Cochlear implant surgery is a major step many parents take when deciding to give their children with hearing loss access to sound. But turning on a cochlear implant does not automatically help a child understand what they hear. The second of a three-part series, this article explores how the audiologist programs the speech processor, a process known as “mapping,” to maximize a child’s ability to make sense of language and the auditory environment.

Initial Hook-Up

A cochlear implant is made up of both internal and external parts, and initial hook-up is a child’s first chance to use the complete system. It may also be the first time the child hears voices and environmental sounds, and the child’s reaction to initial stimulation is often a very emotional moment for the family. Therefore, the primary goal of the session is to create a comfortable setting so the child has a positive attitude toward wearing the device and experiences a wider range of sounds.

To activate the system, the cochlear implant audiologist connects the speech processor to a computer loaded with specialized software. The audiologist then stimulates the implant’s channels or electrode pairs with tiny electrical pulses, often heard as “beeps,” and tests whether the child hears the stimulus. For babies and young children, audiologists look for changes in the child’s behavior or use visually reinforced audiometry (VRA). Play audiometry is used with pre-school aged children who generally can give a reliable response. Older children can raise their hand or tell the audiologist when they hear a sound.

Audiologists do not usually expect that the child will leave the initial session hearing and understanding sounds well. Over the first few mapping sessions, the audiologist will work toward increasing the child’s range of hearing.

Between sessions, family members and educators should bathe the child in hearing speech and environmental sounds. In other words, talk to the child – don’t ask the child to understand you – and support any vocal play the child exhibits without expecting clear speech. Time and listening practice is necessary to develop spoken language.

The “Mapping” Session

Although cochlear implants are electrical and mechanical products, they are implanted in human bodies that are constantly changing and growing. “Mapping” refers to the process of tuning the levels and stimulation parameters of the speech processor so that sounds picked up by the microphone and processed are heard at the individual’s ideal loudness level.

During mapping sessions, audiologists often perform a series of activities to maximize their understanding of the child’s progress and listening needs. A first step involves gathering information about the child’s listening progress at home, at school or in therapy to learn whether any specific problems need to be addressed. Audiologists may also use telemetry to quickly measure how well the electrodes and the internal electronics of the implant are working, and how well the internal and external equipment are communicating with each other.
Pitch Perception

The audiologist will continue to stimulate the implant’s channels with tiny electric pulses, as they did during initial activation. The cochlea is “tuned” to perceive different pitches depending on the area being stimulated. Children who have had a hearing loss for several years may not perceive pitch differences at first, but eventually should be able to perceive at least general pitch differences.

Loudness Level

The audiologist will increase electrical current on each channel to find the most comfortable loudness (MCL) level. The child will be asked to indicate when the sound is quite loud, but not uncomfortable. The MCL level assigned to each stimulation channel governs the maximum output of the device; the system will never send a stimulation pulse that is louder than the assigned MCL level.

Because many children with significant hearing loss don’t fully understand the concepts of “loud” and “soft,” the first few mapping sessions may focus on teaching those concepts until the child becomes comfortable with the process. There are many creative ways to apply the concepts of “big” and “small” to sound, but if the child is unable to provide any feedback about the loudness level, the audiologist may use some type of objective measure to gather the necessary information. Family members and educators can contribute to the success of the mapping sessions by reinforcing the comparative concepts of “big” and “little” in other areas.

Threshold and Sound Quality

Children also may be asked to identify the softest level audible on each channel, commonly called “threshold.” Because obtaining threshold measures requires a high level of concentration, many audiologists choose to spend mapping sessions focusing on MCL levels, particularly when programming implants for young children. Audiologists also set other parameters that govern the way stimulation pulses are generated and their effect on sound quality.

Map Generation

The audiologist will also generate a map that is downloaded to the speech processor. The map enables the speech processor to appropriately adjust volume levels based on the child’s individual needs. Usually this map is activated so that an appropriate volume level can be determined. Additional testing or diagnostic therapy may also be part of a mapping visit.

Deactivating Implant Channels

In cases where telemetry shows that the implant electrodes or internal electronics are not working effectively, the audiologist may choose to deactivate some of the implant’s channels of stimulation. Speech perception research indicates that the ideal number of channels is somewhere between six and 10, so a user’s ability to hear does not depend on the use of all the channels available in today’s implants. In fact, deactivating a channel that does not produce an effective sound perception or that requires excessive electrical current is preferred and may actually improve the sound of the map without decreasing listening performance.

Mapping Strategies

The procedures used by implant centers to create maps vary greatly from center to center. The best way to understand which programs are on a child’s processor, how they vary and when to use them is through regular communication with the child’s implant center. Most children tend to have a primary map that they wear most of the time. As a child becomes a more sophisticated listener, the maps may vary by loudness and other parameters affecting sound quality. Experienced implant users may have additional maps for special situations, such as using the telephone or listening in noisy environments.

Parents may want to establish a predictable system for differentiating the various maps with the implant center audiologist. For example, the audiologist can routinely set the child’s daily use program in position one, volume X, so that parents can always default to the primary map. It is also helpful to establish a system for quickly and effectively communicating changes in program settings to all caregivers, teachers, rehabilitation providers and family members.
Adjusting the Map

Because the human body is a dynamic system, a child will require frequent adjustments to the implant to accommodate changes in the sensitivity of the auditory system during the first months of use. Adjustments simply require a visit to the implant center to re-assess the settings of the speech processing programs. Those visits eventually taper off to semi-annual or annual visits.

The need for re-mapping the implant is similar to changes in clothing size or eyeglass prescription. The inner ear does not grow – it reaches adult size before the child is even born – but its sensitivity to the electrical stimulation does change, a phenomenon seen in all implant users. When an implant user’s sensitivity changes, the audiologist can adjust the program stored in the speech processor to deliver consistent and comfortable auditory stimulation. Routine mapping simply attempts to keep the program up-to-date with that process.

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