2009 Summer Conference Handout

Sunday, July 19, 2009

12:00 – 1:30 pm

Bellis-Ferre Model Updates and Crosschecks

Presenter:
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Functional Deficit Profiling of Central Auditory Processing Disorders: An Update on the Bellis/Ferre Model

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Foundations and Ontogenesis of the Bellis/Ferre Model

- Ontogenesis (def.):
  - Individual development of a living thing, all sequence of its transformations from birth to the end of life (http://www.endeav.org/evolut/age/sntut/sntut.htm)
  - The events involved in the development of an organism, from the earliest embryonic stage to maturity (http://www.nature.com/nrn/journal/v6/n12/glossary/nrn1806_glossary.html)

- 1981-1985: Focus on neurophysiologic aspects; auditory-specific, primarily electrophysiological
- 1985: Musiek et al. Neurophysiologic profiles of CAPD in children with LD (Musiek, Gollegly, & Ross, 1985):
  - **Neuromorphological disorders (65-70%)**
  - **Maturational delay (25-30%)**
  - **Neurologic disorder, disease, or insult (<5%)**

- 1985-1988: Patients (primarily adults) post-TBI, auditory (physiologic and behavioral) combined with neuropsychologic/neuropsychiatric profiles
- 1989: School-aged children and application of neuropsychologic and auditory patterns based on research in brain-behavior relationships

- 1992: Katz Buffalo Model (conceived in 1986) Four classifications of CAPD (Katz, 1992)
  - Decoding
  - Integration
  - Tolerance-Fading Memory
  - Organization

- Recognized need for model that encapsulated evidence both from auditory neuroscience and from neuropsychology, cognitive neuroscience, and related fields

Functional Deficit Profiling

- **Purpose: To relate (auditory) deficits to language, learning, communication, and related sequelae for development of ecologically valid treatment plan**

- Should recognize heterogeneity of disorder(s)
- Should be empirically derived
- Should be consistent with underlying neuroscience and current scientific conceptualizations of the disorder

- As such, should be dynamic
- Should relate test findings to functional deficits and patterns of strengths and weaknesses for purposes of directing ecologically valid intervention endeavors

- Involves examination of auditory and cross-discipline data for patterns that conform to well-established neurophysiologic and neuropsychologic tenets
- Not intended to be a "catch-all," cookie-cutter approach to interpretation and programming treatment

- **Key to interpretation, diagnosis, and effective treatment: Presence of patterns that make sense based on scientific foundations and principles**
- **Functional deficit profiling serves as a guide for clinicians to assist them in understanding these patterns**

The Bellis/Ferre Model (the early years)

- June, 1995 – EAA Summer Institute, Ashville, NC – Bellis & Ferre – "Assessment and Management of CAPD in Children"
- Heavily influenced by research in auditory and cognitive neuroscience/ neuropsychology; Luria's model of primary, secondary, and tertiary brain areas; and Katz's functional Buffalo Model

- Initially, consisted of four primary subprofiles (Bellis, 1996; Bellis & Ferre, 1996; Ferre, 1997)
  - **Auditory Decoding** (left hemisphere, primary auditory cortex)
  - **Integration** (corpus callosum???)
  - **Associative** (left hemisphere, associative cortex)
  - **Output-Organization** (efferent system???)

- 1996-1999 – ASHA CAPD task force document (ASHA, 1996), research on right-hemisphere sequelae, and additional literature led to revisions to the model:
- Three primary profiles and two secondary profiles (Bellis, 1999; Bellis & Ferre, 1999; Bellis, 2002, 2003):

- Primary Profiles:
  - **Auditory Decoding** (left hemisphere, primary auditory cortex)
  - **Integration** (corpus callosum)
  - **Prosodic** (right hemisphere)
- Secondary Profiles:
  - **Associative** (left hemisphere, association cortex…language???)
  - **Output-Organization** (efferent system??? Attention???)

- 2003 – "The Efficacy of a Multi-Dimensional Assessment Approach in the Differential Diagnosis of Children with CAPD and ADHD" by Nicole Campbell, PhD student, The University of South Africa, Pretoria – found that children with ADHD and other pan-sensory disorders inevitably demonstrate findings consistent with the Output-Organization profile

- 2005 – ASHA Task Force on APD Technical Report and Position Statement (ASHA, 2005a,b)

  Definition of (C)APD:

  – (Central) Auditory Processing (broadly) is the effectiveness/efficiency in utilizing auditory information by the CNS

  – More narrowly, it is the perceptual processing of auditory information in the CNS and the neurobiologic activity that underlies that processing and gives rise to the electrophysiologic potentials.

- **(C)AP includes the mechanisms responsible for:**
  - **Sound localization and lateralization**
  - **Auditory discrimination**
  - **Auditory performance with degraded signals**
  - **Temporal aspects of audition**
  - **Auditory performance with competing signals**

- **Key Aspects of the Definition**
  - **Deficit in the neural processing of auditory stimuli**
  - **Cannot be attributed to higher-order language, cognitive, or related confounds**
  - **May lead to difficulties in higher-order language, learning, and communication function**
  - **May co-exist with, but *is not the result of*, dysfunction in other modalities**

- **Activities such as phonological awareness, attention to and memory for auditory information, auditory synthesis, comprehension and interpretation, and similar skills may be related to (C)AP, but *they are higher-order cognitive/communicative and/or language-related functions and ARE NOT INCLUDED IN THE DEFINITION OF (C)AP.***

- Resultant revisions to the model:
  - **Deletion of the Associative secondary profile** (primarily language)
  - **Deletion of the Output-Organization secondary profile** (likely attention or other higher-order function, yields task-related findings rather than patterns consistent with underlying neuroscience; does not meet current consensus definition of (C)APD)

The Bellis/Ferre Model (current)

Auditory Decoding Deficit

- **Central auditory deficits indicate left-hemisphere (primary auditory cortex) pattern:**
  - Right-ear (or bilateral, with right worse than left) deficit on dichotic speech tasks and monaural low-redundancy speech tasks (especially time-compressed speech)
  - Poor phoneme discrimination and absent MMN for contrasts involving rapid spectro-temporal acoustic change

- Poor temporal resolution abilities, possibly worse for right-ear stimuli
- Reduced LH electrophysiologic responses (MLR, cortical) elicited by speech signals]
- May exhibit poor performance on temporal patterning tests in linguistic labeling condition
- Performance on analogous visual tasks unaffected

- **Associated difficulties in left-hemisphere functions:**
  - Phonological decoding (word attack) difficulties in reading/spelling
  - Speech-in-noise problems
  - Better performance with visual/multimodality cues
  - May have a history of other phonological and language- or vocabulary-based concerns
  - Better Performance than Verbal IQ

Prosodic Deficit

- **Central auditory deficits indicate right-hemisphere pattern:**
  - Left-ear deficit on dichotic speech tasks
  - Poor temporal patterning performance (BOTH humming and labeling)
  - Reduced RH electrophysiologic responses (MLR, cortical) to standard nonspeech signals
  - Intact auditory closure (monaural low-redundancy-speech) skills

- Intact phoneme discrimination for contrasts involving rapid spectro-temporal acoustic change
- Performance on analogous visual tasks affected only if contour recognition/sequencing is required (e.g., visual high/low or duration patterns)

- **Associated difficulties in right-hemisphere functions:**
  - Problems with prosody perception
  - Sight word reading and other Gestalt patterning difficulties in reading/spelling
  - Sequencing difficulties
  - Other RH difficulties (e.g., visual-spatial skills, math calculation, better verbal than performance IQ)

Integration Deficit

- **Auditory deficits indicate inefficient interhemispheric transfer:**
  - Left-ear deficit on dichotic speech tasks (opposite for nonspeech)
  - Poor temporal patterning performance (labeling ONLY)
  - Traditional electrophysiologic responses (MLR, cortical) often normal; may see reduced hemispheric asymmetry to speech stimuli

- Intact phoneme discrimination, temporal resolution, monaural-low-redundancy, and related skills
- Performance on analogous visual tasks mirrors performance on auditory tasks (Bellis et al, 2008; Bellis et al., in preparation)

- **Associated interhemispheric difficulties:**
  - Speech-in-noise and localization difficulties – Hallmark Symptom
  - Poorer performance with multimodality or visual cues
  - Sound-symbol association difficulties
  - May have subtle difficulties in other interhemispheric tasks (bimanual/bipedal activites, etc.) but not "true" sensory integration dysfunction

The Future of the Bellis/Ferre Model

(2009 and beyond)

A Fourth Subprofile?

- Brainstem timing (or "speech-sound transcription") deficit
- Abnormal performance on BioMARK, associated with speech-in-noise complaints, phonological reading deficits, and other symptoms
- Indicates potential for success with auditory training

The BioMARK: Biological Marker of Auditory Processing

- Measures "speech-sound transcription" in central auditory pathways
- Neurophysiologic response - Normative values currently available for ages 5-12, 18-28

- Research from Northwestern University's Auditory Neuroscience Lab indicates that approximately 30% of children with language-based learning problems (including reading) exhibit abnormal brainstem timing on the BioMARK (e.g., Banai et al., 2005)
- These same children benefit from auditory training

- The degree of brainstem timing abnormality correlates with the degree of difficulties in phonological abilities and associated auditory difficulties (e.g., speech in noise) (e.g., Banai et al., 2009)

- Research at USD's Neuroscience Lab (Billiet, 2008; Bellis et al., in preparation) indicates that the children with abnormal brainstem timing do NOT meet current behavioral diagnostic criteria for (C)APD
- Therefore, they would be "missed" and auditory training would not be recommended without the BioMARK

- The data suggest further that, of the children tested who did not exhibit abnormal brainstem timing, 100% met current diagnostic criteria for (C)APD
- Patterns of deficit observed in these children suggested left- and/or inter-hemispheric deficit, supporting the Phonological Theory of dyslexia in these children

- Recent reconceptualizations of the relationship among bottom-up/top-down auditory processing, phonological representation, corticofugal influences on phonological representation, and related abilities support these complex associations (e.g., Ramus & Szenkovits, 2008)

- So…stay tuned!

Questions?

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