2014 Siemens Expert Series

June 5, 2014 at 12 PM ET
Matching Technology & Features to Patient Needs
Presented by Jimmie Heine, Ph.D.

The focus of this course is on the importance of matching the patient. By asking the right questions and understanding today’s technology features, we can make it easier for our patients to make better choices. Sample cases will be presented and discussed.

June 17, 2014 at 11 AM ET
Assessment and Remediation of CAPD
Presented by Dr. Stephen Heine, P.T., and Carmen Cargiotti, P.T.

Spatial Processing Disorder is a specific, well-defined form of Central Auditory Processing Disorder. It is often underdiagnosed and underdetected in children by those who work with children that have other conditions. Unlike other forms of CAPD, it is much more sensitive to changes in the environment and can significantly affect a child’s ability to learn the skills of reading, writing, and arithmetic.

July 24, 2014 at 12 PM ET
Tools Pediasts Might Find Helpful in Understanding Different Hearing Aid Technologies
Presented by Michael Shain, M.D.

This presentation will include an in-depth discussion of how the otolaryngologist can assist the audiologist in making the best choices for hearing aid technology. The presentation will include information on otologic findings which can directly impact hearing aid technology selection.

August 12, 2014 at 12 PM ET
Understanding and Managing Severe Hearing Loss
Presented by Mariann Evans, Ph.D.

Among all individuals with hearing loss, patients with severe hearing loss are the most significantly impaired, and are least successful with hearing aids. And there is no “typical” patient: communication ability is highly individualized and unique. This presentation will review the challenges and possible solutions for adults with pure tone thresholds between 70 and 90 dB.

August 22, 2014 at 12 PM ET
Stay To Play Hearing Aid Fitting: Clinical Nuggets From Recent Research
Presented by Michael Shain, M.D.

This course will review the recent findings from select clinically-relevant publications regarding hearing aids, and will address how these findings can be applied to everyday hearing aid diagnosis and fitting. We will review new research in areas such as alternative fitting parameters, other information that impacts technology decisions, and some of the findings where to improve our fitting techniques.

Brought to you in cooperation with AudiologyOnline

Submitted to AAA, ASHA & IIHIS for one continuing education unit (CEU)

Please visit the AudiologyOnline website or the Siemens website for other live and recorded events from Siemens Hearing Instruments, Inc.

www.audiologyonline.com/ce/siemens

www.usa.siemens.com/hearing
then select “Login to mySiemens”
Central auditory processing disorders (CAPD): diagnosis and remediation

Harvey Dillon & Sharon Cameron

With thanks to:

Helen Glyde
Dani Tomlin
Jess Whitfield
Mridula Sharma
Presentation Overview

Spatial Processing Disorder (SPD)

• What is SPD and how does it relate to CAPD?
• What causes it?
• How do we remediate it?

Issues in CAPD test construction

• How do CAPD scores relate to cognitive ability, listening difficulty and academic success?

A national service in Australia for children with CAPD

• Structure and results

Spatial Processing Disorder:

Overview

Diagnosis, cause, remediation
Spatial Processing Disorder
(deficit in spatial release from masking)

Noise

CAPD test battery

Noise

Speech

Noise

National Acoustic Laboratories, Sydney, Australia

Spatial Processing Disorder –

Unique amongst CAPD because we:

- Know its major cause
- Can diagnose it, unrelated to cognitive ability
- Have extensive normative and reliability data
- Can remediate it (blinded, randomized trial)
- Remediation generalizes to real life
Assessing Spatial Processing Ability

Listening in Spatialized Noise – Sentences Test (LiSN-S)

Ability to separate target stimuli from distracting stimuli that arrive from other directions.
LiSN-S

- Virtual auditory environment under headphones.
- Target sentences from 0º.
- Distracter stories at 55 dB SPL from either 0º or ± 90º.
- Stops when SE < 1.0 dB, or max of 30 sentences.

LiSN-S Measurement Screen

- Two Distracters at 55 dB SPL
- SRT = average SNR
- Level of Target (adaptive)
Four LiSN-S Conditions

Same Voice

- D1
- T
- D2

Talker Advantage

Low Cue SRT

Spatial Advantage

Total Advantage

Different Voices

- D1
- T
- D2

Spatial Advantage

High Cue SRT

Anticipated Advantage of Using Difference Scores

- Four base scores likely affected by:
  - Cognitive abilities (memory, IQ, attention)
  - Language abilities (vocabulary, closure skills, second language)

- Three difference scores relatively immune to these
LiSN-S results profile: spatial processing disorder

Explanation Screen

Robert Smith was outside normal limits on the high cue SRT, spatial advantage and total advantage measures of the LiSN-S. These results are suggestive of a spatial streams segregation disorder.
Client Assessment Report

Phonak LISN-S
Client Assessment Report

Product: Phonak LISN-S
Surname: Smith
First name: Robert
Date: 20/08/2009
Age: 10 years 6 months
Teacher: Cameron, Sharon

Background Information:

This Listening in Spatialized Noise - Sentences Test (LISTEN) was developed to assess auditory skills in children who may be having difficulty listening to and following speech in the classroom. A number of sentences are presented under the following conditions: initially at 62 dB SPL, in the presence of two distractor tones presented as a loud, steady sinusoidal at 500 Hz. The distractor tones vary in both the position in relation to the direct sound and the quality of the signals. The listener/task is to repeat each sentence loud. The intensity level at which the listener is adjusted to find the level at which the listener is getting 50 percent of words correct in each sentence.

This test assesses the listener's ability to distinguish the primary sound from the distractor tones. Scores are obtained for each condition, and the overall score is based on the total number of words correctly identified across all conditions.

Language: USA English or proper English
Spatial Advantage (≡ Spatial Release from Masking)

- Australia
- North America

High Cue SRT

- $p < 0.000001$
LiSN-S Cut-off Scores

Cameron et al. 2011

Paired Difference = 0.3 dB
p = 0.178
r = 0.2
Critical Difference Score = 3.3 dB
Children with Spatial Processing Disorder

- Nine children aged 6 to 11 years experiencing listening difficulties in class relative to peers who had no learning or attention disorder and WISC IQ >90 on all subscales (SusAPD group).

- Eleven children with confirmed language, memory or attention disorders, and WISC IQ overall score >90 (LD group).

- Assessed on LISN-S and results compared to 70 age-matched controls.

- Assessed with a traditional (C)APD test battery
LiSN-S vs. Traditional Battery (LD Group)

LiSN-S vs. Traditional Battery (sus CAPD Group)
Link between SPD and Chronic Otitis Media (COM)

SPD and chronic otitis media (COM)

- 50% of children (24/49) diagnosed with SPD at NAL reported a history of COM. (Dillon et al., 2012).
- 30% of children (15/50) previously diagnosed with COM at University of Melbourne were diagnosed with SPD. (Graydon & Rance, ongoing).
- Spatial processing deficit worse for early onset age and longer duration of COM (n=35; Tomlin & Rance, under review).
- 6 yo children with history of COM have below average spatial advantage (n=17; z= -1.0) (Kapadia et al, 2012).
- 13-17 yo adolescents with history of COM have below average spatial advantage (n=20; z= -0.75) (Kapadia et al, 2014).
- 10% of a population sample (9/90) of Aboriginal children from remote Australia diagnosed with SPD. (Unpublished data).
- 7% of a population sample (10/144) of Aboriginal children from regional Australia diagnosed with SPD. (Cameron et al., in review).
Correlation between SPD and Onset and Duration of COM

Co-located

Spatial advantage

Age of Onset

Duration

Tomlin & Rance (Under Review)

Interpretation Based on These and Other Studies

Chronic otitis media

Fluctuating access to binaural cues

reduced effectiveness in better-ear glimpsing
Remediation of SPD:

The LiSN & Learn Auditory Training Software

LiSN & Learn

- Deficit-specific remediation for SPD.
- Trains children to attend to a frontal target stimulus and filter out distracting talkers from left and right.
- Adapts to 70% performance level.
- Used in the home or schools/clinics.
- Provides detailed feedback, analysis and reporting.
Description of LISN & Learn

- Five games presented on PC over headphones.
- Target sentences at 0º azimuth.
- Competing stories - same voice at ±90º - (55 dB SPL).
- Weighted up-down adaption of target level.
- SRT calculated over 40 sentences.
- 131,220 unique sentences.
- 50 training sessions (2 games x 5 days p/w x 10 weeks).
- Reward system.

Target: The horse kicked six wet shoes
LiSN-S Results - Pre- vs. Post-Training

Cameron & Dillon (2011)

LiSN & Learn – Preliminary Study

- 9 children with SPD (6 to 11 years)
- LiSN & Learn – 2 games/day, 5 days/week, 12 weeks

Cameron & Dillon (2011)
**Self-Report Questionnaire - Pre- vs. Post-Training**

- **CAPD SSQ**
  - **SSQ - Noise**
  - **SSQ - Quiet**

- **SSQ – Listening in Noise:**
  - Pre vs Post: \( p = 0.0002 \)
  - Post vs 3M: \( p = 0.397 \)

- **SSQ – Listening in Quiet:**
  - Pre vs Post: \( p = 0.103 \)
  - Post vs 3M: \( p = 0.529 \)

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**Blinded Randomized Control Study**

1. 10 children (aged 6 yrs 0 mths to 9 yrs, 9 mths) diagnosed with LiSN-S as having SPD:
   - a) 5 x *LiSN & Learn* (experimental group)
   - b) 5 x *Earobics* (control group)

2. **Questionnaires**
   - a) Participant (LIFE)
   - b) Parent (Fishers)
   - c) Teacher (LIFE)

3. **LiSN & Learn or Earobics** training – 15 minutes daily x 60 sessions

4. Re-evaluate LiSN-S and questionnaires post-training
LiSN-S Results – Pre vs. Post Training

Earobics (n = 5)  
Lisn & Learn (n = 5)

Cameron, Glyde & Dillon (2012)

Questionnaires – Post Training Improvements

L&L = 16 pts;  
Earobics = 7 pts;  
where 0 pts = "no improvement"

L&L = 31%;  Earobics = 9%  
L&L = 22%;  Earobics = 9%
Catalyst
The Australian Broadcasting Commission

Disclosure

The National Acoustic Laboratories, is an Australian government laboratory

- NAL licences the LiSN-S test to Phonak, and is paid a royalty on sales.
- NAL directly sells the LiSN & Learn training package through its web site.
Subjects

• Clinical Group: (n=105)
  – Children referred for clinical AP assessment
  – Aged 7.0 to 12.9 years (Mean Age 8.9 yrs, ± 1.5)

• Control group: (n=50)
  – No reported auditory, listening or academic difficulties
  – Aged 7.0 to 12.2 years (Mean age 9.1 yrs. ± 1.4)

• Peripheral hearing assessments all normal
Measures obtained

**AP**
- Frequency Pattern Test (%)  
- Dichotic Digits Test (%)  
- Gaps In Noise (msec)  
- Listening in Spatialised Noise Sentences test (LiSN-S) (dB)  
- Masking Level Differences (dB)

**Cognition**
- Non verbal IQ  
- Auditory Working Memory  
- Sustained Attention  
  (Quotient Scores)

**Academic Results**
- Reading Fluency –WARP  
- NAPLAN  
  (Numerical scores)

**Listening Ability**
- Questionnaires:  
  LIFE (child)  
  Fisher (Parent)  
  TEAP (Teacher)  
  (Total item scores)

*Results need to allow for development & comparison of measures → z scores*

Source: Dani Tomlin

### CAPD scores versus cognitive scores

<table>
<thead>
<tr>
<th></th>
<th>Digit Span Forward</th>
<th>Digit Span Reverse</th>
<th>Non-verbal IQ</th>
<th>Sus Aud Atten</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DDT_L</strong></td>
<td>0.43</td>
<td>0.39</td>
<td>0.38</td>
<td>0.19</td>
</tr>
<tr>
<td><strong>RD T_R</strong></td>
<td>0.36</td>
<td>0.34</td>
<td>0.28</td>
<td>0.22</td>
</tr>
<tr>
<td><strong>FPT</strong></td>
<td>0.25</td>
<td>0.36</td>
<td>0.43</td>
<td>0.16</td>
</tr>
<tr>
<td><strong>GIN</strong></td>
<td>0.09</td>
<td>0.04</td>
<td>0.13</td>
<td>0.12</td>
</tr>
<tr>
<td><strong>MLD</strong></td>
<td>0.15</td>
<td>-0.05</td>
<td>0.07</td>
<td>0.04</td>
</tr>
<tr>
<td><strong>LiSN_LC</strong></td>
<td>0.27</td>
<td>0.18</td>
<td>0.28</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>LiSN_HC</strong></td>
<td>0.12</td>
<td>0.11</td>
<td>0.22</td>
<td>0.14</td>
</tr>
<tr>
<td><strong>LiSN_Spat Adv</strong></td>
<td>0.00</td>
<td>0.03</td>
<td>0.08</td>
<td>0.04</td>
</tr>
</tbody>
</table>
Structural equation modelling

Caution: heterogeneous!

Confirmatory factor analysis
Confirmatory factor analysis

Auditory processing and cognition

62% → NVIQ
86% → Attenu
55% → Mem
54% → DDT
72% → FPT
97% → GIN
85% → LiSN

Cog

r = 0.07
r = 0

P = 0.23
All metrics OK

Auditory processing and cognition vs. Cog

Subjective report of listening difficulties

Listening ability

Teacher TEAP
Parent Fisher’s
Child LIFE
Subjective report of listening difficulties

Error component = 17%

Listening ability

Teacher TEAP 23%
Parent Fisher’s 48%
Child LIFE 69%

Fits, but cannot be tested

Academic attainment

Academic ability

NAPLAN Numeracy
NAPLAN Grammar
NAPLAN Spelling
NAPLAN Writing
NAPLAN Reading
WARP Reading
Academic attainment

- NAPLAN Numeracy: 42%
- NAPLAN Grammar: 21%
- NAPLAN Spelling: 16%
- NAPLAN Writing: 20%
- NAPLAN Reading: 30%
- WARP Reading: 42%

Error component = 5%

P = 0.18
All metrics good

R² = 72%

Relationships between variables in different domains
Path analysis
Path analysis
(model; no latent variable)

Path analysis
(results; no latent variable)

P=0.12
Most metrics OK
Path analysis (delete link from AP to Listening ability)

Path analysis (reverse listening ability to reading fluency)
Dichotic Digits and Cognition

Dichotic Digits Test

Dichotic presentation
- Dichotic ability
- Auditory working memory
- Attention
- IQ

Dichotic Digits Difference Test

Diotic condition
- Auditory working memory
- Attention
- IQ
## Correlations – DDDT and cognition

<table>
<thead>
<tr>
<th></th>
<th>Dichotic</th>
<th>Diotic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attention - Prudence</td>
<td>0.37</td>
<td>0.32</td>
</tr>
<tr>
<td>Attention - Vigilance</td>
<td>0.34</td>
<td>0.24</td>
</tr>
<tr>
<td>Number memory forward</td>
<td>0.35</td>
<td>0.41</td>
</tr>
<tr>
<td>Number memory reverse</td>
<td>0.34</td>
<td>0.47</td>
</tr>
<tr>
<td>Non-verbal IQ</td>
<td>0.26</td>
<td>0.26</td>
</tr>
</tbody>
</table>

### Dichotic vs diotic perception

![Graph showing correlation between DDDT integrated total (SD) and DDDT diotic (SD)]

- **Dichotic presentation**
  - Dichotic ability
  - Auditory working memory
  - Attention
  - IQ

- **Diotic condition**
  - Auditory working memory
  - Attention
  - IQ

R = 0.69
ASHA (2005)
“(C)APD is a deficit in neural processing of auditory stimuli that is not due to higher order language, cognitive, or related factors.”

Moore, Ferguson et al (2010)
“What is currently called APD, for individuals without known neurologic lesions, should be redefined as primarily a cognitive disorder, rather than a sensory disorder.”
APD can be thought of as:

1. A concept
2. A set of symptoms
   … but other things can cause the same symptoms
3. Failure by some criterion amount on tests in a battery
   … but other things can cause failure
   … and failure has unknown real-life consequences

Questionnaires to diagnose CAPD

*Questionnaires* (or other ways to gather symptoms) might be able to confirm there is a problem, but can’t tell us the cause.
Reasons for APD referral

1. Children are typically referred for APD assessment because of:
   • Perceived difficulties in understanding speech, and/or
   • Poorer than expected academic progress

2. Difficulty understanding speech and poor academic progress can be caused by any of:
   • Auditory processing disorder
   • Specific language impairment
   • Cognitive deficit
   …… acting individually or in combination

Therefore, not all children with genuine listening difficulties being assessed for APD will have APD
Parents’ CHAPS scores – children referred to Great Ormond Street Hospital for APD assessment

Reason for assessing APD

Not primarily diagnosis, but doing something about it!

1. **Management**: changing the input to the child
2. **Treatment**: overcoming the deficit itself - training
3. **Compensation**: giving the child skills to compensate for a deficit that can’t be fixed

But also diagnosis:
- Impact on person, significant others, school
- Obtaining funding for support
Management of APD

Management of APD (FM systems, classroom placement) is not at all informed by performance on a CAPD test battery, but is nonetheless appropriate if the child, parent or teacher reports an apparent deficit in understanding speech when there is noise present.

Treatment of APD

Treatment (i.e. training to reverse the deficit) should be specified on the basis of a detailed diagnosis of the deficit, but there are very, very few examples of an evidence-based treatment that follows from the detailed diagnosis, that improves performance on the test, and that generalizes to real-life benefit.
Dealing with **problems in understanding speech**

1. **Questionnaire / history**
2. **Audiometry**
3. **Measured disability**

   - **Is there a problem that CAPD might explain?**
     - **No**
       - Exclude CAPD; Refer elsewhere
     - **Yes**
       - **Master test battery**
         - **Detailed test battery**
           - **Test result interpretation leading to a disorder-specific diagnosis**
             - **Disorder-specific remediation**

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**Non-specific remediation and management:**
- Classroom placement
- FM use
- Instruction style
- Soundfield amplification
Causation

1. The direction(s) of causation in the relationships, and the time scale of causation, between auditory processing abilities, language abilities, cognitive abilities, reading ability, and parent/teacher report of functional listening ability are largely unknown.

2. Interventions for putative underlying causes are the only way to determine them.

And finally

It is not productive to define APD as either not involving cognition, or as only involving cognition.

Rather, focus on finding out
- Whether individual children have difficulty listening,
- Why they have difficulty when listening, and
- What can be done to change that.
Spatial Processing Disorder:
Prevalence in a clinical population

Australian Hearing’s CAPD Service

- Operating in 42 Australian Hearing centers around Australia since May 2012.
- Diagnosis, assessment and management of specific aspects of CAPD.
- Recruitment targets children experiencing difficulty hearing in background noise.
- Tests are chosen which:
  1. Have been shown to be associated with difficulties in real life.
  2. Are reliable, repeatable and relatively quick to administer.
  3. Lead to remediation that is backed by research evidence.
Test structure

LiSN-S high cue → LiSN-S → Remediate (L&L)

Auditory memory (digits forward and reverse) → Remediate (Memory booster)

Dichotic digits → Remediate (FM .....)

Age Distribution

N=618
Passes and Fails

- **Hearing screening**: 666
  - **Mild Conductive**: 23 (Pass 636)
  - **Unknown**: 3 (Z ≥ -1 307)
  - **LiSN - HC**: 4 (Z < -1 329)
  - **LiSN**: 120 (SPD 19%)

- **Auditory memory**: 167 (Pass 349)
  - **Pass (not SPD)**: 209 (26%)

- **Age**: < 7 yrs 76 (Pass 173)
  - **≥ 7 yrs**: 273 (27%)

- **DDT**: 100 (Dichotic deficit 20%)

National CAPD service results: LiSN & Learn effects

- Pre-training
- Post-training
LiSN & Learn training: COSI results

Effect of Memory Booster training
In summary

- Spatial Processing Disorder (SPD) is a well-defined type of APD
- SPD is commonly caused by COM, but can be fully remediated
- Performance on many other AP tests affected by cognitive abilities.
- Link between AP test scores and real-life hearing difficulties is uncertain
- Hearing difficulties can be managed, irrespective of diagnosis of APD
- Treatment of APD likely to benefit from very specific diagnoses
- Need for auditory processing tests less affected by cognitive abilities.

→ Difference tests
Thanks for listening

The support of the Commonwealth Department of Health is greatly appreciated

CAPD.NAL.gov.au - TV news story
- science TV show