

Hearing, Learning and Listening: The role of auditory function in academics and everyday life. Kay Ness, MS, Neurodevelopmentalist, copyright, 1999

INTRODUCTION

Great confusion exists today in the areas of analysis of auditory function. This confusion exists because of errors in the methods used to analyze and diagnose these problems. What is commonly used today is a symptomatic label such as ADD, ADHD, dyslexia, learning disabled, visual or auditory processing problems, CAPD, mentally retarded, autistic, PDD, ODD and so forth. It is our experience that all of these labeled individuals have some problem with auditory function. These models are prevalent in our society today and I will not go into a great deal of detail analyzing their errors. Suffice it to say that most "analysis" of learning problems does little to help a child or adult learn to function in a more effective way. Most diagnosis consists of listing symptoms and applying a label and perhaps teaching some compensatory skills. We all know the devastating effect of labels, slower learning paces and drugs on children and adults.

These labels are treated as medical absolutes. ADD, for instance, is merely a check list of symptoms displayed by the child. If 8 out of 14 items are checked by parents, teachers and an analyst, then the child has this "disease" of ADD. The Merck Manual lists this under a developmental psychiatric disorder. The usual ritalin, behavior modification and compensatory teaching are presented, but little hope is given that the child will ever function normally, especially without drugs. The Merck Manual indicates that symptoms persist into adulthood. This is true. If a child has a problem attending and there are real problems that are causing this, then if the causes are not treated, symptoms must persist. If symptoms are strictly behavioral in nature, then the child will never be required to behave without medication. This normal child has become disabled by a check list.

My goal is to present the model of auditory analysis that is clear, simple and logical. This is based on works of developmentalists and researchers since the 1940's. My model is a developmental model, that is, from newborn level to maturity, the necessary and sufficient developmental steps that must be achieved to gain full competence in "human" function.

Working with and in the field of neurodevelopment for the last 12 years, I have seen the "miracles" that approaching learning inefficiencies based on the developmental model has produced. I have consistently seen children and adults defy labels, improve function to normal or superior levels and go on to productive lives.

It is extremely important that parents and professionals get the message that labeling children based on symptoms does nothing to ameliorate the problems. We must address the causes of learning problems if these children are to function normally.

THE MANIFESTATIONS OF AUDITORY PROBLEMS

Most learning takes place through the major sensory channels of hearing and seeing - that is, visually and auditorily. Developmentally we would look at visual, auditory and tactile inputs, here we are going to concentrate on auditory.

First we need to define exactly what symptoms point to an auditory problem. I have seen many children labeled with visual processing problems that actually have auditory processing problems that are interfering with reading.

One of the first things I look for is a history of ear infections, tubes and sinus congestion. If there were ear infections or congestion, tubes in the ears, especially during the critical first 2 years of life, there is likely to be distortions in the hearing. I will go into the details of this later, but essentially the individual may test well on an audiogram, but when we look at the QUALITY of the hearing and the ability to LISTEN, we see distortions. This means that the child does not hear clearly and has problems distinguishing one sound in a background of sounds. This is the child that may be able to attend well at home in a quiet environment, but in a noisy environment like a classroom or other public place, the behavior and ability to discriminate sounds deteriorates. This could also be the

individual with very sensitive hearing, being bothered by the slightest noise and hence demanding quiet for concentration.

If the quality of the hearing is bad, then the rest of the functions that depend on hearing are likely to be affected. Speech may be delayed, of poor quality or absent, the voice may be flat or too loud, and so forth. One of the major components of speech is hearing. When the output (speech) is bad, look at the input (hearing).

When an individual cannot follow instructions, gets confused when there are multistep assignments or gets lost during compound sentences, I look at the auditory processing of that individual. A simple way to test auditory processing is to do a test of auditory digit spans. To do this, simply say a sequence of numbers, slowly, at the rate of about one digit every 2 seconds. Say them in a monotone and don't group them. For instance, I'd say "3 8 7 4 3". When finished, I have the individual repeat the sequence to me in the same order. The above was a sequence of 5 digits. I would say that the individual could repeat 5 digits has an auditory digit span of 5. Up until the age of 6, the auditory digit span usually correlates with the age of the child: a one year old can do 1 digit, 2 year old 2 digits, 3 year old 3..... up until 6 years old. Today, the average adult has an auditory digit span of 6 to 7. This is down about a digit from when I started in this work 12 years ago. Actually, the average adult digit span should be 10 or better to understand and process normally complex language. If the individual has a low digit span, then he cannot process normal, everyday language. This is the individual that will pick up parts of sentences and scramble the rest. This is the "spacey" individual. This is also the child who is not having success learning to read longer words with phonics.

There is also a strong correlation between auditory digit span and maturity level. If a 10 year old child has a digit span of 3, that child will act more like a 3 year old than a 10 year old. When we get the digit spans up to the 6 to 7 level, the maturity level becomes age appropriate.

The next area of auditory function we need to assess is long-term memory. Can the individual learn auditorily and retain that information? If a child is having problems remembering math facts, etc. this is usually associated with what we call auditory dominance. We have found that to have good long-term memory, an individual should have all skilled functions on one side of the body, thus establishing what we call a dominant hemisphere of the brain. If the individual is right-handed (and the individual should have a dominant hand for all skilled activities and not be ambidextrous), then that individual should be right-eyed, right-eared and right-footed. Note which ear the individual uses for the telephone, which ear does that individual turn towards you to hear more clearly, to which ear does that individual bring an object to hear slight sounds like a watch.

Lack of a dominant hemisphere of the brain causes reversals, whether visual or auditory, and stuttering and long term memory problems.

In summary, to assess if an individual truly has an auditory problem, look at the history of allergies, congestion and ear infections, look at speech quality, look at the auditory digit span, look at the individual's maturity level, look at the behavior and the long-term memory. Assess behavior and academic function in a quiet versus a noisy environment.

THE DEVELOPMENTAL MODEL

HEARING

What is implicitly stated above will now be more explicitly presented. We look at how the brain receives, processes, stores and utilizes auditory information, which is a well accepted principle of information theory.

Is the input to the brain (that is, the hearing) good? Many people have audiograms done when hearing problems are suspected. An audiogram will give you certain information. It will tell you the threshold hearing levels and if there is hearing loss in one or both ears. This is good information. But, often people manifest auditory problems, have an audiogram done and it shows that the hearing is fine. Then what is going on?

Listening is an active process and must have good tonal processing. Research has shown that the ability to distinguish sounds and process those sounds can be bad even though the audiogram looks good. Working with many, many individuals that manifest auditory problems, we can see that there are certain frequencies in which a

person processes very little information, certain frequencies in which the individual is too sensitive and hence shuts down, and frequencies in which the hearing is distorted and sounds can't be distinguished in a noisy background...everything is a buzz. The autistic child, who has major auditory problems, usually manifest normal or superior hearing across the frequencies, but with extreme distortions. Many of the ADD or ADHD children manifest extreme hypo/hyper-auditory hearing profiles, manifesting both problems in the same individuals.

What we see quite frequently is that individuals with a history of ear infections or congestion often have developed distorted or low quality hearing although the threshold hearing is fine.

It makes sense that the hearing would be distorted in individuals with fluid problems in the ears, especially if those problems occurred during the critical first 2 years of life.

The brain has to learn to hear. A new baby only has a startle reflex, and those auditory pathways to the brain are laid down by hearing sounds in the environment, especially during the first and second years of life when the brain "wiring" is being developed. If one day that ear is full of fluid, the sounds from the environment will sound different from sounds heard by the ear that is not filled with fluid. The ear is an extremely sensitive dynamic system. It hears from the tiniest whisper to the loudest booms - over 10 octaves. The eye, on the other hand, if measured in the same units can only see in a range of 1 octave. So the ear has a dynamic range 10 times greater than the eye. The ear is the first system to develop in utero, a full-sized cochlea being developed by about 4 and 1/2 months gestation. So it is clear that a gross problem with the system like fluid in the ear would have a profound effect on this extremely sensitive system during developmental years.

We see many, many children that are labeled ADD or ADHD that have VERY distorted hearing. I suspect that up to 70% of the children on ritalin are on it for this specific reason. We see many, many children that are hyperauditory, that is, extremely sensitive to certain sounds. This is the child that puts his hands over his ears when others don't, that has behavior breakdowns in noisy environments, that can hear the washing machine running at the other end of the house and can't get to sleep with it on.

The extreme of this is the child that is labeled "autistic". Many of the children with this label have extremely distorted hearing. To them, sounds are a roar. I compare this to trying to listen to 3 or 4 radio shows superimposed. Sounds are very threatening and one sound cannot be isolated and attended to the exclusion of others. Many of these children don't develop expressive language, that is, they don't talk. They also develop what we call sensory play, making sounds, banging on things, drowning out noises with music, etc. The input is bad so the output is not there. The good news is that if we can fix the hearing, these children learn to talk.

There is also speculation that hearing quality effects the moods and behavior of the individual. Dr. Tomatis, the pioneer French ENT that started this work on re-training hearing, speculated that hearing affects the whole central nervous system. He states that because hearing is so primary, being the first sense developed by the infant in the uterus, and because it is so intimately tied to the entire central nervous system in 5 major areas, that the quality of hearing affects the well-being of the individuals. It is also possible that many "psychological" problems are a consequence of this distorted hearing.

PROCESSING

Processing is defined as the ability to take in pieces of information, hold them in your mind and manipulate them in the short term. We discussed above how to do a test of the auditory digit span. This gives us an indication of the ability to process auditory information short term. This skill is necessary for conversational language, understanding complex instructions and compound sentences, sound out long words using phonics and many other areas of social and academic function.

If I was going to pick the greatest functional problem in our society today, I would chose auditory processing. How many times have you given instructions to someone to find that they heard something completely different from what you said? Why do politicians give policy in sound bites? Look at the political speeches and sermons from centuries past. Would today's congregations and audiences hold still for or be able to process these long, complex speeches?

There is much in our environment today to stimulate and improve visual processing. There is very little in our society today to improve auditory processing. We don't talk to each other very much. We don't listen to great speeches. We don't read aloud to each other.

The child increases his auditory processing ability one digit a year until he...starts school. We must look at the effect of school on the learning abilities of children. As a society, we tend to stagnate at an auditory digit span of 6 to 7. Actually, an auditory digit span of 7 is not high enough to engage intelligently in a semi-complex conversation. An auditory digit span of 10 to 12 is necessary to discuss and manipulate complex ideas. If we could go back and test the people of this country in the 1700's, I would guess that the auditory digit spans would be in the 10 to 15 range. If you meet someone who is totally "dingy", doesn't get what you are saying at all, ask them to repeat a sequence of numbers....you will probably find that they have a digit span of 5 or less. Also, most of us are familiar with asking a store clerk for something with 4 or 5 steps or parts to it, and having them get little bits or pieces of the instructions and having to repeatedly go back before the order is correct. This is a symptom of the low auditory processing prevalent around us.

Once you have tested a child's auditory digit span, you can know how to teach that child better. A child must have an auditory digit span of 6 or better to really take off with phonics. A child with low auditory processing, trying to learn to read using phonics, will sound out the first part of the word, sound out the last part of the word and guess at the middle. This could be a child that knows all the rules, works really hard at reading, but when it comes to those longer words, just can't hold the auditory pieces in his mind to figure out the longer words. To help this child, simply have him exercise that auditory function. Have him practice doing the auditory digit spans a couple of minutes at a time, a few times a day. Have him listen to books on tape and higher-level language into his dominant ear via headphones. Read to him. Expand his auditory vocabulary. As the processing improves, the problems disappear and the child takes off.

I had one child test at an auditory digit span of 4 the first time I saw him and he got up to a 9 four months later. This was a home-schooled child. I'll never forget the look on his face when he walked in to his re-evaluation appointment. He had a big grin on his face, looked me in the eye and said, "I can do 9 now". Since each digit is a developmental year, it is highly unusual for a child to improve one digit in 4 months, much less 5 digits. Well, I tested this child and sure enough, he could do 9 digits. His reading jumped 7 grade levels and everyone in the family and at church commented on his improved maturity level. So, as processing improves, academic function improves.

I must comment on the lower end of the scale. Those who are called "mentally retarded" simply have an inability to process. I have tested children and adults with this label and they test at auditory and visual digit spans of 1 or 2. These individuals can learn and often can recite details of many, many things. But because they can't hold information in short-term memory and process it, they function at a very low level. The GOOD news is that if we can improve their processing, they can approach normal function.

In individuals with low auditory processing, I have often seen wonderful and interesting compensatory skills. One ten year old girl I tested had an auditory digit span of 4 to 5, which is very low for her age. Her father talked in long, complex sentences. This pretty little girl would stare and try to catch what was going on. She had learned to guess very, very well, probably visualizing what was being said and then reading off the picture. I tested her reading. Her word recognition was about 2nd grade level. Her reading comprehension was at the 8th grade level. She had learned to guess what was going on from tiny bits of information.

LONG TERM MEMORY AND ORGANIZATION

It is our experience that long-term memory problems, recall problems and problems with organizing materially mentally is associated with cortical dominance.

Cortical dominance is normally established by the age of 7. This means that if the individual is right-handed, then he is right-eared, right-eyed and right-footed. If the individual is left-handed, then all skilled functions should be left-sided.

Most of the evaluation of left-right brained activity popular in the literature today is too simplistic. It is more accurate to speak in terms of dominant and sub-dominant hemispheres. To be "intelligent", all individuals

should be able to do things in a linear and a wholistic or visual fashion and blend the methods. If an individual is weak in an area, we know enough to remediate that weakness while we teach to the strengths of that individual. This is usually what is meant by right/left brain activities. This is NOT what we refer to when we discuss cortical dominance.

Functions of the dominant hemisphere include language, emotional control, linear thinking and long-term memory. Functions of the sub-dominant hemisphere include emotionality and creativity.

If an individual is having a problem with long-term memory, dominance may be the problem. If an individual has no dominance or is mix-dominant after the age of 7, dominance will not be established without specific intervention. Some individuals may be able to compensate for lack of dominance, but the fact is that to be neurologically efficient, establishing dominance will make organizing information learned visually and auditorily much easier. An analogy would be a filing system. An individual with dominance established has an orderly filing system and can retrieve information easily and efficiently. An individual without dominance has trouble retrieving information, especially when he gets emotional. This is often seen in the child who studies and studies the night before a test. He KNOWS the material cold. The next day he goes to the test, gets a little nervous and can't remember anything. After the test pressure is off, he can again remember everything. Going "subdominant" or getting emotional causes the individual to not be able to remember things he knows. This "test anxiety" is eliminated by establishing dominance. First of all, the information is mentally filed in a more orderly fashion, making it easier to remember. Secondly, because the logic of the dominant hemisphere can override the emotionality of the subdominant hemisphere, emotional control is improved.

Mixed dominance is also the specific cause of reversals known as dyslexia. The information goes in one hemisphere and to output the information, it must come from the other hemisphere, resulting in reversals. I have seen children, especially boys, with very bad reversal problems. One very bright young man I tested couldn't do a visual digit span test well because he couldn't read off a sequence of numbers the same way each time without switching the numbers around. The good news is that once we establish eye and ear dominance on the right side, the reversals disappear.

So, achieving cortical dominance improves long-term memory, emotional control and reversal problems. It also helps the individual be more organized and is often manifested in external as well as internal organization.

CAUSES

There are various reasons that sensory functions are distorted. It could be that there was a brain injury at some point either before or at birth. This is not unusual nor is it anything to get all upset about. Studies show that there is brain injury in about 98% of births. But the human brain has much duplicity and plasticity. In other words, it is designed with much back-up capacity so that with the right stimulation we can bypass the injured area of the brain and good parts of the brain can take over for injured ones.

Since most sensory problems are developmental, that is, they develop as the child develops, we need to look at how we bring these problems on and how we can avoid them.

The first area we need to look at is diet. We cannot expect excellent development and function on a junk-food diet. There are many good books on the subject of diet, but basically a child should be breast fed and then fed a good variety of whole foods that are cooked at home. Avoid food additives, chemicals, sweeteners and sugar, Whole grains should be used. Milk should be avoided.

Any child that has a history of ear infections should have a trial period off all dairy products and should be kept off milk. The milk we have today is not the milk we had 50 years ago. Homogenized, pasteurized milk with hormones and other contaminants, make milk the number one allergen in our diets today. I no longer have milk in our house. It is my guess that most children with ear infections have milk allergies. This results in the distorted hearing discussed earlier, which results in learning problems and attending problems. This means that probably 70% of the children on ritalin are there because of milk. Of course the sugar, artificial colors, flavors, etc. don't help either. As of 8 years ago, over 2000 additives were allowed in our food. We need to give our children plain, whole foods as our grandfathers ate. Don't eat food that comes in a box.

There may be a genetic component of some of these problems. Some individuals are genetically predisposed to be mixed dominant. Some individual may be genetically disposed to be especially sensitive in certain sensory channels. This doesn't mean that we can't improve function in these individuals. It just means that it won't improve without specific intervention.

There are many parents with whom I have worked that identify vaccinations, especially the MMR, and DPT as the start of their child's troubles. There is much information out there for parents to research on this subject and should be seriously considered.

Lack of good quality input, that is, excellent language, music, etc., can result in lack of ability in auditory function. There are indications that high frequency sounds stimulate and energize the brain. Low frequency and distorted sounds (like rock and rap music) disorganize and shut the brain down. If we want excellence in our children, we must surround them with excellence.

CONCLUSIONS

Problems with hearing quality, auditory processing and dominance can result in problems attending, behavior and "psychological" problems, reading using phonics, following instructions, speech quality, stuttering and long-term memory. The good news is that once the cause of the problem is identified, the cause can be eliminated and normal function can be achieved.

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