognition requires high performance of auditory system, since sounds are produced by high-frequency vibrations of the vocal cords, which evoke resonant effects in the vocal tract, due to mouth and tongue effects. Such vibrations have frequencies about 10 Hz, that means these are below the audible spectrum. Nevertheless, if such vibrations are correctly modulated the ear can decode them. In fact, the selective tuning of receptors and fibers of the acoustic nerve allow the auditory system to function as a *frequency analyzer*. In this way the formative elements of language, including the peaks of the frequencies that characterize the sounds produced by the different vowels, are represented in the individual nerve fibers, below form of action potentials bursts having characteristic properties (Kelly, 1991). Some pathological processes interfere mostly with one or more of these characteristics. For instance, the form of language can be altered by lesions of central or cortical structures. There are regular and universally widespread stages in language learning. Children start from babbling to single words speech, then two words speech syntactically joined and finally they arrive to complex form of language. Some children advance through these stages more quickly than others, but the age of these stages is the same in every culture. These observations suggest that there is a sort of critical period during the development, in which language is learned effortlessly (both verbal and sign language). Nowadays, there is no evidence linking language learning with maturation of specific brain areas, and only few research focuses on the conceptualization at cognitive level for investigating how human forms linguistic constructs starting from world experience (Shapiro, 2011). Neither research that attest what styles, uses and characteristics of the learned language help to further develop some functions and areas of brain (Kuhl, 2007). Despite the lack of sound evidence-based research, linguists and psychologists believe that the mechanisms related to universal aspects of language are determined by the structure of the human brain. According to this hypothesis, the human brain is prepared to learn and use language like it would follow a predeterminate development program. While the type of spoken language, dialects and inflections depend by social environment. Currently, linguists are debating whether linguistic universals derive from nervous structures specifically related to language learning itself or from more general cognitive universals (Mayeux, 1991). In both cases, an explanation able to justify how the type of language learned (as in the case of the bi- and multilingualism), characteristics (iconic, musical, philosophical, mathematical, etc.), can influence the definition of life path of individuals is still missing.

Negri emphasizes that the “embodiment” perspective rejects the metaphors used by classical cognitive science to represent the mind. In particular, the sandwich and computer models (Negri et al., 2022). The first model views perception, cognition, and action as three

events that occur in linear sequency, as separate processes representing the input and output of the cognitive system (Gallistel, 1980; Hurley, 2001; MacKay, 1987). In the computer model, the mind is considered as a computational system that transforms inputs into abstract a-modal symbols representing the external world as outputs (Pfeifer & Scheier, 2001; Thompson, 2007; Bickle, 2020).

According to several authors (Leitan & Chaffey, 2014), these models have some limitations. For example, the sandwich model (perception-cognition-action) is not dynamic enough to cope with the need of taking immediate actions as required by the complex scenarios of everyday life (Burr, 2017; Hurley, 1998; Cisek, 2007; Cisek & Kalaska, 2010; Levy & Glimcher, 2012; Padoa-Schioppa, 2011). On the other hand, the computer model does not consider the importance of connections between body, sensory process and cognition (Thompson, 2007).

Decades of research attest how much the study of language development and the ability to communicate are extremely complex. Therefore, this chapter intends to provide a sound contribution in investigating the role of a psychoeducational intervention to face the interference of a pathological event in one of the crucial stages of a child language development.

2. BACKGROUND

The child was born in September 2016 and accessed our service in the summer of 2020 after the first year of kindergarten, attended with a support teacher and an assistance operator. In the initial request to our service, family reported the difficulties experienced by child in creating relation with peers due to his strong language delay. At four years of age he still didn't speak, and he had tendencies towards isolation and didn't play with other children, except with his twin brother. He had stereotyped behaviors that didn't fit properly with peer relationships, because of the absence of verbal communication. From the anamnestic interview emerged that the child was born at 36 weeks + 6 days with planned twin births without perinatal consequences. Breastfeeding was artificial with effective suction. Weaning took place without problems around 6 months. They didn't report chewing and/or swallowing difficulties. The child was able to eat with cutlery and chewing occurs in a rotational fashion. Deictic gestures emerged after 2,5 years. While babbling was initially productive, a later regression led to the first diagnostic investigations. The first "words" seemed emerge around the age of 3 years, with a limited lexicon (Italian was the language the child learned). First steps emerged at 13 months. Sphincter control and autonomy was achieved even during the night. He had a quite regular sleep. The child attended school (kindergarten) since the age of eleven months. In November 2018 the child started to be cared by the local Child Neuropsychiatry Service and the first diagnosis was "delay in linguistic and psychomotor development". A diagnostic hospitalization was carried out in January 2019 and analysis conducted through the Auditory Brainstem Response with sedation showed a conductive deafness due to a complete bilateral endo-tympanic catarrhal block. Wave V was found to be replicable on the right up to 40 db nHL and on the left up to 60dB nHL. Later, it was scheduled an adenoidectomy and tonsillar reduction which took place at 2 years and 7 months of age due to an aggravation of the hearing impairment. It was estimated that conductive deafness developed around the age of 10 - 11 months (preverbal period) and that the child remained hearing impaired for about a year and 8 months. It was reported that since this period the child tried to use more the visual channel, consequently worsening the interaction with others. He didn't turn around if called by name and there was fear of loud noises and non-constant reactions to environmental noises. After the adenoidectomy and tonsillar

reduction operation, hearing improved. In December 2019 a diagnosis of neuro-psychomotor developmental delay impacting on communicative and relational aspects was provided. Therefore, the initial diagnosis (based on DSM V) changed in "previous hearing loss between submissive impairment syndrome (H90), impairment of psychological development (F84.1), cognitive development delay of medium degree (F71). The first approach to psychoeducational intervention took place at the beginning of summer 2021. The availability of outdoor space allowed the child to enter and easily explore the park of our structure. He didn't interact with adults and peers, but runed around the perimeter to examinate the new environment. After the first impact with the new context, he noted a jar of flowers and started to play with soil. This activity was carried out with repetitive actions, consisting in selecting soil containing small stones and recovering some magnolia leaves. During this activity that lasted half hour, he experienced heights and different positions from which to let filter the soil, with extreme attention to the produced sound. The support team tried to create a relation through such game, but child didn't respond when called with his name and had no eye contact. During brakes he was sometimes attracted by weak auditory stimuli. He was distracted from playing with soil and looked at something in distance, accommodating the position of the head, almost tuning to a distant sound. Therefore, the team hypothesizes a hypersensitivity auditory compensation for the previous hearing loss, a kind of compensatory hyperacusis since he spent several months with an estimated hearing impairment of 80%. Despite the impairment once the occlusion solved auditory hypersensitivity remained. In literature, hyperacusis and its effects on speech is widely documented. In particular, the difficulties to isolate and distinguish vowel from ambient sounds. As consequence, the child was not able to isolate, imitate, and use sounds to develop language. Grandin describes his own hyperacusis as "have a hearing aid set on maximum volume" (Bogdashina, 2016, p. 77) and compares his ears to a microphone that collects and amplifies sounds. Hyperacusis subjects may be able to hear some frequencies that are normally heard only by animals. Often, these subjects have a light sleeping, they are frightened by sudden and unexpected sound, hate storms and the crowd, are terrified of cutting hair. They often cover their ears when the noise is painful, even if others have no perception of disturbing or alarming sound. Sometimes they produce spontaneously repetitive noises as "bloke-out" annoying sounds (Bogdashina, 2016). The clinical diaries highlighted behaviors and stereotypies that the child performed with frequency are:

- banging the head on the ground or against the wall,
- jumping like a frog,
- drumming and flickering with the hands,
- deviations of the head and eyes,
- verbal stereotypies,
- continuous need for tactile and sound sensory stimulation.

Also, the frustration resistance and ability to wait were very low, while angry manifested with crying, yelling, kicking, as well as throwing chairs and objects around the room. All conditions that limit inclusion with peers and in the school environment.

3. THE PSYCHOEDUCATIONAL INTERVENTION

3.1. Objectives and Design of the Intervention

The objectives of the psychoeducational intervention consisted of creating an inclusive environment for rehabilitation and facilitating the development of communication and expressive skills. Therefore, the intervention was designed for beginning with a music therapist, who proposed eight E.V.P. (electronic voice phenomenon, also called psychophony) sessions for the re-education in sounds' recognition. At the end of sessions, the child correctly imitated single sounds and rhythmic sequences. Also, the music therapist suggested using the Tomatis Auditory Stimulation Method©, which is performed by listening to music (Mozart and Gregorian Chants), mother's voice recording and other voices through an active vocal work, processed and filtered through an electronic device. Once the music therapist's intervention was concluded, different games were planned and implemented at home, to further develop the relationship with his brother and family members and reduce the situations of isolation and stereotypy behaviors. The home intervention lasted two months, once a week. From clinical observations emerged that he interacted with his brother using eye contact, contextual smiles and consistent behavioral responses. In the domestic environment, he looked for games of movement (somersaults, being lifted high), or structured games such as exchanging toy cars, pushing the train. After this intervention, the Picture Exchange Communication System (PECS) was introduced at home and school, to allow the child to express his needs and choices. Concurrently, stereotypies and undesired behaviors significantly reduced, eye contacts increased, and the intentional use of communication appeared through the utilization of pictograms and the deictic gestures.

3.2. Method Applied

The method applied to observe and analyze the intervention was based on the naturalistic observation (Furlong, 2013) and NDM (Naturalistic Decision Making) framework. Naturalistic Observation allowed to collect information on changes as result of the intervention (Furlong, 2010; Morgan et al., 2017). The adoption of this methodology permitted to analyze the insights generated through practical experiences and find evidence in study and research on the topic of language learning. MDTs framework (including recognition of decisions, coping with uncertainty, team decision making, as well as decision errors) helped to identify important areas of intervention previously not considered (Bartolo et al., 2001). Also, an action-research approach was used for defining a functioning profile for understanding child's Auditory Processing Disorder (APD), and how the brain processes auditory information. Through the application of the psychoeducational intervention a diagnosis of APD was defined – a neurodevelopmental disorder involving the processing of auditory information by the brain that occurs even if individuals with APD don't have impairments at outer, middle, and inner level of ear structure and function. The method used for the observation showed how sensory processing disorders lead to stereotypes and behavioral dysfunction that can benefit from an inclusive approach aimed to improve communication and social skills, as well as provide sensory rehabilitation.

3.3. Results

The elements gathered through the analysis of this intervention and the evidence emerged through the literature review on this theme, led to define the strengths of the psychoeducational approach when applied to address difficulties due to language learning. The data available through the anamnesis and naturalistic observation allowed to formulate

two hypotheses: language and neurodevelopmental delay (difficult in communication) could depend by previous pathology, occurred in critical stages of language development. Another hypothesis was that "something" (congenital) reduced ability to develop language capability. After confrontations, the team initially agreed with a hypothesis of Central Auditory Processing Disorder. A neurodevelopmental disorder involving the brain auditory information processing, in the absence (o after resolution) of the outer, middle, or inner ear pathologies. Following the definition of the American Academy of Audiology (2010) *"Auditory processing disorder, rarely known as King-Kopetzky syndrome or auditory disability with normal hearing, is a neurodevelopmental disorder affecting the way the brain processes auditory information". Individuals with APD usually have normal structure and function of the outer, middle, and inner ear. However, they cannot process the information they hear in the same way as others, which leads to difficulties in recognizing and interpreting sounds, especially sounds composing speech. It is thought that these difficulties arise from dysfunction in the central nervous system. It is highly prevalent in individuals with other neurodevelopmental disorders, such as attention deficit hyperactivity disorder (ADHD), autism spectrum disorders (ASD), Dyslexia, and Sensory Processing Disorder*. Also, comorbidity with others unknown neurodevelopment disorders was possible. After some naturalistic observations, the support team decided to adopt auditory discrimination strategies to discover and focus on other symptoms, as well as how to approach the child.

For these reasons, with supervision of a music therapist specialized in Tomatis Method© eight sessions of E.V.P. and re-education in sounds recognition were planned. The room where sessions were carried out was isolated, but not soundproofed, and family members were present beyond the door for increasing child's sense of safety. The activity was conducted on a carpet, and it lasted one month with two sessions per week. In Table 1 are reported the description of the 8 sessions and the results obtained for each session.

Table 1.
Description of activities proposed, and results achieved.

Session	Activity proposed	Results achieved
1st	Electronic piano: proposal of sounds (initially the A at 440Hz) and tones within the same octave. Therapist plays and sings.	Interruption of stereotypies in response to the sound stimulus. Attention maintained up to 5 minutes. Exploration of instruments and keyboard. No vocalization produced.
2nd	With electronic piano: proposal of pure sounds (initially the A at 440Hz) and tones within the same octave. Therapist sings the sound with his voice and invite to imitate.	Initial game activity with episodic attention maintained for at least 10 minutes. He started to explore other instruments (e.g., Orff and boom whackers) and produced selective attentional response to therapist's voice.
3rd	With boom whackers and maracas, rhythmic movement, and sound experience.	At the end of session, the child started to imitate therapist's movement, and a "sound dialogue" begun.
4th	Electronic piano: pure tones and major fourth and fifth chords, with therapist's voice imitation.	First vocalizations produced on a fifth chord with a basic tone, with correct repetition of intonation and rhythm.

5th	Electronic piano: pure tones and major fourth and fifth chords, with therapist's voice imitation.	The child rejected the piano, while using boom whackers and maracas he come up with a beat. No vocalization produced, and attention was maintained for about 25 minutes.
6th	Choice of instruments: piano, boom whackers and Orff instruments Use of different kind of sounds.	The therapist singed a song the child listened in previous session. Repeated for several times, attention was maintained. The therapist invited a colleague to sing the same song with different vocal timbre, and the child has maintained attention to both voices.
7th	Repetition of song singed during previous session with a colleague and using guitar. Electronic piano: major fourth and fifth harmonics.	The child listened with interest both the alternation and overlapping of two vocal timbres. Produced intentional vocalizations imitating sounds of fourth and/or fifth vocally, producing two vocal sounds in sequence.
8th	Children's song, use of guitar and electronic piano.	The child maintained his attention for almost the entire session (45 min). While singing, he emitted impromptu vocalizations and correctly imitates two sounds in sequence.

Once the music therapy intervention was concluded, game activities at home were implemented to further develop the relationship with sibling and family member, and to limit his isolation and stereotypies. The intervention at home took place once a week for two months. The relationship with twin brother and peers improved. Then he improved the interaction and physical games with his brother. The child demonstrated to acquire the capability to manage functional relationship (eye contact, coherent interaction), even if for a limited duration, and only with people who interacted with him in a non-invasive way. In this case, he accepted to leave solitary game for starting with a relationship in a reciprocal dimension, with eye contact, smiles and active participation for 20-30 minutes. After three months of intervention, the child learned to express a form of intentional communication. Consequently, he started to perceive difficulties in communicating. This caused anger crisis with various behavioral problems that were interpreted as a manner to show his needs. Therefore, the team decided to introduce the use of the Alternative Augmentative Communication (AAC) as additional speech therapy for promoting reciprocity in the communication with peers and adults, as well as acquisition of complex communication structures. Through AAC the child started using basic symbols. The first symbol represented the meaning "again". This symbol allowed the child to express and generalize his own preference (for example about games, activities, and food). The second symbol learnt was "enough", used to express the willingness to end an activity or action. Other symbols used represented bathroom, ball, bubbles, crackers, biscuits, water. Initially the child had some difficulties in indicating the symbols chosen. This difficulty was reduced when the team suggested to limit the choice of symbols using a binary choice (two pictograms) and provide physical gestures for helping his choice. Following the intervention, the child learnt to

express different words with a well-defined vocalization as “water”, “mom”, “dad”. Also, vocalizations started to be composed of sounds he imitated when expressed by adults. In addition, he started to use deictic gestures for making requests (e.g., open hand), and sporadically expressed the “hello”. Concerning the interactions with others, he started to accept the relationship with peers, teachers, and parents, including his twin brother. Moreover, he started to accept teacher’s proposals of different activities, such as coloring within borders, decoding, and coupling of images, manipulation activities with objects (e.g., Lego). Finally, he started to move in a functional way, respecting the spaces of others and accepting the presence of peers (e.g., on the same worktable), sharing materials and exploring autonomously the school building, identifying places through Picture Exchange Communication System (PECS) as classroom, gym, and bathroom.

4. FUTURE RESEARCH DIRECTIONS

Future research could explore the effects of the intervention in other countries (this intervention was developed in Italy), since the topography of language skills for mastering communication can vary across cultures and locations. Therefore, it could be useful to further study the features of the psychoeducational approach that allowed the child to build the abilities for intentional communication with peers and adults. In particular, the combined effects of Tomatis Method© (Gilmor, 1989; Kurkowsky, 2013) and speech therapy, that need to be further observed and investigated because there is a paucity of qualitative studies on this issue (Kuhl, 2007).

5. CONCLUSION

After three months of intervention, the child started to express a form of intentional communication and consequently perceived his difficulties in communicating. This caused anger crisis with behavior problems. These behaviors were interpreted as a manner to show his needs. Therefore, the team decided to introduce as speech therapy the use of the Alternative Augmentative Communication (AAC), for promoting reciprocity in the communication with peers and adults, as well as complex communication structures. Through AAC the child started using basic symbols. The first symbol represented the meaning “again”. This symbol allowed the child to express and generalize his own preference (for example about games, activities and foods). The second symbol learnt was “enough”, used to express the willingness to end an activity or action. Other symbols used represented bathroom, ball, bubbles, crackers, biscuits, water. Initially the child had some difficulties in indicating the symbols chosen. This difficulty was reduced when the team suggested limiting the choice of symbols to two pictograms (binary choice) and providing physical gestures for helping his choice. The strengths of evidence of the intervention consisted of allowing child to learn how to express different words with a specific vocalization such as “water”, “mom”, “dad”. Also, vocalizations started to be composed of sounds he imitated when expressed by adults, to use deictic gestures for making requests (e.g., open hand), and sporadically expressing the “hello”. Another strength concerned the interactions with others, as he started to accept the relationship with peers, teachers, parents, family members including his twin brother. And to accept teacher's proposals of different activities, such as coloring within borders, decoding and coupling of images, manipulation activities with objects (e.g., Lego). Moreover, he started to move in a functional way, respecting the spaces of others and accepting the presence of peers (e.g., on the same worktable), sharing materials and exploring autonomously the school building, identifying places through PECS as classroom, gym,

bathroom. Other important strengths of the intervention for improving communication abilities had consisted of using specific methods such as music-therapy, psychomotor games and augmentative alternative communication, demonstrating also their effectiveness (Lorah, Holyfield, Miller, Griffen, & Lindbloom, 2022). Lastly, the adoption of the psychoeducational approach allowed the interdisciplinary team to focus on the functioning profile rather than the diagnosis. The profile was elaborated using the International Classification of Functioning (ICF) model. This provided the opportunity to highlight needs, define educational objectives, involve different persons (such as peers, teachers and family members) as well to analyze the context in terms of barriers and facilitators. The profile was used also to settle a personalized learning environment, both at home and at school. When the child started to attend primary school a new education program was designed, including new education objectives and competences to be acquired, in order to improve his communication abilities. The activities proposed consisted of E.V.P. using the Tomatis Method©, speech therapy and AAC (Tatum, Oelfke, & McCauley, 2004; Corbett, Shickman, & Ferrer, 2008; Brbić & Tomić, 2020). These activities allowed the identification of new communication needs and stereotypes to be addressed. Also, the first attempts to use language allowed the development of relationships with teachers and peers.

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