Cognition Friendly Amplification

HLAA
Washington DC
June, 2011

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sadly....
Listen Fast!

I have absolutely no original thoughts or ideas.

But how and where you ATTEND will determine how you do!
TOP-DOWN

Executive Functions, Cognition, Auditory & Speech Processing, Memory (short and long-term), Rational Thought & Reason...
BOTTOM-UP:

- Non-linguistic sounds, Clicks
- Pure Tones, psycho-acoustic stimuli,
- Phonemes,
- Pre-cognitive acoustic stimuli
When BU sensory-input is compromised, TD must work harder to maintain balance.
TD & BU balance changes as we age…

Young people w/normal hearing & normal cognition successfully process multiple sensory input.

Cognition is finite.

Multi-Tasking.

Attention.
Driver distractions leading cause of crashes

2009 National Highway Traffic Safety Administration

80% of crashes have distraction within three seconds of the crash!

Leading Distractions:
- Cell phone use.
- Reaching for a moving object inside the vehicle.
- Looking at objects outside the vehicle.
- Reading.
- Applying makeup.
Humans are Dynamic

In 1800, life expectancy 37 years.
In 1900, life expectancy 50 years.
In 2009, life expectancy 79 years.

Life expectancy increased 50% in 100 years, DOUBLED in 200 yrs.

From Page 324, The Singularity – When Humans Transcend Biology. Ray Kurzweil, 2005
CDC 2008 (very similar numbers)
Demographics Summary:
Living longer in an older community! (USA)

From 1990 and 2000, over age 85 yrs grew TWENTY TIMES faster than those between ages 15 and 44 years.

(CDC, 2008).
50 active years after 50 via University of Leeds.

half the babies born in wealthy nations will live to 100 years.
Alzheimer’s Disease:

Alzheimer’s Disease (AD) is the most common dementia. Between 65 and 74 years, 3% has AD. Between 75 and 84, 19% have AD. Above age 85, 50% have AD.
Synergy

Negative Synergy
Negative Synergy

confusion
frustration,
isolation.
What happens when auditory decline and cognitive decline co-exist in the same person?
Audition Matters More as Cognition Declines: Cognition Matters More as Audition Declines.
Audiology Today March/April 2009
Beck & Clark
Nobody lives in a sound booth

Patients live in a world where cognition, attention, memory and audition interact and each plays a critical role in listening.
Listening …

is where hearing meets brain
Hearing Science

Listening Is Where Hearing Meets Brain...in Children and Adults

Research continues to find close links for cognition and hearing

BY DOUGLAS L. BECK, AuD, AND CAROL FLEXER, PhD

Dogs have extraordinary hearing. The literature varies on the actual spectral response of canine hearing across breeds, but in general, it appears to be from about 50 Hz to 40,000 Hz. In practical terms, dogs hear roughly one octave more than humans—thus allowing dogs to hear annoying dog whistles, which are the frequencies humans cannot.
Hearing Professionals speak about HEARING.

We need to speak about LISTENING.

And...with LISTENING, the topic expands exponentially...
LISTENING is more challenging for people who perform less well on cognitive tests, and they do even worse in noisy backgrounds.
Memory Matters

Speech occurs over time and working memory must retain sounds/phonemes/words....
Lunner, 2003:

72 subjects assessed for cognitive function based on working memory and verbal information processing speed.

**VOLUNTEER?**

Subjects with best working memory capacity were better able to identify and report processing effects of experimental hearing aids.

Cognitive ability may significantly impact hearing aid experience.
213 elderly hearing loss subjects evaluated for auditory processing and cognitive function.

Cognitive function was the strongest predictor of individual performance differences.

Performance of auditory processing measures were more related to cognitive ability than auditory ability.
The Role of Cognition in Age-Related Hearing Loss, JAAA, July/Aug 2007, Fergus I.M. Craik

After amplification difficulties w/ speech comprehension remain.

Outcomes depend on allocation of attentional processes.

Audibility may have an inverse relationship with cognition.

Age-related cognitive decline has profound impact on hearing and comprehension.
Individual cognitive processing resources may determine “listening success.”

Signal processing to improve speech understanding may be dependent on working memory (WM).
Multi-tasking, Cognition, Attention and Relaxation…..

“ATTENTION IS THE HOLY GRAIL”

(D. Strayer)

Article: Outdoors and Out of Reach, NY Times, August 15th.
Author: M. Richtel. Quoted David Strayer PhD, Professor of Psych, University of Utah, N.Y. Times, August 15, 2010
Where you attend is how you will do!

Beck, 2010
What to do?

Train the Brain!
SKILL BUILDING
(aka BRAIN TRAINING)

AR

Listening and Comm. Enhancement (LACE)

EXERCISE
Q- What can be done to keep your brain healthy and improve deficits, like memory problems?

A- Everything good for your heart is good for your brain. Exercise is the best thing you can do. Exercise increases brain volume, produces new brain cells in grown-up brains. Exercising your body helps your brain.
Neurogenesis (creation of new brain cells) happens in humans and animals.

Exercise increases neurogenesis.

(...demonstrated conclusively late 1990s by Dr. Fred Gage, Salk Institute.)
Exercise, Cognition, and Audition?
JAMA. 2008;300[9]:1027-1037 (Sept 3, 2008)
Nicola Lautenschlager MD et al (Australia)

Exercise improves cognitive function.

Investigated cognition & auditory processing. The Alzheimer Disease Assessment Scale — Cognitive Subscale (ADAS-Cog) to assess cognitive function.

138 subjects, 59 yrs and older w/memory problems, not dementia.

Group 1-usual care     Group 2-usual care and exercise.
Group 2 improved cognitive function w/modest exercise (walking 20 mins/day).
Skillful Listening:


Listening Skills and Blindness:

Three groups of 10 adults all with normal hearing.
Group 1 - Sighted adults 18 through 30 years
Group 2 – Sighted adults 60 through 80 years.
Group 3 - Blind adults 60 through 80 yrs (blind at least 20 years).

Time compressed (40, 50, 60%) speech in quiet and noise.
Older blind adults (Group 3) recognized time compressed speech better than older sighted adults (Group 2) - and older blind adults (Group 3) performed similar to the younger sighted group (Group 1).

8 members of Group 3 used audio presentations of rapid speech while listening to books-on-tape etc. Seems likely....in the presence of a greater need to develop listening (i.e., cognitive) skills, older people have the ability to improve their listening skills with intentional, motivated and dedicated practice.
Brains change over time...

- Neural Plasticity
- Auditory deprivation effect
- Auditory acclimatization
- Learning
- Memory
- Maturation
- Efferent Nervous System
- Cognitive Reserve
ASHA 2005…

Training should exploit plasticity and cortical reorganization.
Train the brain.

Hearing is a sense, listening is a skill. We can teach & learn skills
Technology’s Role?

Sensory-based percepts drive the process.

If we maximize BU signal, TD functions are easier & more efficient.

Improved opportunity for LISTENING SUCCESS!
Oticon • Amigo

FM Made Friendly
FM: MAJOR ADVANTAGES…

Reduces effect of background noise
Reduces the effects of distance
Reduces the effect of reverb

(see Beck, Doty-Tamasula and Sexton 2006)
What else can we do to achieve Listening Success?
Intelligent Application of Automatics:

Engage (if and only if) SNR improves
Digital Noise Reduction

International Journal of Audiology
Digital Noise Reduction: Outcomes from laboratory and field studies.

Lab-based ratings of EASE OF LISTENING showed digital noise reduction SIGNIFICANTLY better for listening comfort.
Digital Noise Reduction & Speech Enhancement

(Dillon, Ching & Golding in PEDIATRIC AUDIOLGY, 2008, by Madell and Flexer)

Multiple studies over decades show adults prefer noise suppression for speech comfort, and to make noise less salient (prominent), despite noise reduction having little or no effect on WRS.....
Noise Reduction & Speech Enhancement (paraphrased…)  
(Harvey Dillon, Teresa Ching & Maryanne Golding)

Spectral changes from noise suppression ALWAYS improve speech.  
Therefore, we tentatively recommend noise reduction systems be routinely enabled for children of all ages… just like adults.

16 children ages 5 to 10 yrs w/mild-to-moderately severe SNHL
Goal: To examine the effects of digital noise reduction.
Test Stimuli: Nonsense Syllables, Words, Sentences in Noise

CONCLUSION:
Consistent with previous studies, NR does not have negative effect on perception of nonsense syllables, words or sentences for these children using SNRs of 0, +5 and +10 dB.
Wireless:

High speed transfer of information.
High speed exchange of information.
True binaural fittings.
Bluetooth, NFM, etc…
What else can we do to achieve Listening Success?
Feedback Management
Evolution of Feedback Approaches

- Turn down volume
- Limit the High Frequencies
- Notch the Response
- True Cancellation
What else can we do to achieve Listening Success?
Extended Bandwidths in Hearing Aids
Beck & Olsen, Hearing Review,
October 2008

- Improved spatiality.
- Improved Speech-in-Noise.
- Improved Word Recognition Scores.
- Improved music perceptions.
- Improved sound quality.
Bandwidths to 10 kHz
Stelmachowicz et al. / Ear & Hearing, Vol. 28, No. 4, 483–494
What else can we do to achieve Listening Success?
Directionality

Effective in a limited set of conditions

Speech in front, nearby.
Noise present, back & side.
Reverberation not excessive.

(Walden et al 2003)
Directional Microphones (paraphrased…)
(Harvey Dillon, Teresa Ching & Maryanne Golding)

As of 2008, results at NAL based on efficacy of directional mics in real-life listening situations suggests…Once the child is old enough to turn their head to face the talker, enable directional mics to get better SNR.
Every sound has a spatial signature

Yet we usually only address spectral and amplitude components.
New Compression Concept

When two hearing aids communicate, coordinated compression can better preserve spatial cues.

Spatial Sound 2
Speech Guard
What else can we do to achieve Listening Success?
How important is Spatial Sound?

What is the number one complaint of people (children in particular) with APD?

What is the number one complaint of patients with regard to hearing aids?

What is the number one complaint that brings people in for a hearing evaluation?
To understand speech in noise...

...identify the sound source
Knowing WHERE TO LISTEN matters.
Michael Merzenich Ph D
British Academy of Audiology,
Liverpool, England, November 2009

NeuroScientist and Professor Emeritus UCSF

Known world-wide for brain plasticity research

PhD from Johns Hopkins Medical School (Physiology)

Recognition and Prizes from:
National Academy of Sciences
Ipsen Prize, Zulch Prize from the Max-Plank Institute,
Thomas & Alva Edison Patent Award, Purkinje Medal…

Contributed to more than 232 publications
Merzenich Paraphrased (DLB):

Hearing correction NECESSARILY drives neurological change.

Brains continuously change via input and stimulation.

Brain plasticity is modulated by ATTENTION and WORKING MEMORY.

With regard to the AUDITORY DOMAIN, we can improve at any age.

The CAPACITY for POSITIVE BRAIN CHANGE is largely UNDER APPRECIATED.
Cognition & Audition:

When we provide extended high frequencies, spatial cues, noise reduction, adaptive directionality, we provide a better bottom-up stimuli.

When the bottom-up signal is maximized the top-down system requires less brain power trying to untangle the input, communication is maximized.
Cognitive Friendly Amplification:

Hearing aids that maximize the SNR.
Hearing aids with directionality.
Hearing aids with extended bandwidth.
Hearing aids that preserve spatial cues.
Hearing aids that decrease annoyance.
Hearing aids that provide binaural hearing.
Hearing aids that people will wear.