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Overview

- What is dichotic listening (DL)?
- Possible mechanisms & their relationship to clinical populations
- Common DL tests
- Why Test DL in the Clinic?
- Treating DL deficits (DIID Training)
What is Dichotic Listening

Mechanisms – “Transmission line”
Mechanisms – “Transmission line”

![Graph showing data](image1.png)

Fig. 4. Effect of commissurotomy on dichotic performance. Note decrease in left ear scores post commissurotomy.

Mechanisms - Attention

![Diagram of attentional resources](image2.png)
Mechanisms - Attention

Attentional Resources

Mechanisms – Relationship to Clinic

- Pediatrics

Dichotic Performance

<table>
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<tr>
<th>Percent Correct</th>
<th>8 Years</th>
<th>9 Years</th>
<th>10 Years</th>
<th>11 Years</th>
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<tbody>
<tr>
<td>Left</td>
<td></td>
<td></td>
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<tr>
<td>Right</td>
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CONTINUED
Mechanisms – Relationship to Clinic

• **Pediatrics**

Yakalev and Lecours, 1967

Westerhausen et al, 2011

Mechanisms – Relationship to Clinic

• **“Older” Adults**

Dichotic Performance

- Left
- Right

Percent Correct

Years:
- 40
- 50
- 60
- 70
**Mechanisms – Relationship to Clinic**

- "Older" Adults

![Graph showing age-related changes in FA with corresponding p-value and r-value](image)

Ota et al, 2006

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**Common Clinical Tests of DL**

- Dichotic Digits (Musiek, 1983)
- Competing Sentences (Willeford, 1978)
- Staggered Spondaic Words Test (Katz)
- Dichotic Sentence Identification (Fifer & Jerger)
- Dichotic Rhyme (Wexler & Halwes, 1983; Musiek et al, 1989)
Common Clinical Tests of DL

Bellis et al, 2011

Competing Sentences

Dichotic Digits

Weihing Pediatric data
Common Clinical Tests of DL

Dichotic Digits (Musiek, 1983)

- Alternative Index: Interaural Asymmetry (applied to normal hearing & hearing loss)
  
  \[ \text{IDD} = |\text{Left Ear} - \text{Right Ear}| \]

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Efficiency</th>
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<tbody>
<tr>
<td>IDD &gt;14%</td>
<td>85%</td>
</tr>
<tr>
<td>Raw Scores &lt;80%</td>
<td>90%</td>
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</tbody>
</table>

Weiuing & Musiek

Why Test DL in the Clinic?

Dichotic Deficits Common in Children Referred for CAPD Evaluations

[Graph showing Competing Sentence and Unilateral Deficit]

Weiuing et al, In Preparation
Deficits also common in adult patients

Why Test DL in the Clinic?

Relationship to Hearing in Noise (Pediatric Data)

Competing Sentence Left Ear Correlation X Speech in Speech Babble
(controlling for the effects of age)

R² = ~20%
Why Test DL in the Clinic?

**Relationship to Hearing Handicap**

- An auditory training procedure which seeks to improve a psychoacoustic skill that receives contributions from the CANS
- Applicable for patients with a unilateral or asymmetric dichotic deficit
- Based on depriving the stronger ear of stimulation so that the weaker ear can improve

Chmiel & Jerger, 1993

Chmiel & Jerger, 1996

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Treating DL Deficits – DIID Training

- An auditory training procedure which seeks to improve a psychoacoustic skill that receives contributions from the CANS
- Applicable for patients with a unilateral or asymmetric dichotic deficit
- Based on depriving the stronger ear of stimulation so that the weaker ear can improve

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**CONTINUED**
How to Administer the DIID?

Terminology

Terms used in the DIID protocol

CP  Cross-over point: as one decreases the intensity of the stimulus in the stronger ear, the CP is the level in the stronger ear at which performance in the weaker ear exceeds the stronger ear.

WE  Weaker ear: the ear that performs poorer on dichotic tasks

SE  Stronger ear: the ear that performs better on dichotic tasks

BI  Binaural integration: repeat back the stimuli presented to both ears

BS  Binaural separation: repeat back the stimuli presented only to the attended ear
Decisions to Make…

• Is your patient a candidate?

• What stimuli to use?

• How will you measure progress and “real-world” benefits?
  – Don’t train to the test

Candidacy

Criteria for participation in the DIID are as follows:

1: Patient’s age is 7 years or older
2: Normal peripheral hearing per ASHA standards
3: Interaural SRT difference no greater than 10 dB
4: A unilateral or asymmetric dichotic processing deficit
5: Intensity of the stimulus presentation to the stronger ear cannot be below the level of audibility at the cross-over point
Existing Media for Dichotic Training

- Dichotic training packages:
  - Constraint Induced Auditory Training (CIAT) - Hurley & Davis 2012
  - Auditory Rehabilitation for Interaural Asymmetry (ARIA) - Moncrieff & Wertz 2008

- CDs with stimuli that can be presented dichotically:
  - Dichotic Digits Extended Edition – Musiek 1983
  - "Q-Mass" Disc - Moncrieff & Wertz 2008
  - Dept. of VA – Speech Recognition and Identification Materials – Wilson, 1993
  - Dept. of VA – Tonal and Speech Materials – Wilson, 1993

- Formal training – control level through an audiometer

Outcome Measures

1: NU-6 Lists in Speech Babble  
   (Wilson, 1993)

2: Speech Perception in Noise Test  
   (Kalikow et al, 1977)

3: Words in Noise Test  
   (Wilson, 2010)

4: Hearing in Noise Test  
   (Nilsson et al, 1994)

5: Listening in Spatialized Noise Test  
   (Cameron & Dillon, 2007)
Steps in Training

• Find Cross-over point
• Train, Train, Train
• Retest
• Train?
• Retest & Outcome Measures

Finding the Crossover Point

![Graph showing percent correct against Interaural Level Difference (IAD) in decibels for Left and Right ears.](image)
Training

- **Schedule**
  - 3-4 times a week for 30 minutes

- **Tasks**
  - Binaural integration & separation
  - Some degree of variety is important

- **Increasing level in SE (stronger ear)**
  - Each session try and increase a bit. If performance suffers, decrease to baseline levels for that session

Retest and Outcomes

- Training is generally effective in under 2 months
  - Retest at that time

- If dichotic performance is within normal limits, administer outcome measures

- If not, re-train for one to two weeks, then retest with outcomes

- If performance still below normal limits, reconsider rehabilitation plan
Informal Training

Better Ear

- Volume set to MCL

Weaker Ear

- Increase level until performance near 0%
- Decrease slowly until WE performance ~60%

How to Determine Levels

- WE (weaker ear)
  - Volume set to MCL

- BE
  - Increase level until performance near 0%
  - Decrease slowly until WE performance ~60%
How to Gauge Performance?

• Present WE audio and BE competition in brief “snippets”, 10-20 seconds in length

• Ask questions to ensure comprehension
  – Please summarize the segment
  – Tell me about … [specific detail]
  – What was the first and last noun of the segment?

Efficacy

• Does the DIID improve dichotic processing?

• Does the training yield improvements beyond what would be expected in control conditions?

• Does the training yield benefits beyond dichotic listening?
Dichotic Word Improvement in Poorer Ear

Musiek, Lau, & Weihsing, Unpublished data

SCAN Improvements (Left and Right Ears)

Moncrieff & Wertz, 2008
Musiek, Lau, & Weihing, Unpublished data

Performance re: Control Group (SL Therapy)

Research from Neuroaudiology Lab @ UL

- Dichotic training in older adults
- Two case studies, two older adult hearing aid users with relatively symmetrical hearing
  - S5 – presents with a left ear deficit on dichotic listening
  - S6 – presents with bilateral dichotic deficits
Pre-Training Dichotic Performance

![Graph showing pre-training dichotic performance with categories DDL, CSL, DDR, CSR and two participants S5 and S6.](image)

![Screenshot of a computer interface for dichotic interaural intensity difference training with status, initialization settings, control panel, calibration, and score user response.](image)

CONTINUED
S5 & S6 Task Frequency

S5 Training Progress - Left
S5 Results

S6 Training Progress - Left

CONTINUED™
• Dichotic deficits negatively affect patients' ability to understand speech in difficult listening environments and contribute to hearing handicap.

• There are options for rehabilitation, one of which is auditory training (DIID)

• DIID training benefits dichotic processing and possibly hearing in noise ability

Summary of Today’s Talk

Thank You!

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