Auditory Processing Disorders

Dichotic Listening and
Monaural Low Redundancy Speech

Relationship and Role in the APD Battery

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Recent Dichotic Listening Studies

- Dyslexia

  2014- University of Toronto – the hypothesis that dyslexia is associated with atypical left hemisphere lateralization was disproved with a forced dichotic listening study in combination with neuroimaging research. Instead, results suggest that dyslexia rises from impoverish connections between the left anterior and posterior language areas

Recent Dichotic Listening Studies

- Stuttering

  2013 – University of Canterbury, New Zealand – study using dichotic CV stimuli to look at strength of the right ear advantage in controls and adults who stutter. Found that both groups have a right ear advantage but the cross over point with interaural intensity difference to a left ear advantage occurs much sooner in the adult stutterer.

Recent Dichotic Listening Studies

- Hemisphere Specialization for Prosody

  2014 – Leidan University, Netherlands. Study looks at hemisphere specialization of emotional prosody perception and linguistic prosody perception. A dichotic listening paradigm and event-related evoked potentials were used. Results supported that hemispheric specialization is driven by non-prosody-specific processing of acoustic cues such as spectral analysis. EEG indicated that the emotional task elicited more response at the frontal sites where the linguistic tasks elicited more response at the posterior sites. No reliable ear advantage was found.

Recent Dichotic Listening Studies

- LEA and Memory

  2014 – University of Brunswick, Canada – undergraduates were presented with dower, power, bower and tower stated in a happy, sad, angry or neutral voice dichotically and asked to identify the emotion in each ear. There was an immediate response condition, a delayed response condition of 5 seconds and then a delayed response with a concurrent task to prevent rehearsal. A left ear advantage was found and was larger for the immediate response than the delayed response. For the delayed response with a concurrent task, pattern of results supported that memory / rehearsal can account for the LEA found in the two first experiments.

Recent Studies with Dichotic Listening

- Sugar Ingestion

  2014 – Carroll University, Wisconsin – Divided attention vs. focus attention in dichotic listening tasks using category related and noncategory related dichotic words. Participants were tested without the sugar drink and then with the sugar drink in a randomized fashion. Results found that sugar ingestion significantly decreased errors for the the divided attention task (repeat both words) but not for the focus task (repeat left ear only). This supports an energy model for the effect of sugar on perceptual tasks rather than a motivational model.

Studies with Dichotic Listening Having a Really Large N

- Global Dichotic Listening Experiment using a Smart Phone App – Univ. of Norway - 4,000 participants and 60 different languages. Found left hemispheric dominance is universal but the degree of lateralization appears to be modulated by linguistic background
- Brain Asymmetry Relates to Performance – 1839 participants in the UK. Found that the degree of lateralization (based on the difference of correct responses between the left and right ears) and the overall response accuracy (left plus right responses) created a U shaped relationship, meaning that the greater the laterality (stronger left or right ear advantage) the better the overall accuracy. This consistently emerged in females, males, right handers, left handers and across age groups.

An Interesting Study Concerning the Battery of Tests for APD

- 2014 Assessment of children with suspected auditory processing disorder: a factor analysis - Ear and Hearing

  Using the IMAP and SCAN-3 – 12 different factors – factor analysis extracted three factors, being:

  General Auditory Processing

  Working Memory / Executive Attention

  Processing Speed / Alerting Attention

Dichotic Testing in My Auditory Processing Battery of Tests

- Staggered Spondaic Word Test (partially overlapping, nondirected, compound words)
- Dichotic Digits (overlapping, nondirected, numbers)
- Competing Words – SCAN (overlapping, both directed (DR) and nondirected (FR), single syllable words)

Advantages of Using These Three Types of Tasks

- Have words and numbers as stimuli
- Have partially over lapped words and completely over lapped words
- Have a cross check system (sort of)
- Access to testing developed by three different researchers with three different approaches
- Two of the tests look at each ear specifically while the third scores using both ears

Experience Using Different Dichotic Tasks

- If only one test is significant, it will be the SSW if the child is younger than ten years and has normal intelligence
- If Dichotic Digits is significant and SSW is not, the child has very strong cognitive / linguistic skills and beat the SSW
- If the SCAN -3 for DR and FR dichotic listening is significant ever, the child is really in trouble
- The SSW allows analysis of errors which aids greatly in determining a therapy plan

Dichotic Listening – Separation / Ear Focus

- Competing Sentences – SCAN – 3
  - Is a focused task in that the listener repeats what is heard in one ear and ignores the message in the other ear
  - Assesses auditory system maturation
  - Assesses hemispheric specialization

Experience Using the Competing Sentence Task

- Appears to be associated with my patients who are more complicated and more severely affected by APD
- When Competing Sentences was significant, other areas were equally poor or much worse than normal
- Therapy created to work with this issue is very different than the usual auditory training techniques which is apparently due to being a different concern.

Monaural Low Redundancy Speech Tasks

- Filtered Words

  Low redundancy due to frequencies being removed

- Time Compressed Speech

  Low redundancy due to compression of time

- Auditory Figure Ground (speech in noise)

  Low redundancy due to the presence of noise covering up some of the speech frequencies and also tasks the ability to pick out speech from noise

My Experience Using MLRS

- Did use dichotic CV and NU Filtered Words Tests. To often both of these tests came up significant when nothing else did so I discontinued them.
- When I have a High to Low Pattern of the SSW, filtered words and time compressed speech seems more likely to be significant. When I have a Low to High Pattern, auditory figure ground seems more likely to be significant.
- Use of these tests translate easily into real life situations that the parent / listener can understand

My Battery of Tests

- Dichotic Listening
  - SSW
  - DD
  - Competing Words FR and DR (maybe, depending on SSW)
- Binaural Separation
  - Competing Sentences
- Monaural Low Redundancy Speech
  - Filtered Words
  - Time Compressed Speech
  - Speech in Noise
- Word Discrimination
  - Word Discrimination TAPS

My Battery of Tests cont.

- Phonemic Synthesis
- Temporal Resolution
  - Pitch Patterns Test
  - Gap Detection Test
- Short-term Auditory Memory
  - Numbers forward, numbers reversed
  - Word Memory
  - Sentence Memory
- Auditory Comprehension – TAPS -3
- Auditory Reasoning – TAPS - 3

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		Score	Limits of Normal
DICHOTIC LISTENING			
Staggered Spondaic Words Test (SSW)			
NOE Analysis	***Right Non Competing***	2	***1 or less***
	Right Competing	***31***	***2 or less***
	Left Competing	***13***	***4 or less***
	Left Non Competing	1	1 or less
	Ear Effect	***-5***	***-2,+2***
	Order Effect	***16***	***-2,+3***
	Reversals	0	1 or less
	Type A Pattern	none	difference of 3, 2x other CN
Competing Words - SCAN-A			
	Scaled Score	***5***	***Borderline***
Dichotic Digits			
	Right Ear	***30%***	***90% or better***
	Left Ear	***45%***	***88% or better***
BINAURAL SEPARATION			
SCAN-3 Competing Sentences			
	Scaled Score	***1***	***Disordered***
			(errors right ear)
MONAURAL LOW REDUNDANCY SPEECH			(Equipment Checked)
Filtered Speech SCAN -3			
	Scaled Score	7	Low Average
Time Compressed Speech SCAN -3			
	Scaled Score	9	Average
Auditory Figure Ground SCAN -3			
	Scaled Score	9	Average
PHONEMIC SYNTHESIS			
	Quantitative	***22***	***23 correct or better***
	Qualitative	22	22 correct or better
TEMPORAL RESOLUTION			
Pitch Patterns Test			
	Verbal	100%	75% or greater
	Nonverbal	NA	75% or greater
Gap Detection			
	Gap	5 ms	15 ms or less

Patterns I Have Found with DL and MLRS

Looked at the last thirty three children between the ages of seven years and fourteen years who presented significant findings in my APD battery

Percentage of significant finding for each area listed

LC	RC	LRC	REV	Type A	H-L	L_H	CS	FW	TC	AFG
27%	9%	36%	18%	9%	15%	21%	21%	39%	33%	55%

Relationship Between Dichotic Listening and BinauralSeparation

	Left Competing Significant	Right Competing Significant	Left and Right Competing Significant
Binaural Separation Significant	0%	0%	50%

Relationship Between SSW Pattern and Three Tests of MLRS

	Left Comp	Right Comp	Left Right Comp	Rev	High to Low Errors	Low to High Errors	Type A
Filtered Words	44%	0%	42%	33%	40%	28%	0%
Time Comp Speech	10%	10%	58%	50%	60%	28%	0%
AFG	44%	22%	50%	50%	40%	43%	67%
All Three	10%	0%	25%	33%	20%	10%	0%

What Jumped Out of the Data

- Significant scores for FW and TCS were never found for a Type A Pattern but significant score for AFG was found for 67% of the children with Type A Pattern
- Significant RC children never performed poorly for FW
- All measures (LC, RC, LRC, Reversals, H – L, L – H, and Type A) had 40% or more of the children with APD significant for AFG except RC which was 22%

What Jumped Out of the Data

- Reversals had the highest number of children with significant scores for all three tests of MLRS
- High to Low Errors (Tolerance / Fading Memory) had a stronger relationship with Filtered Words and Time Compressed Speech than Low to High Errors (Decoding Deficit)
- It appears that Filtered Words, Time Compressed Speech and Auditory Figure Ground should not be all group together under MLRS. Rather, Auditory Figure Ground should perhaps have its own category as it appears to tap a larger area of auditory processing.

Skirmishes in Auditory Processing Disorders – US vs. Brits!

How to Diagnose APD in Children

2010 – AAA publishes clinical practice guidelines include tests using Speech Stimuli

2011/2012 – British Society of Audiology Position Papers proposes that language problem cannot be distinguished from an auditory problem with tests that uses words as stimuli. Therefore the best tool to use is a parental questionnaire targeting clinical characteristics / presentation of APD.

Cont.

2012 – Australia (Dillon and Cameron)– Yes, we should look at clinical presentation and a general term such as APD is not useful and there may be many different types of APD and each should have their own test. The first is “spatial listening disorder” that a test has been developed for and relates to clinical presentation.

2012 – USA (Jerger, Martin, Bellis) - Proposes auditory evoked potentials and brain imaging to be the next standard to diagnose APD and that a good clinician can get around the confound between language and auditory assessments with behavioral tests

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An Effect Way to Conduct the Follow Up Counseling Session

HELP PLEASE !

DICHOTIC LISTENING				
Staggered Spondaic Words Test (SSW)				
NOE Analysis	Right Non Competing	3		3 or less
	Right Competing	***12***		***9 or less***
	Left Competing	8		16 or less
	Left Non Competing	1		4 or less
	Ear Effect	-1		-10,+5
	Order Effect	2		-9,+13
	Reversals	0		6 or less
	Type A Pattern	none		difference of 5, 2x othe
Dichotic Digits	Double Pairs			
	Right Ear	71%		70% or better
	Left Ear	86%		70% or better
BINAURAL SEPARATION				
SCAN-3 Competing Sentences				
	Scaled Score	10		Average
MONAURAL LOW REDUNDANCY SPEECH				
Filtered Words Scan-3				
	Scaled Score	10		Average
Time Compressed Speech Scan-3				
	Scaled Score	11		Average
Auditory Figure Ground Scan-3				
	Scaled Score	9		Average
PHONEMIC SYNTHESIS				
	Quantitative	***15***		***17 correct or better***
	Qualitative	***12***		***15 correct or better***
SHORT-TERM AUDITORY MEMORY				
Scaled Scores	Number Memory	11		Average
	Number Memory Rever	***5***		***Borderline***
	Word Memory	7		Low Average *
	Sentence Memory	12		Average
AUDITORY COMPREHENSION				
TAPS - 3	Scaled Score	16		Superior
AUDITORY REASONING				
TAPS - 3	Scaled Score	7		Low Average

Structure and Function of the CANS

Structure	Function	Relates Back to Practice
Auditory Nerve	Receives the auditory signal from the cochlea, preserves tonotopic organization through the 30,000 fibers of each Auditory Nerve with each fiber representing a particular frequency and range of loudness.	Speed of processing auditory information Clarity of the signal given to higher structures, issues here have a severe impact on communication such as auditory dyssynchrony
Cochlear Nuclei	Preserves and enhances the timing of the signal. This is the beginning of feature extraction.	Contributes to localization and to successful listening in background noise. Weakness

Structure and Function of the CANS

Structure	Function	Relates Back to Practice
Superior Olivary Complex	First major site for the convergence of ipsilateral and contralateral pathways from the cochlear nuclei for coding of binaural cues. Medial Superior Olive is thought to measure the timing difference between ears. Binaural separation and binaural integration begins here.	Localization of the source of a sound, Listening in noise Reaction reflexively to sound at this level Interspecies related, the SOC is larger in bats and rodents than in humans Gap detection takes place here? SSW, Dichotic Digits (integration) Competing Sentences (separation)
Inferior Colliculus	Binaural cues and amplitude modulation from the auditory signal are further enhanced here	

Structure and Function of the CANS

Structure	Function	Relates Back to Practice
Medial Geniculate Body	Transmit auditory information between the brainstem and cortex, coding of the auditory signal for slow changing acoustic parameters (for example, vowel and syllable contrasts0, additional binaural encoding, modulation enhancement and feature extraction. Multimodality Integration begins at this level	Children who need to start at the bottom of the auditory training hierarchy with task such as one syllable vs. two syllables may have weaknesses here. Also children who have a profile indicating a need for sensory integration training

Structure and Function of the CANS

Structure	Function	Relates to Practice
Primary Auditory Cortex (Heschel's Gyrus, Superior Temporal Gyrus,	Analyzes rapid changes of the signal – consonants. Awareness of auditory space (location and position localization). Transmits auditory signals back to the lower CANS and is interconnected to other parts of the cortex	Discrimination of phonemes, phonemic synthesis test primarily assesses this area. Identifies and segregates auditory objects – this area is affected in autism
Auditory Association Cortex	Surrounds the auditory cortex and is the area of comprehension of language and recognition of linguistic stimuli	Area assessed with number, word, sentence memory and auditory comprehension measurements

Left Ear Advantage in Speech-Related Dichotic Listening

- 2013 Cincinnati Children's Hospital – looked at whether a left ear advantage for a dichotic speech task is truly an indicator for APD or are other supramodal factors such as attention are influencing this finding. Using fMRI, evaluated LEA and REA children, ages 7 – 14 and found that LEA was predicted by increased axial diffusivity in the left internal capsule and decreased functional activation in the left frontal eye fields during words presented diotically as compared to words presented dichotically. This indicates that both sensory and attentional deficits may be predictive of LEA and LEA may not be a specific indicator of APD.

Internal Capsule