Chapter Five

DEVELOPING LANGUAGE

In 1970 a chilling case of child abuse was reported in Los Angeles. A partially blind woman had walked into a county welfare office seeking public assistance. She brought with her a small child who could not stand erect and who only whimpered. The social worker discovered that the child was 13 and that her father had kept her locked in a room and tied to a potty-chair. The girl, who was known only as Genie, had spent over 11 years in that room, deprived of toys, social contact, and communication with other human beings. Genie, who was mute, was about to become an important figure in the field of developmental linguistics.

At the time Genie was found, linguists had been debating the idea that language was an innate, inborn skill unique to humans. One linguist, Noam Chomsky, proposed that children were born with an innate set of grammatical rules for learning language (e.g. a "universal grammar") and that their experiences with language then triggered its emergence.[1] A neuropsychologist named Eric Lenneberg disagreed, arguing that the only the capacity to learn language was inborn and that this capacity could not be realized without social and linguistic experiences. Both of these scientists believed that the ability to learn language was

1.To read more about these ideas, see Noam Chomsky's lecture, *Linguistic Contributions to the Study of Mind (Future)*, published in *Language and Mind* by Harcourt Brace Jovanovich (1968) or available online at: www.marxists.org/reference/subject/philosophy/works/us/chomsky.htm. See also Lenneberg, E.H. (1969). "On explaining language," *Science*,164 (880): 635-643.

constrained by time (the “critical period” hypothesis) and that children could not acquire language after adolescence. Genie’s discovery provided a unique opportunity to put this idea to the test.

In a strange twist of fate, a movie by the French director Francois Truffaut premiered in the United States one week after Genie was found. The movie, *The Wild Child (L'Enfant Sauvage)*, was the true story of a young boy who had been captured in a forest in Aveyron, France, in 1799. The boy, known only as Victor, was believed to be about 11 years old and had apparently lived alone in the forest for many years.

At the time Victor was found he behaved more like a wild animal than a little boy. He walked on all fours, spoke in grunts or squeals, and responded only to sounds that he associated with food or danger. Victor’s captors gave him to a woman in the town to raise, but Victor escaped and returned to the forest. Victor was eventually recaptured and sent to Paris where Dr. Phillipe Pinel, the head of the Paris insane asylum, diagnosed him as an incurable idiot.

A young medical student at the National Institute for the Deaf in Paris, Jean-Marc Itard, disagreed with this assessment and convinced the authorities to assign him the task of rehabilitating Victor.[2] Itard, who would later earn him a reputation as a founding father of special education for his work with Victor, brought Victor to live in his own home with him and his housekeeper, Madame Guerin. Although Victor still ran away at times from Itard’s home, he developed a close bond with Madame Guerin.

Victor had many characteristics that today would be considered autistic. He avoided social contact and eye gaze,

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2.For a translated version of these diaries, see Itard, J.M., *Wild Boy of Aveyron*, translated by George and Muriel Humphrey, New York: Appleton-Century-Crofts (Original work published 1894, (1962).

could not speak, his mood swings were abrupt and extreme, and he would rock back and forth in front of the window. Victor showed no interest in toys or other objects and he often ignored sounds. He had an aversion to clothing and was apparently insensitive to cold or pain.

Itard began by establishing five goals: interest Victor in social life by rendering it more pleasant than his previous existence, awaken Victor's senses through energetic stimulation and intense emotion, extend the range of Victor's ideas by giving him new needs and social experiences, teach Victor to speak through the exercise of imitation and out of necessity, and teach him to read in order that he may pursue education. Itard decided that the way to accomplish these goals was to create routines for Victor to follow and to train him to discriminate between strong sensations.

Itard also spent hours each day trying to teach Victor to speak by imitating sounds and words, beginning with items that had the most extreme contrasts and gradually progressing to items that were similar in nature. Eventually he decided that Victor would never learn to speak and resolved to teach him to read instead in the manner of instruction used to teach deaf mutes. Through these experiences he was about to discover the core principle underlying language development, although Itard would be unaware of it at the time.

Itard began by training Victor to look at a list of words and match them to the objects that they represented. Then he expanded this exercise by requiring him to look at the list, go to his own room and retrieve the objects listed, and then return with them to Itard's study. When Victor had learned to do this quite reliably, Itard suddenly changed the rules of the game.

Before presenting Victor with a list of objects to retrieve, Itard placed the objects on the list around the study in plain sight and locked the door. When Victor was presented with the list, he attempted go to his bedroom to retrieve the objects. He was confused by the locked door, but Itard refused to open it and encouraged him to look around the room for what he needed.

Victor searched the room, looking repeatedly at objects that matched the words on his list, but he touched none of them. In order to help Victor find the objects, Itard gathered them together on his desk and asked Victor to search his desk for the objects he needed.

Victor looked hard at the objects placed there but did not touch them. With increased annoyance, Itard cut the words on the list apart and placed each word on top of the object that it represented. This only confused Victor further, and the young boy began to cry in frustration. Devastated by his young pupil's failure, Itard stopped to consider the problem.

Itard thought about what had happened when he handed Victor the word, "book." Victor had looked uncertainly at the books on his desk for a moment and held his hand uncertainly over them as he searched his teacher's face for signs of approval. When he saw no look of encouragement there, Victor had withdrawn his hand and began once more to search the room.

In a sudden flash of insight, Itard realized the problem. He ran to a cupboard and brought out a book identical to the one in Victor's room. He brought this and several other books back to the desk and handed Victor the word, "book." Victor looked at the pile of objects on the desk, snatched up the familiar book and handed it to his teacher.

After considering this strange event, Itard decided that his methods for teaching Victor had previously been flawed. He wrote, "In a word, it was a question of teaching him to consider things no longer with reference to their differences, but according to their similarities."[3]

Without knowing it, Itard had discovered the principle of contexts. When the brain links sensory experiences, the entire context in which the experience was encountered is included. Only by encountering things in a variety of contexts can the brain differentiate the meaning of an event. If it only encounters something in one particular context, the brain will assume that the meaning is dependent upon that particular context. This is called an *error of exclusion,* because the brain fails to exclude irrelevant information when it attaches meaning to a word.

In order for the brain to attach the proper meaning to a word, it must be able to determine the features to which the word refers. In the case of the word, "book," the features "printed words and/or pictures" and "pages bound together" make something a book. Since Victor had been trained only with a particular book, he also included the irrelevant features, "in my bedroom" and "a rectangular object that looks like this one" into the meaning of the word, "book."

Victor could not transfer the meaning of "book" to a new context because he learned the word in a very rote, redundant manner. If he had also had opportunities to compare different kinds of books in different situations, he would have been able to discover the features that they had in common. When Itard understood this principle (although he believed it only applied to Victor), Victor was able to understand the meaning of a word rather than simply reproduce a series of actions related to a printed symbol.

Victor eventually learned to read and write in this manner, although he did not learn to speak. Itard wrote in his report,[4]

"Those who did not see him there (e.g. in Paris when Victor first arrived there) and might see him now would find in him

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3.Itard, from a translated work of his *Rapports et Memoires sur le Suavage de L'Aveyron, Paris,* 1894 reprint, translated by George and Muriel Humphrey, 1932 and 1962, p. 76-77.

4.Itard, in the English translation of his reports, *L'Enfant Sauvage,* translation by G. and M Humphrey, 1962 reprinted edition, p. 49.

an almost ordinary child who can not speak. They would not be able to appreciate the distance that separates this almost ordinary child from the savage of Aveyron."

In spite of this success, Itard decided after five years of work that while Victor could continue to learn, his education required too much effort. He wrote in his final report,[5]

"...I resigned myself to the necessity of giving up any attempt to produce speech, and abandoned my pupil to incurable dumbness."

Itard sent Victor to live out his days with Madame Guerin, who had been companion and mother to him since his arrival. Victor died in 1828, at around forty years of age.

The story of Victor excited Genie's team of therapists. If such progress could be achieved with the wild child, how much more could they accomplish with Genie? The hospital sponsored a conference to view Truffaut's movie, *L'Enfant Sauvage*, and discuss how Genie's team could improve on Itard's methods.

One suggestion proposed at this conference was to add sign language to Genie's training. Itard had avoided the use of signs because he believed that oral language was the only true form of language. The technique appeared to work. Within six months Genie had acquired a vocabulary of over a hundred words and within a year her language was at the level of an 18 month old child.

In time Genie developed the ability to combine three or more words together into a sentence, but she often put the words in the wrong order and omitted conjunctions and articles. She also had difficulty using pronouns and verb tenses. Genie's speech was quite similar to that produced by adults who have

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5.Itard, in the English translation of his reports, *L'Enfant Sauvage*, translation by G. and M Humphrey, 1962 reprinted edition, p. 86.

suffered damage to the language centers in the left hemisphere of the brain. This pattern of speech, which is called aphasia, can resolve if the brain either repairs the damaged networks or transfers language functions to undamaged networks in other areas.

Of course, the process or repairing or rewiring language centers takes a great deal of time and intervention. Researchers have reported that children who have the entire left hemisphere of their brain surgically removed to control seizures often take 10-12 years to recover the full grammatical use of language, and receptive (understood) language skills will develop before expressive (spoken) language emerges.[6]

Unfortunately, Genie's slow progress did not impress the agency that was funding her therapy. Her team eventually lost their grant and Genie was returned to her mother. Ironically, the progress that Genie had made during her stay at the hospital also failed to impress her own mother. When Genie was returned to her she sued the hospital for exploiting Genie's case. Still, Genie's case demonstrated that it was possible for a child to learn a first language late in childhood, but it would take a great deal of time and effort for language to develop.

Disrupting Language in the Critical Period

Even as it lies suspended in the dark embrace of amniotic fluid, the fetal brain is surrounded by the sounds within and outside the womb and begins to wire itself for language. By

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6.See Hertz-Pannier et al (2002), Ruben (1997) or Curtiss, de Bode, and Mathern (2001).The latter authors provide a chart of individual results for comparing type of neuropathy, age at surgery, years post-op, and level of language recovery. Developmental pathologies related to abnormal brain development due to a genetic error had poorer outcomes than pathologies related to acquired injuries or abnormalities.

the time of birth the infant brain will not only be able to distinguish between all of the sounds produced by every language of the world, it will be able to recognize which of these sounds are part of its native tongue.[7]

During the first year of life the infant brain begins the process of neural housekeeping, eliminating circuits and cells that will not be needed and strengthening and elaborating those that will become the foundation of later language skills. Cells that respond to sounds that are never heard will be targeted for disposal while those that receive consistent stimulation will grow and extend vast connections.[8] The process is both elegant and dangerous. If the brain is exposed to a sufficient amount of language, and if nothing disturbs the passage of language sounds from the ear to the brain, then language networks will form and grow. However, if something disrupts the transmission of language sounds between the environment and the brain, language networks will not form properly.[9] Mice who are exposed to nicotine during the second week of life, at a time when auditory networks are forming, develop abnormal circuits in this area of the brain.[10]

The most common reason that language sounds are distorted before they reach the brain is mild or fluctuating hearing. This

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7. Native languages are those to which the fetus and infant have been exposed. For more information about developmental changes in the perception of non-native sounds, see Polka and Werker (1994). Lecanuet, Granier-Deferre, and Busnel (1988); Lecanuet and Schall, (1996); Shahidullah and Hepper (1994).

8. See Eimas 1985; Joseph, 1999; Kandel, Schwartz and Jessell, 1991; Sininger, Doyle, and Moore (1999).To learn more about how the brain rewires auditory areas after a period of deafness, see Ponton et al (1996).

9. Whaley and Wong (1991), p. 1092-1097. Xia et al (1998) found that 50% of the cases of early, profound deafness are caused by genetic factors. Sha and Schacht (1999) implicate the broad-spectrum antibiotic gentamicin in middle ear damage and deafness. Bergstrom (1980) reported that as many as 30% of children who suffered one acute episode of otitis media with effusion in infancy suffered hearing loss for up to two years afterwards. See also Oller, Eilers, Neal and Schwartz (1999).

10. Hsieh, Leslie, and Metherate(2002).

type of hearing impairment can be caused by blocked Eustachian tubes, tumors on the auditory nerve, abnormal anatomy of the inner ear, viral or bacterial infections, and certain types of toxins. Perhaps the most common of these is Eustachian tube blockage.

The Eustachian tubes in the inner ear act to equalize the pressure in the middle ear so that sound waves can travel unimpeded from the ear drum (tympanic membrane) to the cochlea (from which the auditory nerve extends). If the Eustachian tubes are compressed by tumors or large adenoids or blocked by fluid (effusion) or nasal secretions, some of the sound wave is sheared away. The high frequencies, which carry many consonants, are particularly vulnerable to this effect.

Eustachian tube blockage from nasal secretions or effusion is particularly common among children who are allergic or who have immune disorders and children who are bottle fed or who use pacifiers, or who are chronically exposed to cigarette smoke.[11] Eustachian tube blockage from effusion (fluid) is often the result of a viral or bacterial infection in the middle ear (otitis media).

Otitis media is a concern in young children for two reasons. Many of the viral agents that cause ear infections can damage the hair cells in the cochlea or vestibular canals. Ear infections can also produce effusion or fluid in the area behind the ear drum, which interferes with ability of the ear drum to vibrate when it is struck by a sound wave.

Effusion and nasal secretions are a greater problem for infants and toddlers because the Eustachian tubes are not yet fully rotated downward until around the third birthday and

11.See Jackson and Mourino (1999); Niemela, Pihakari, Pokka, and Uhari (2000); Schonweiler, Ptok, and Radu (1998); Sininger, Doyle, and Moore (1999); Uhari, Mantyssari, and Niemela (1996); Whaley and Wong (1991) pp. 1432-1433. Also see Derebery (2000) on the allergic management of Meniere’s disease.

therefore do not drain as easily. The effects of effusion on hearing are surprisingly long lasting. Researchers have found that effusion may not resolve for weeks after an ear infection; in some cases children have been noted to experience hearing problems up to two years after an episode of otitis.[12]

Ear infections (otitis media) and blocked Eustachian tubes can have a wide range of effects (including none at all) on a child's language development, depending upon the timing and duration of the infection or blockage. Even one infection, if it is experienced at the peak of the critical period, can have devastating effects on development. Chronic (repeated) episodes of otitis have been liked to lower IQ scores, developmental and language delays and a variety of learning disabilities.[13]

The effects of otitis media on language development can hardly be exaggerated. One group of researchers found that *every* child they studied who experienced chronic episodes of otitis before their first birthday exhibited an expressive language delay at age two.[14] Children who experience repeated episodes of otitis media have also been found to be at risk for developing permanent sensorineural hearing loss.[15]Finally, chronic episodes of otitis media can alter the expression of certain genes.[16]

Chronic otitis is often treated by surgically inserting tympanotomy tubes in the ear drum (tympanic membrane) to keep

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12.See Shriberg, Friel-Patti, Flipsen Jr. and Brown (2000) and Bergstrom (1980).

13. See Friel-Patti, Finitzo-Hicher, Conti and Brown (1982); Gibbs and Cooper (1989); Gravel and Wallace (1992); Katz (1978); Roberts (1997); Konstantareas and Homatidis (1987); Rvachew, Slawinski, Williams, and Green (1999); Smith, Miller, Stewart, Walter, and McConnell (1988); Teele, Klein, Chase, Menyuk, and Rosner (1990); Vartiainen and Karjalainen (1997)

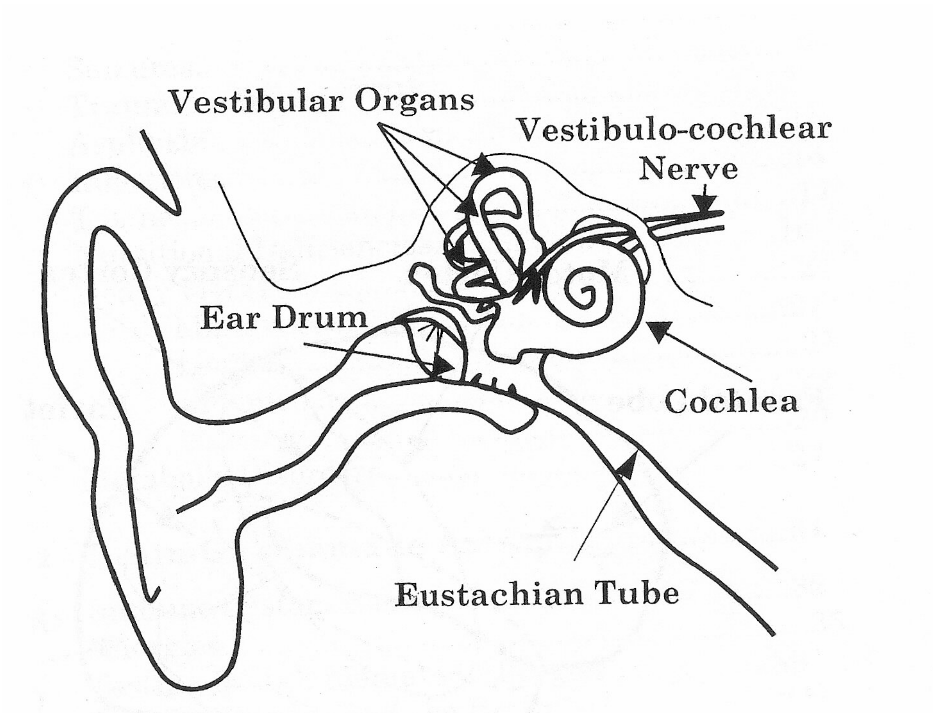
14. Abraham, Wallace, and Gravel (1996).

15. Mutlu, Odabasi, Metin, Basak, and Erpek (1998).

16.Gravel and Wallace (1992).

fluid from accumulating in the middle ear. Unfortunately, this approach does not always ensure that language or hearing will be preserved. Researchers have found that some children develop hearing loss in the high frequencies even after tympanotomy tubes have been inserted.[17]

Reducing or eliminating risk factors for otitis may be a more effective way to avoid the damaging effects of otitis media. Common risk factors for developing otitis media include the use of pacifiers, living in a highly polluted area, being male, living with a parent who smokes, having large (hypertrophied) adenoids or physical abnormalities of the Eustachian tubes, and being allergic.[18]



17.Lopponen, Sorri, Pekkala, and Penna (1992) .

18.See Hanafin and Griffiths (2002); Caceres Udina et al (2004); De Franza, Aligne and Weitzman (2004)., Doyle (2002)

Auditory Processing

Speech comprehension requires the brain to focus attention on a stream of speech, determine where words in that stream begin and end and recognize the meaning of words and their grammatical markers.[19] The entire process is often referred to as auditory processing, but it is actually a set of skills that include:

1. **auditory attention** (the ability to attend to one speech pattern and ignore others)
2. **speed of processing** (the ability to identify word boundaries)
3. **auditory closure** (the ability to recognize words that are not pronounced clearly, that are muffled, or when accented)
4. **auditory figure/ground separation** (the ability to understand speech in background noise)
5. **semantics** (the ability to recognize the meaning of words and grammatical markers e.g. verb tenses, plurals, etc.)
6. **pragmatics** (the ability to use cultural context and non-ver-

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19.For a discussion of auditory processing see Campbell, Hugo, Uys, Hanekom and Millard (1995); Tallal, Merzenich, Miller, and Jenkins (1998); Merzenich et al (1996) or Samson et al (2001).Coherence sensitivity appears to be related to inhibitory inputs and the effects of subcortical neurons (see Barbour and Wang, 2002). See also Golz, Westerman, Gilbert, Joachims, and Netzer (1991); Golz, Netzer, Angel-Yeger, Westerman, Gilbert, and Joachims (1998); Paradise et al (2000).

bal information to interpret the meaning of language)

A child may be impaired in only one of these areas or in any combination of them. Impairment in the first four areas indicates an auditory processing disorder, while impairment in the last two areas indicates a semantic-pragmatic language delay that occurs subsequent to an auditory processing disorder. Since auditory processing is a cognitive function related to language comprehension in the brain rather than hearing, children can be severely impaired in their ability to understand spoken language in spite of having normal hearing.

The following risk factors have been found to predispose a child to hearing loss or auditory processing problems:

* head injury or neurological damage
* genetic disorders that affect the organs of hearing or the brain
* Eustachian tube dysfunction
* viral and bacterial infections
* severe jaundice (hyperbilirubin) or birth asphyxia
* physical abnormalities of the ear, cochlea, or vestibular organs.

The formation of networks that process language in the brain can also be disrupted by abnormalities in vision, since speech is perceived by both the ear and eye.[20] If a child experiences abnormal vision during the critical period when language networks are forming, language processing as well as visual

20.See Calvert and Campbell (2003).

processing can be permanently affected.[21]

It is sometimes difficult to identify children with auditory or visual processing disorders because the brain automatically fills in any gaps in its perceptual field. We are completely unaware, for example, of the hole in our visual field created by the attachment of the optic nerve at the back of the eye. Any visual form that falls on this “dead” area is automatically filled in by the brain.

In the same way, if the brain hears speech as a skipping phonograph record, it tries to fill in the missing information based on context and other cues. This filling-in occurs at an unconscious level so the child is never aware that they have heard something different than what was said.

Unfortunately, this filling in phenomenon is often inaccurate or incomplete, especially in children who have little language or cultural information to guide them. This is why misunderstandings are so common among children with auditory processing problems. Even if the brain is fairly adept at filling in missing information so that misunderstandings are minimized, the cognitive effort required to repair these gaps leads to rapid fatigue, stress, and irritability.

Children who are experiencing auditory processing problems will typically exhibit one or more of the following symptoms:[22]

* inattention to some sounds or voices
* complaints about the ears or pulling at the ears
* delayed language milestones

21.See Finney and Dobkins (2001).

22. See Bellis (2002).

* difficulty following or understanding oral instructions
* difficulty understanding what was said
* difficulty learning to read or spell
* articulation problems
* abnormal language development
* reliance on movements or gestures to grasp what was said
* increased comprehension when speech is slow
* difficulty using the past, future, or imperfect tenses
* difficulty understanding sequences or time related concepts
* difficulty understanding expressions, tone of voice, or gestures
* preference for facts rather than stories
* difficulty entering a conversation or sustaining conversation
* may become angry or upset easily in school
* a preference for solitary activities
* difficulty following or remembering rules
* symptoms of vestibular dysfunction

Identifying auditory processing problems in children over age five can be done by means of a standardized test called the SCAN-C. This popular test examines a child's ability to understand speech that is muffled or that is heard against background noise as well as their ability to process language rapidly and to focus auditory attention on one particular conversation. The SCAN-C is normed for children age 5 and up.

There is currently no standardized measure of auditory processing functions in infants or toddlers, so I rely on the following list of symptoms to help expose auditory processing difficulties in young children:

* tendency to ignore a new sound
* tendency to ignore someone calling their name
* tendency to alert to a whisper more often than a shout
* difficulty understanding what was said to them
* hypersensitivity to some noises (hyperacusis)
* tendency to chant, hum, or talk aloud
* vestibular signs

The interventions for auditory processing difficulties depend upon both what type of auditory processing difficulty is present and the age of the child. For children under age four I have found that the most effective intervention is cognitive therapy. In this therapy the child is paired with an adult partner who demonstrates the meaning of words, grammar, and social cues during free play. The adult accomplishes this by:

* pointing out how things are related and how they are used
* pretending to misunderstand when the child uses vague terms
* modelling or initiating a word or sentence when necessary
* explaining the meaning and use of words and social cues

* using sign language, objects, drawings, and pictures to describe and explain words and actions

For children over age three I have found the following interventions to improve auditory processing:

* **Cognitive therapy through play** (see the example above)

* **Computer programs and games** designed to improve auditory memory, auditory segmentation skills, and phoneme perception. Examples include Earobics (www.cognitiveconcepts.com) or FastForward (available through certain speech pathologists).

* **Auditory attention training** in which children watch video tapes of stories and the adult stops the tape frequently (perhaps every minute or so) to explain vocabulary or actions and to draw the child's attention to names, dates, places, and cue words like "since," "so that," "that's why," etc.

* **Activities to increase vocabulary and comprehension of grammar**

* **Visual imagery and mnemonics** in which the child is taught to draw pictures of events as they listen to stories on tape and to use visual imagery or visual memory to enhance memory

* **Field trips or field activities** that increase an understanding of cultural expectations and behaviors

* **Games** like board games, construction projects or art projects that are done as a group with an adult facilitator

* **Vestibular therapy** in which the child engages in a variety of exercises and activities designed to improve balance, visual tracking, and vestibular functions

* **Physical activities** that require a child to learn new motor sequences (e.g. sports, exercises, songs, dances, etc.)

As is the case with many types of sensory processing disorders, rehabilitation requires many years and a dedicated using a wide variety of activities to resolve. Although some auditory processing problems may never resolve completely, children can learn to compensate for processing difficulties.

Factors that Interfere with Language Comprehension

The brain does not process speech simply as an auditory event. Instead, it processes language as a combination of facial movements and speech sounds. Indeed it is the face, not the voice, that is granted priority access to the language centers of the brain.[23]

In children with normally functioning language networks the cues carried by lip and face movements improve language

23. See Calvert and Campbell (2003). Brodmann's areas 40, 41, 42 process both the visual movements of the lips and face in speech as well as the meaning of language. Adults who watch a face pronouncing a phoneme while hearing a different phoneme will actually report hearing neither the phoneme from the face or voice but another sound entirely. For more information on this audio-visual mismatch experiment, see Mottonen, Krause, Tiippana, and Sams (2002).

comprehension by giving the brain additional information about what was said. In children who have auditory processing problems, however, this is not always the case.

When language requires a great deal of cognitive effort, as when a child is either listening to or constructing complex or unfamiliar sentences, looking at a face can actually disrupt the comprehension of language. The more severe the language processing problem a child has, the more they need to look away from a face when it is speaking.

Some children report that when they are forced to look at a face that is speaking, particularly if the speaker has an unfamiliar accent or is saying something entirely novel, they will actually stop hearing the speaker's voice. This effect is similar to that seen in children who have dramatically different vision in one eye. When both eyes are open the brain simply ignores the less reliable signal and the child experiences monocular instead of binocular vision.

I have found that it is possible to avoid this effect by asking a child to look at me and then mouthing words silently while I sign what I said. Then the child looks away and I sign in front of them and repeat what I said. The signs act as a bridge between the visual cues of the face and the auditory cues of speech. Children can also sustain eye contact better if speech is significantly slower and more clearly articulated.

In my experience, children tend to look at the speaker's face more frequently as their language comprehension improves. This makes gaze aversion is nice way to monitor how well a child is processing what was said and the degree of difficulty they are experiencing understanding speech.

Hyperacusis (Hypersensitive Hearing)

One of the most common complaints among children with auditory processing problems is hyperacusis, or hypersensitivity to some sounds. Hyperacusis actually refers to a marked intolerance of some environmental sounds in spite of normal hearing. It has been associated with sensitivity to environmental sounds, concentration difficulties, tension, and sensitivity to light or colours.[24]

The prevalence of hyperacusis in children with delayed development, brain damage, peripheral auditory damage or genetic disorders is even higher than in the general population, and in some disorder the incidence has been reported to be as high as 95%.[25] Hyperacusis may also be an early warning sign of hearing loss. This is because the brain recruits or borrows additional neural circuits to respond to sounds and frequencies that are becoming fainter. This borrowing can dramatically increase the loudness of a particular sound. In children who are experiencing neural recruitment some sounds can actually be amplified beyond the pain threshold.

Hyperacusis can also be related to an abnormal habituation, which refers to an inability to stop alerting to common sounds or to alert to sounds that are new or different.[26] Abnormal habituation is fairly common among autistic children and infants born to mothers who used cocaine when pregnant.[27]

Treatments for hyperacusis generally involve one or more of

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24. ibid. Levitin et al (2003) have found that the cortical organization of non-speech sound processing in individuals with Williams Syndrome is strikingly different than that of normal controls, primarily due to reduced temporal lobe activation and increased amygdala activation. See also Binder et al (2000).

25.Andersson, Lindvall, Hursti, and Carlbring (2002) reported an incidence rate of 5.9-7.7% for hyperacusis among responders to a survey among the general population. Klein, Armstrong, Greer, and Brown 3rd. (1990)

26. See Arnold (1984).

the following:

* r**elaxation techniques**
* **habituation** through chronic exposure to certain sounds
* **repeated exposure to certain sound frequencies** embedded in music to temporarily reset auditory thresholds
* **cognitive training** (e.g. training the brain to ignore certain sounds).

Habituation and sensory therapies that involve chronic exposure to certain sounds tend to wear off over time and must be repeated. This is because the brain constantly resets sensory thresholds to respond to the sensory environment. When the brain no longer experiences chronic exposure to certain sounds it will reset the thresholds again.

Cognitive training appears to be a longer lasting approach to hyperacusis or abnormal habituation. It is particularly effective for treating children who startle or react with fear when they hear motors, plumbing noises or phone rings. Habituation training is most effective for children who are hypersensitivity to a wide range of sounds or for children who have experienced neural recruitment.

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27. For information about abnormal response habituation and autism, see Barry and James (1988) or Kiln (1993). For information about response habituation and cocaine-exposed infants, see Potter, Zelazo, Stack, and Papgeorgiou (2000). In both cases, children failed to habituate to repeated sounds (a normal response) and failed to alert to novel sounds.