NIH Toolbox

Assessment of Neurological and Behavioral Function

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Sensation

Motor

Emotion

Cognition

Sensation and the NIH Toolbox

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This issue of the Toolbox newsletter is the first of two editions dedicated to the Sensory Domain. While the original Toolbox RFA was fairly general in its approach to the sensory arena, information gleaned during the literature reviews and two requests for information led us to divide the sensory domain into distinct areas for further exploration. In this regard, we have established a total of six separate sensory scientific teams in Audition, Somatosensation Taste, Olfaction Vestibular Balance, and Vision. Work in the first three areas is overseen internally by Jamie Griffith, PhD. He coordinates the activities of three independent scientific teams whose membership is listed in the following pages. In other news, the Toolbox efforts continue to be presented at numerous conferences including February's International Neuropsychological Society (INS) meeting in Atlanta (see page 3). I will be available to answer any of your questions at that time, or feel free to email me at the address above for more information.

Audition

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In generating a conceptual definition of audition, the Audition Team emphasized the breadth and complexity of this domain. Audition is the area within sensory functioning that processes acoustic energy (sound) in order to allow us to hear. It involves the transduction of acoustic energy at the ear drum into mechanical energy which is transmitted via 3 middle ear bones (ossicles) to the inner ear (cochlea), which then transduces the mechanical energy into electrochemical energy to activate the auditory nerve and eventually reach the cortex where 'perception' occurs. The auditory system is characterized by high sensitivity, sharp frequency tuning, fast temporal resolution and a wide dynamic range. Hearing can be measured and quantified using a variety of techniques, including behavioral, psychophysical and electrophysiological measures. Hearing communication function, and the consequences of hearing loss can also be quantified through self-reports and the reports of others. Hearing can be measured in response to both linguistic and nonlinguistic stimuli, and it can be assessed under both optimal and challenging listening conditions.

Based on our literature review, the Request for Information (RFI) survey, interviews with audition experts and suggestions from team members, the Audition team reviewed dozens of candidate measures. A number of considerations (age appropriateness, technical characteristics, cost, time and expertise to administer, and intellectual property considerations, among others) resulted in many candidate measures being eliminated from further consideration.

At the end of this initial process, our original list was narrowed down to ten measures which appeared to best fit within our conceptual definition. Further discussion among team members resulted in the elimination of additional candidate measures. The Audition team ultimately decided to focus on three different methods of assessing auditory functioning: Pure Tone Audiometry (PTA), the processing of spoken Words in Noise (WIN) and the subjective evaluation (via a rating scale) of one's auditory ability and communication functioning.

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Somatosensation

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Somatosensation is the detection, discrimination and recognition of body sensations. Somatosensation includes light touch, vibration, firm pressure, texture discrimination, pain, itch, temperature sensation, and sensing the location and movement of body parts. For Toolbox, somatosensation refers to all body sensations that contribute to a person's awareness of body parts. The experience of sensing involves a complex integration of somatosensory inputs with motor, emotional and cognitive experiences.

Somatosensory function changes over the lifespan. For example, compared to children and young adults, mid-age adults are less sensitive to various aspects of touch. Much of this decline over time seems to be associated with changes in the receptors, and has large implications for quality of life and health. When we examine people with disorders, we see a higher rate of somatosensory changes, and diminished function is associated with these changes (e.g., increased falls, burns). During the validation phase, we will examine the relationship between age and somatosensation by administering the same tests across the life span.

There are few valid and reliable assessments available to measure touch sensation in clinical research programs. Lab studies use precise measurements to characterize receptor activity, whereas clinical programs continue to use measures that evaluate neurological status. Part of the challenge for the somatosensation team was examining the literature and determining how clinical measures could be modified and standardized for use in epidemiological research .

Instrument Selection

We are selecting items that represent different aspects of somatosensation. We are trying out temperature, texture, pain, body position and touch sensation items, and expect to identify which items are the most discriminating among the general population. New ground is being forged with this process, because the items we are testing are used with clinical populations, but have not been validated with the general population.

Some items that are helpful with a clinical population will be too easy for the general population and therefore won't be useful for large scale studies. Whenever possible, we will make use of computer adaptive testing to select items that are appropriate to a person's estimated level of ability.

After we complete our tryouts, we will select certain items to form the Somatosensory Toolbox assessment. First we will compare the selected items to measures used in laboratory studies to validate them. We will also examine convergent and divergence validity with other tests in the Toolbox. For example, we expect that the Wrist Position Sense Test will correlate with some tests of motor function. The Wrist Position test should be orthogonal to tests of emotional health. Pain measures, however, may be more closely related to emotional health.

Wrist Position Test

Next Steps

The relationships among somatosensation, motor functioning, cognition, and emotional health are integrated, and they determine the overall human experience. Our team is excited about the ultimate goal of the Toolbox project: to develop an assessment battery for research that examines how somatosensation is related to, and integrated with, other areas of human functioning. At present, we are trying out several pain, temperature, touch and proprioception test items at the University of Kansas, and texture discrimination at LaTrobe University. We will also test somatosensation across the life span at several sites across the country.

Somatosensation Team

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Somatosensation Instruments

Tactile Discrimination Test
PROMIS Pain
Heat Perception Test
Wrist Position Sense (2 forms)
Bottom of Feet Touch
Stereognosis Test
Body Part for Pain
Kinesthesia Test

2009 Conference Presentations

February 11-14, 2009

International Neuropsychological Society
Atlanta, GA

NIH Toolbox Symposium & Poster Presentations

The NIH Toolbox for the Assessment of Neurological and Behavioral Function: Development of Standardized Measures in NIH-Funded Research

David Tulsky, PhD

The Future of the NIH Toolbox for the Assessment of Neurological and Behavioral Function: Implications for the Clinical Neuropsychologist

Richard Gershon, PhD

Executive Functioning and Language Task Development: The NIH Toolbox Project

Beth Borosh, PhD

The Imitation Based Assessment of Memory

Patricia Bauer, PhD

Processing Speed and the Working Memory Task Development: The NIH Toolbox Project

Noelle Carlozzi, PhD

Taste

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Taste perception arises from stimulation of taste receptor cells within taste buds located on the front (in fungiform papillae), sides (in foliate papillae) and rear (in circumvallate papillae) of the tongue. Additional taste buds are located in the palate, uvula, epiglottis, pharynx, larynx, and esophagus. Many of the sensations arising from stimulation of taste receptors cells may be categorized as sweet, salty, sour, bitter, or umami (a meaty or brothy taste). Retronasal olfactory sensations as well as trigeminal sensations (pain and irritation) combine with taste sensation to produce the flavor and mouth feel associated with eating such foods as licorice, peppermint, and peanut butter. Thus taste sensation is an important component, but not the only sensation, contributing to the flavor experienced when consuming foods.

One aspect of taste that Toolbox is planning to assess is the hedonic response to taste – the extent to which a participant likes or dislikes a particular taste. Strong hedonic responses to taste are observable even at birth, with neonates posing recognizable grimaces to bitter tastes, puckering to sour tastes, and pleasant facial expressions when given sugar solutions. In young children, measures of hedonic reactions to taste are the most reliable and valid assessments available. Pediatric assessments of taste will therefore focus on hedonic reactions to tastes. Children are known to have preferences for greater amounts of sugar than adults (higher Sweet Taste Preference). There are also individual differences in Sweet Taste Preference, with some people preferring much less sugar than do others. Currently, Dr. Julie Mennella on the Taste Team, is examining her existing data sets to evaluate the reliability of a shortened two-alternative forced choice tracking technique for determining Sweet Taste Preference across various age ranges. This analysis will be used to make a recommendation for inclusion of this assessment as a Toolbox measure.

We made a decision to focus on taste perception at higher concentrations (supra-threshold assessments). The presence of data linking Taste Intensity to health outcomes eventually led the group to select a measure of Taste Intensity for consideration for inclusion in Toolbox. Members of the Taste Team at the University of Washington, Monell Chemical Senses Center, and University of Connecticut will collect intensity ratings for sodium chloride, sucrose, citric acid, and quinine solutions (salty, sweet, sour, and bitter) using the general Labeled Magnitude Scale, a special type of visual analog scale. Validity of the measure will be assessed in different age ranges by determining whether or not participants give reliably different intensity ratings to water and two different concentrations of sodium chloride in solution. *Continued on next page*

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Taste Instruments

Beaver Dam Taste Intensity Test
Paired Comparison Sucrose Test
PROP Taste Intensity Test
Regional Taste Sensitivity Test

Audition *(continued from first page)*

While all three of these candidate measures have a rather well established history of usage in the clinical audiology community, their potential inclusion in the research-oriented Toolbox presents some challenges. We recognize that there will be a need to modify all three of these measures in order to make them appropriate for the Toolbox. For example, PTA (specifically, air conduction) will utilize automated computer administration, an exciting development that will eliminate the need for costly equipment and experimenter expertise. The lifespan perspective of the Toolbox poses some challenges in assessing Audition, particularly at the lower end of the age spectrum. For example, the use of parental report will be necessary for younger children (below 8 or 10 years of age) on the rating scale, and instructions and stimuli will need to be modified on PTA and WIN to accommodate the linguistic and cognitive limitations in young children and perhaps the elderly.

As tryouts progress, we may encounter challenges in each measure's abilities to meet the needs of the Toolbox, but we believe that all of these measures hold considerable promise. We look forward to these challenges and are confident that we can meet them and refine the instruments in such a way as to fully meet the goals of the Toolbox.

Audition Team

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Audition Instruments

Pure Tone Audiometry-laptop

Word in Noise

Tympanometry

Hearing Handicap Inventory for Adults

Taste (cont'd)

It is anticipated that very young children will not be able to use the general Labeled Magnitude Scale. Very young children will thus be asked to indicate whether they like or dislike the solutions.

Because taste receptors in the oral cavity are innervated by three different cranial nerves (glossopharyngeal, facial, and vagus), it is difficult to detect loss of taste perception using whole-mouth testing. However, localized loss of taste perception can be detected using measures of Regional Taste Sensitivity. The Taste Team plans to include a measure of regional taste sensitivity in the Toolbox Taste Assessment. In the Regional Taste Sensitivity measure selected, quinine (bitter) is applied separately to the front and rear of the tongue. Participants indicate the intensity of the sensation on each part of the tongue using the general Labeled Magnitude Scale.

The final taste measure under consideration is taste sensitivity to 6-n-propylthiouracil (PROP), PROP Intensity. In large doses (150 to 300 milligrams per day), PROP is used to treat hyperthyroidism. In microgram doses, PROP is commonly used to study individual differences in taste perception. Considerable variation in taste sensitivity to PROP is known to exist in the general population, including some people that are practically taste-blind to the compound, and others that are extremely sensitive. The genetics of taste blindness are now understood, whereas the considerable variability in perceived intensity of PROP at moderate concentrations is not yet understood. PROP testing is commonly done using solutions of PROP or filter papers soaked in supra-saturated PROP solution and then dried. The Toolbox Taste Team plans to examine the comparability of the commonly-employed filter paper method and a taste strip being developed by Osmic Enterprises (Cincinnati, OH). Participants will report perceived PROP Intensity on the general Labeled Magnitude Scale.

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