Multisensory Integration and Aural Habilitation for Children with Reduced Hearing

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Language Outcomes of Children with Reduced Hearing: We've Come A Long Way…

Widespread implementation of newborn hearing screening

Benefits of 1-3-6 (Moeller, 2000; Downs, 2000; Yoshinaga-Itano, 1998)

…but we have a long way to go…

>40% of children with varying hearing levels *underperform* in the area of language (Meizen-Derr et al., 2018)

Social communication abilities in those with reduced hearing *lag behind* those of peers with normal hearing (Hoffman, Quittner, & Cejas, 2015; Meizen-Derr et al., 2014)

Children with CI are *not achieving age-appropriate levels of language proficiency* (Niparko et al, 2010; Nittrouer, 2016)

Variability in post-operative CI performance remains (Cosetti & Waltzman, 2012)

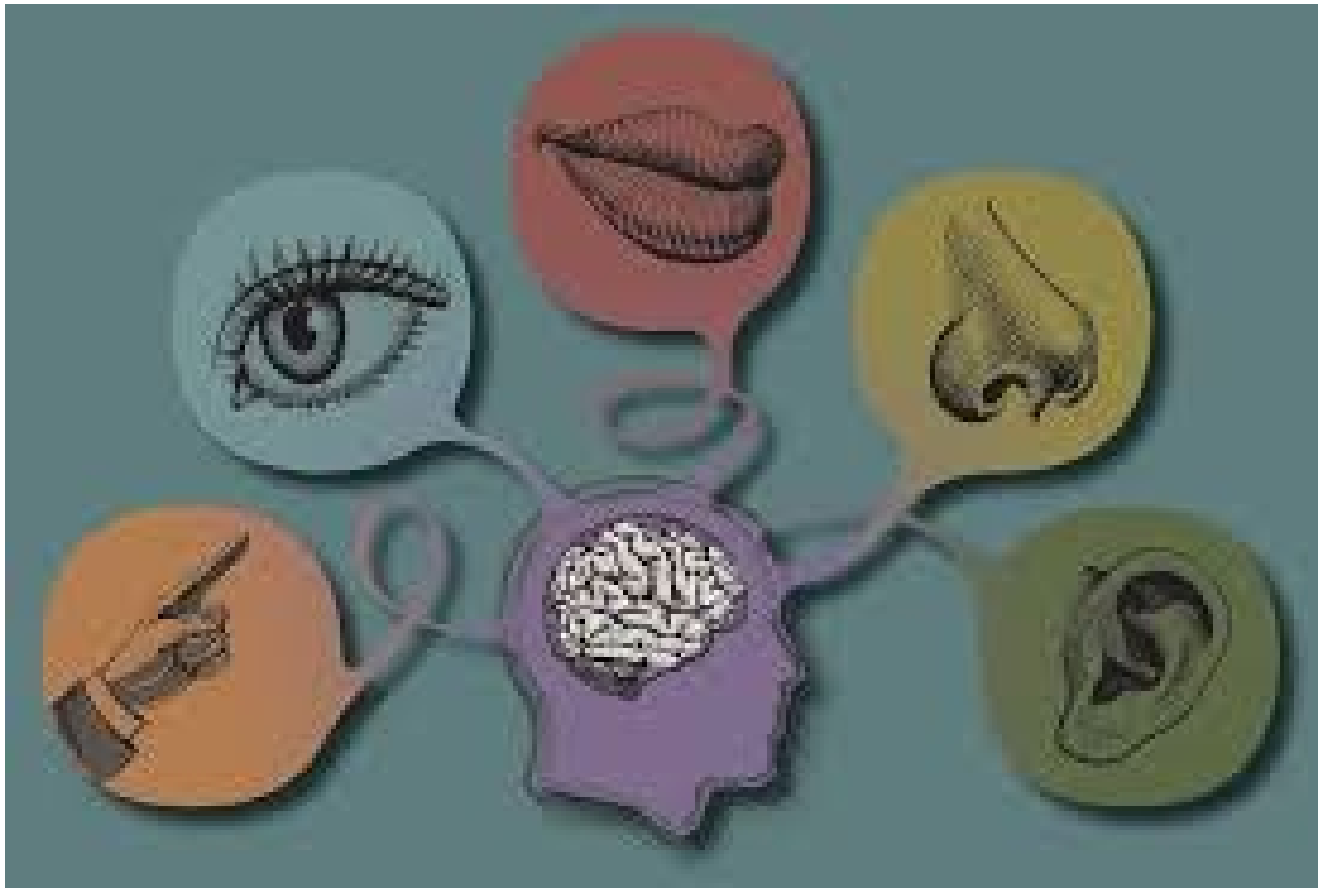
Using Brain Science to Inform Current Clinical Practices

- First human magnetic resonance imaging prototype created in 1977
- Largely, aural rehabilitation tools have remained static

Limitations of Unisensory Input

The brain works best when it uses **MULTIPLE** senses together, thus employing **MORE** areas to **PROCESS** the signal

(Dionne-Dostie et al., 2015; Lewkowitz & Krabel, 2004; Murray & Wallace, 2012; Stein, 2012)



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What is Multisensory Integration (MSI)?

- The process by which information from different sensory systems are combined to influence perceptions, decisions, and overt behaviors (Stein, Stanford, & Rowland, 2009)

Benefits of Using MSI

Increased acuity in one of the modalities

Reduction of detection thresholds

2+ senses stimulated=> increase in brain activation

Decreased response time

Increased target detection accuracy

(Dionne-Dostie et al., 2015)

Medicaldaily.com

Babies are Multisensory Beings!

Most, if not ALL, of the neocortex processes information in a *multisensory* way

MSI and Infants

- Infants who are just a few hours old can learn sight-sound pairings (Morrongiello, Fenwick & Chance, 1998)
- Infants pay more attention to faces when the visual and auditory signals match (Kuhl & Meltzoff, 1982; MacKain et al., 1983)
- 4-month-old infants use multiple modalities to perceive affect (Caron, Caron & MacLean, 1988; Flom & Bahrick, 2007)

Parenting.firstcry.com

Baby Brains Crave Language

- Brains are primed to access all languages to which they are exposed (Baker & Pettito, 2005; Kuhl, 2010;)
- Statistical learning
  - dependent on input
  - greater variety of linguistic information → greater the ability to perform these statistics (Kuhl, 2010)
- Ability to perceive linguistic categories - similar for both audition and vision; infants “ignore modality differences” (Baker, Pettito, Michnick-Golinkoff, 2006).
- Brain seeks patterns, then determines meaning
  - In ASL (Baker, Sootsman, Golinkoff, & Petitto, 2003)
  - In spoken English (Kirkham, Slemmer, & Johnson 2002)

Social Interaction is Necessary for Language Learning

Connections and Interactions with Communication Partners is Where the Magic Happens

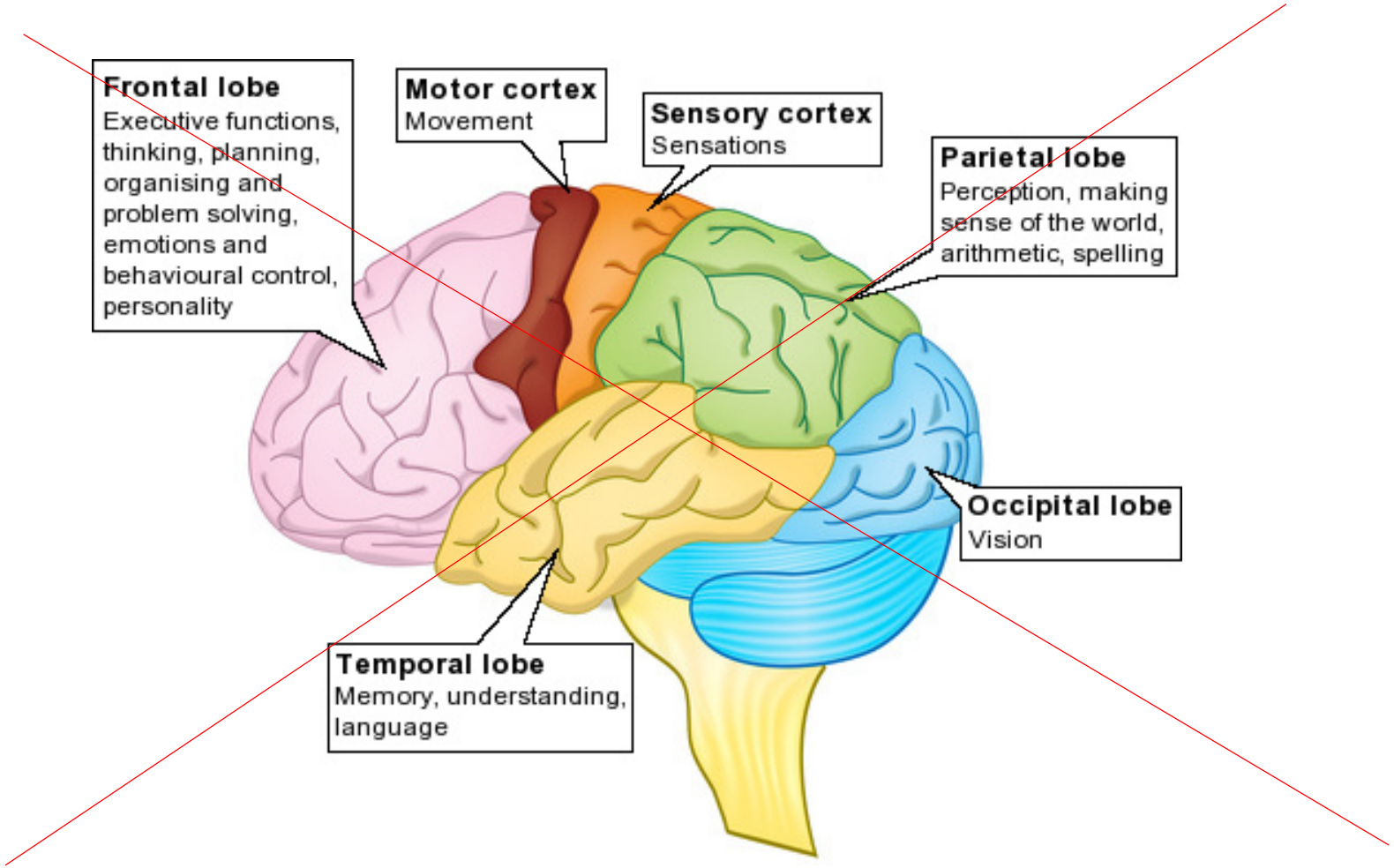
Social aspects of communication (joint attention & turn-taking) = building blocks for preverbal communication (Kuhl, Tsao & Liu, 2003)

Parental responsiveness to the exploratory and communicative behaviors of infants facilitates language learning (Tamis-LeMonda, Kuchirko & Song, 2014).

Caregiver/child turn-taking - impact > # words (Romeo et al, 2018)

When child is DHH, parental responsiveness & caregiver-child reciprocal communication should be as accessible as possible, utilizing all senses that the infant can process.

Unisensory Processing Areas in the Brain

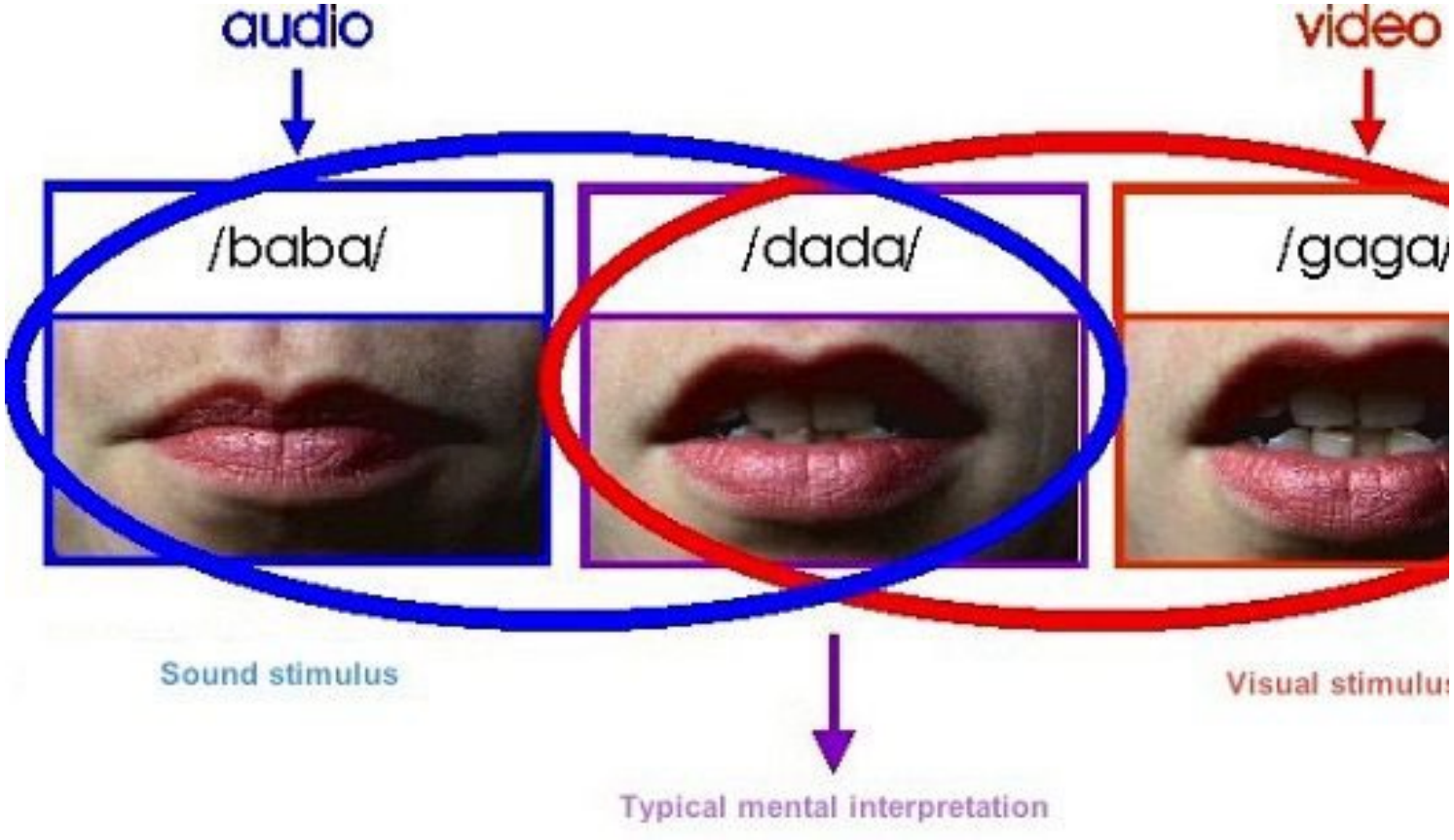


Truthseeker.co.uk

Multisensory Integration & Learning

- Connections between language & motor cortices → enhance comprehension, faster processing of information (Dionne-Dostie et al, 2015; Murray et al, 2016).
- Specific language + actions → "cell assemblies," facilitates faster processing of info (Pulvermuller, 2005).
- Using multiple modalities increases efficiency and accuracy in the task (Shams & Seitz, 2008)
- Memory is strengthened by multiple sensory inputs (Quak, London, & Talsma, 2015).

Multisensory Input are “More than Additive”



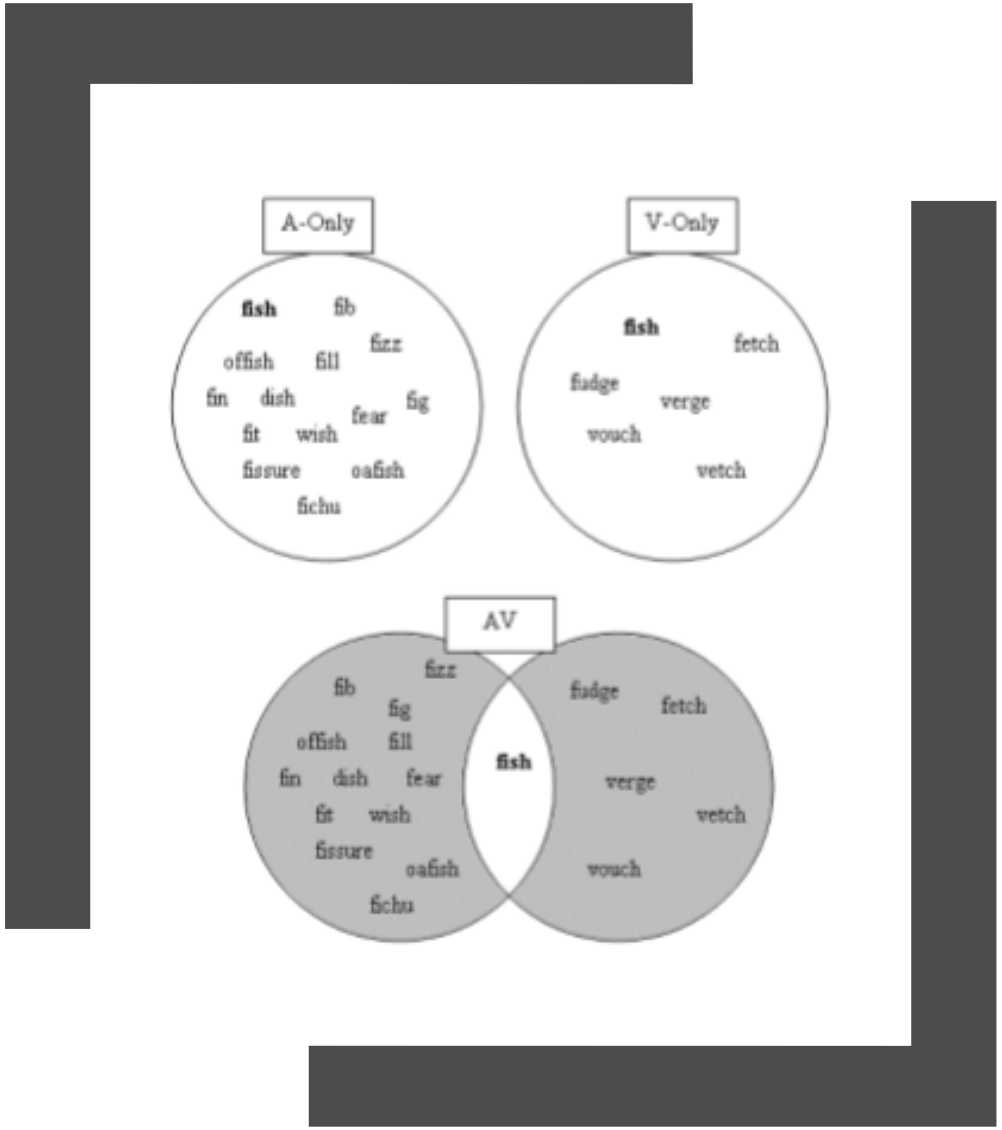
Multisensory Integration & Speech Perception

- McGurk Effect
- Listeners combine auditory + visual input
- Perceive a response that is not detectable in either condition, but is perceptible in the presence of the combined auditory and visual stimuli.
- Kinematics of the head, face (especially eyebrows), and mouth contribute to greater speech understanding than exposure to the mouth and lips alone (Yehia, Kuratate, & Vatikiotis-Bateson, 2002).

Whether one has reduced hearing or typical hearing, most people demonstrate enhanced speech recognition when they both hear *and* see the person speaking versus listening alone (Tye-Murray, 2007)

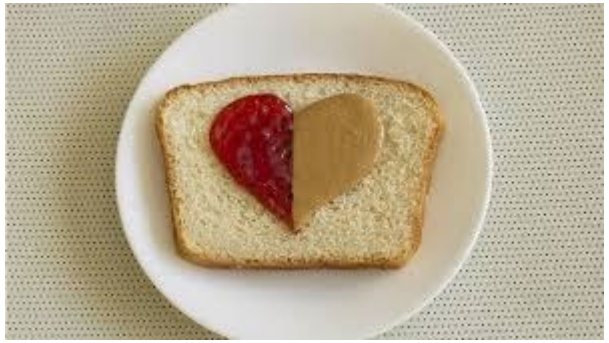
combined auditory and visual information, surpassed what would have been predicted by simply adding the scores obtained in the auditory and visual conditions alone (Sommers, Tye-Murray, & Spehar, 2005)

1+ 1= 3.4?



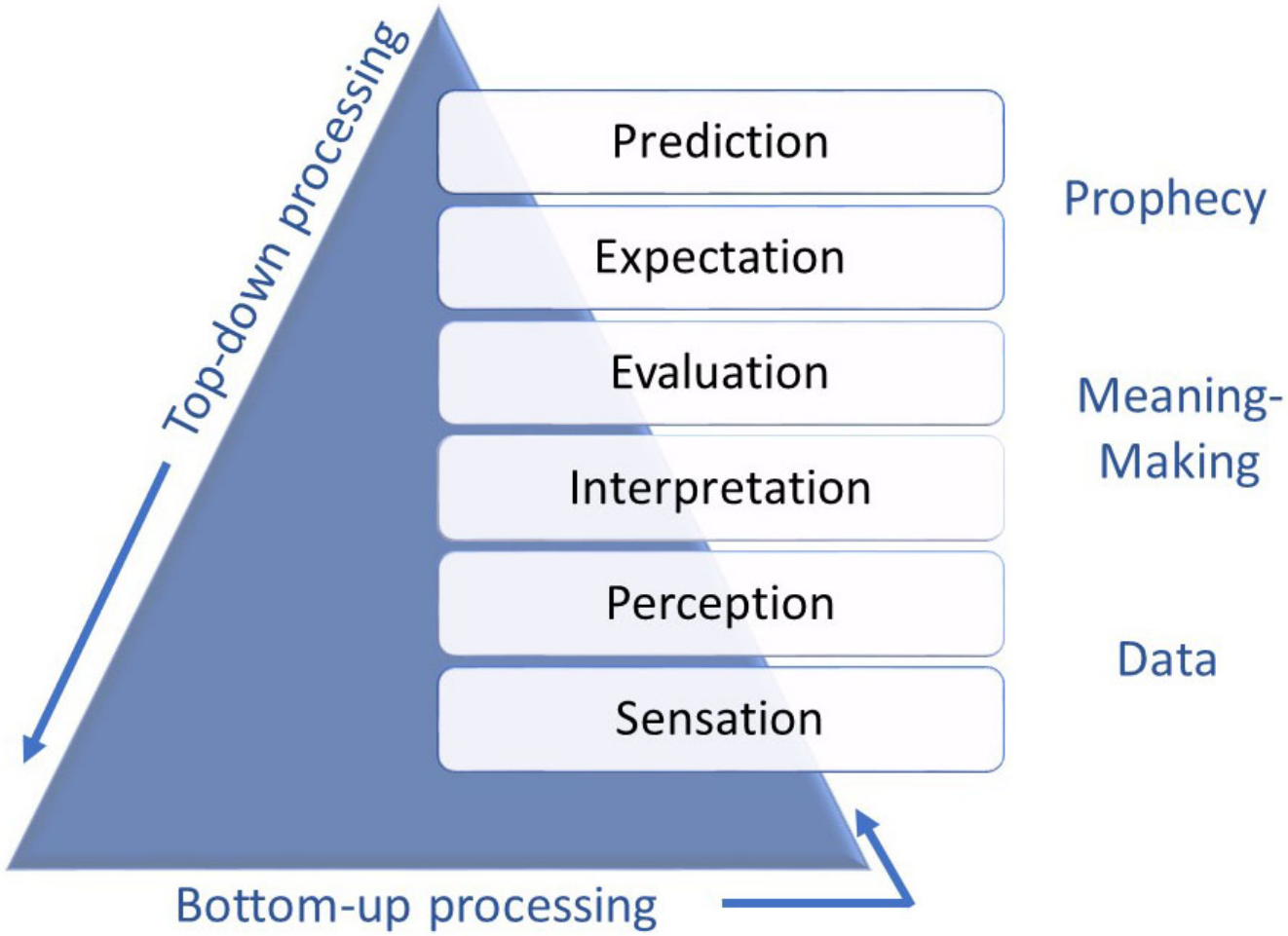
(Tye-Murray, Sommers, & Spehar, 2007)

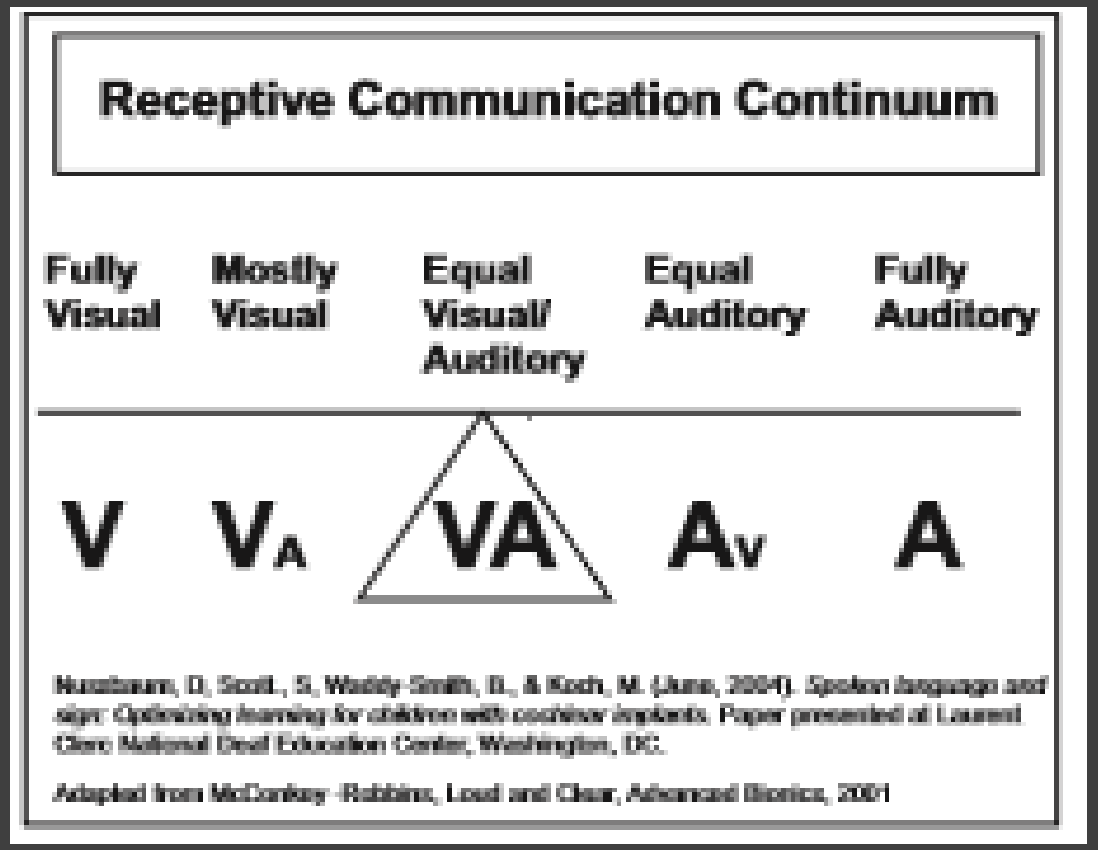
Visual and Acoustical Lexical Neighborhoods: Like Peanut Butter and Jelly!

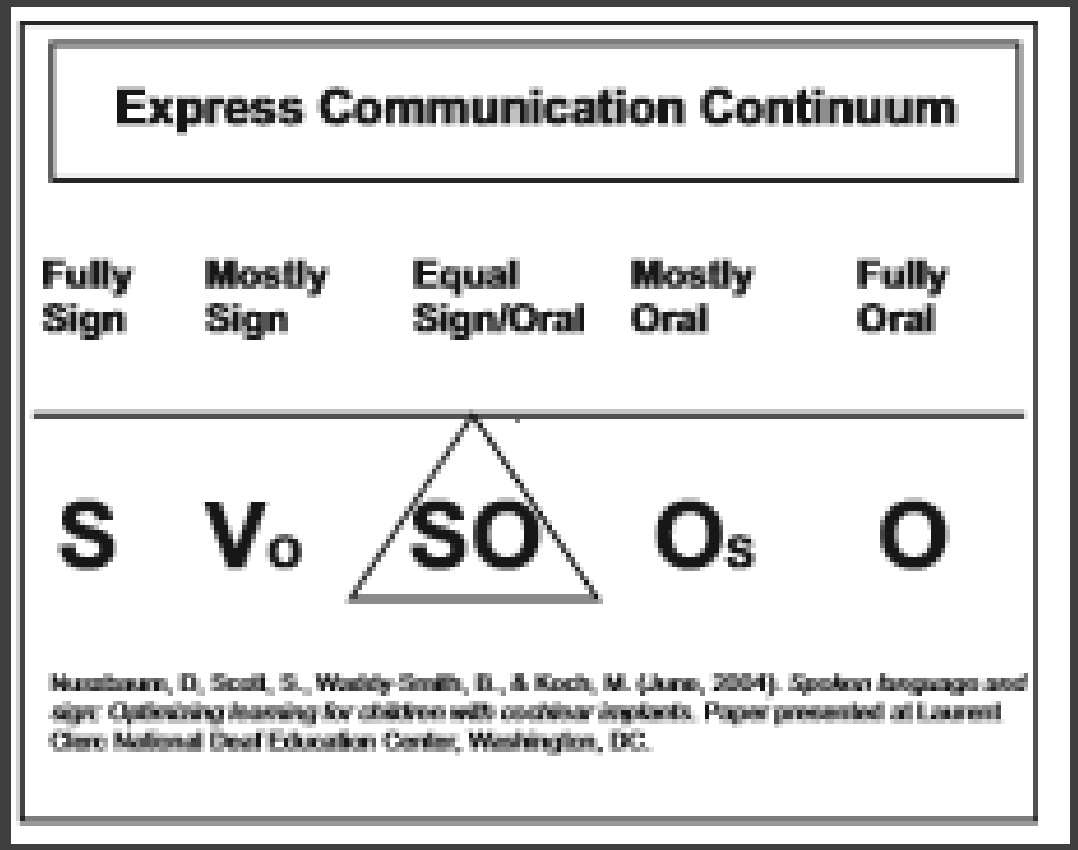


News.temple.edu

The Brain Uses Top-Down & Bottom-Up Processing

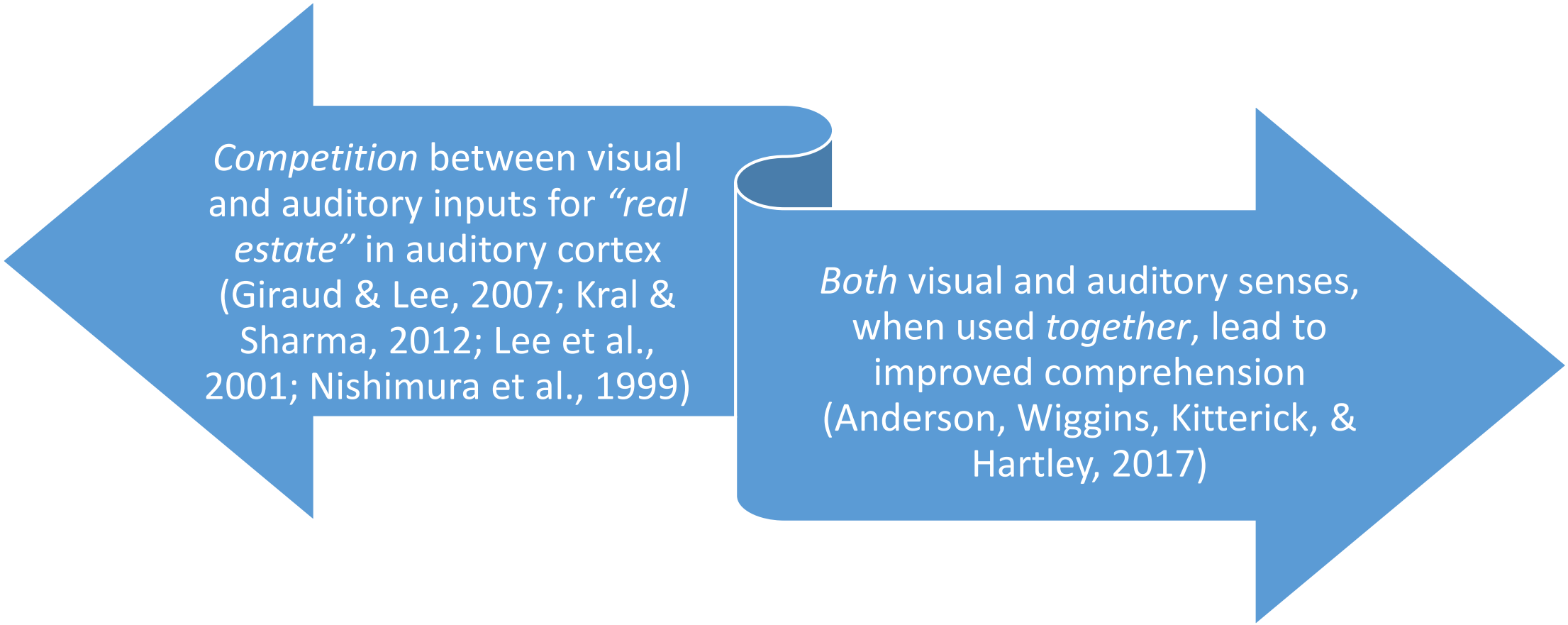






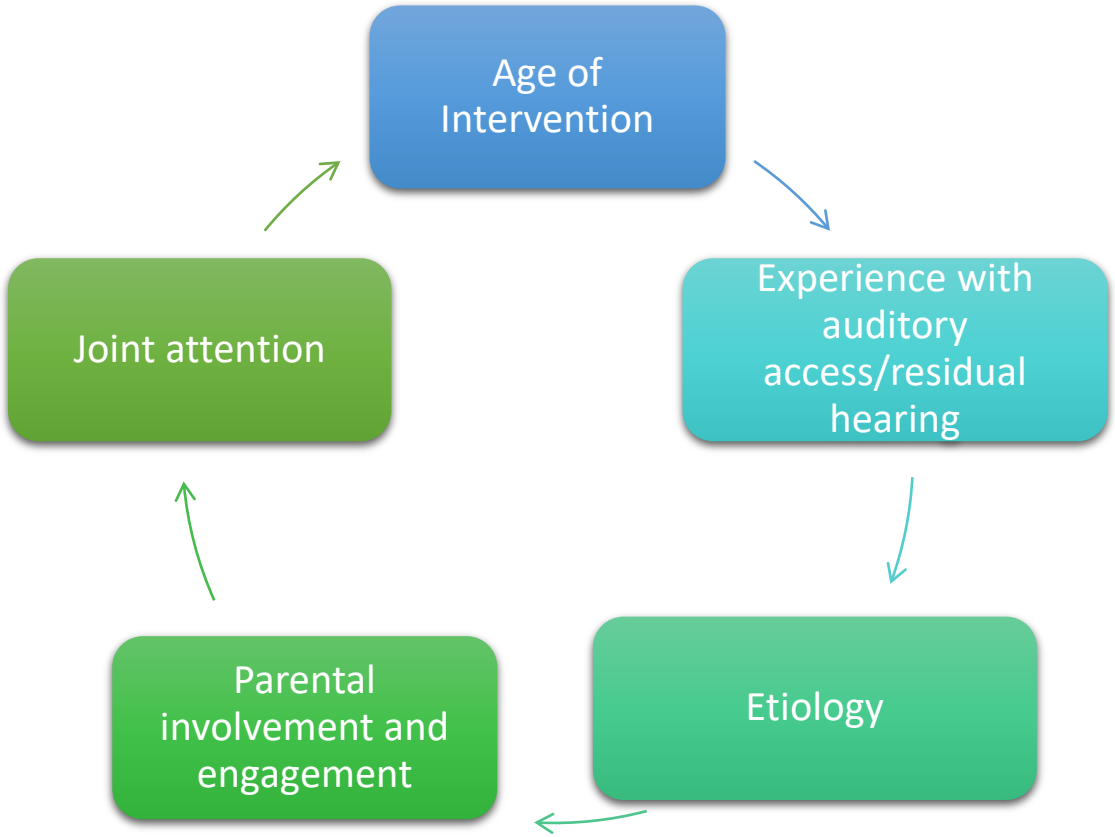
The Continuum of Communication Opportunities

Beliefs Regarding MSI and the Deaf/HOH Population



Outcomes Are **Not** Solely Related to Using A Specific Communication Strategy or Technological Tool…

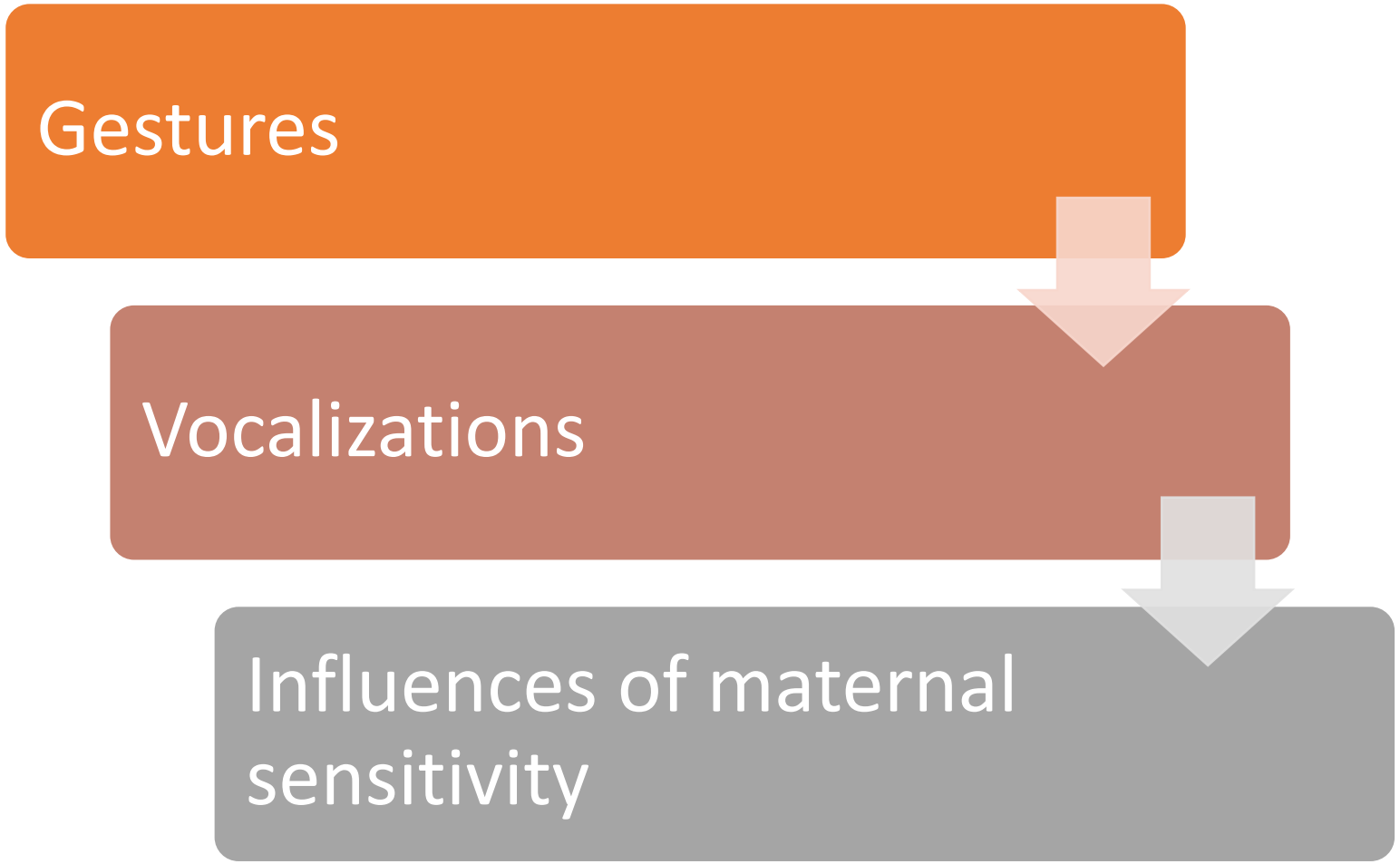
Hearingaidcentre.in, blisspeech.com, sites.google.com, pbs.org



(Szarkowski, 2018)

…But are a Multifactorial Process

Benefits of *Multimodal* Early Communication Interactions



A "Cascading Model of Language Learning" (Roberts & Hampton, 2018)

Multimodal Input & CIs

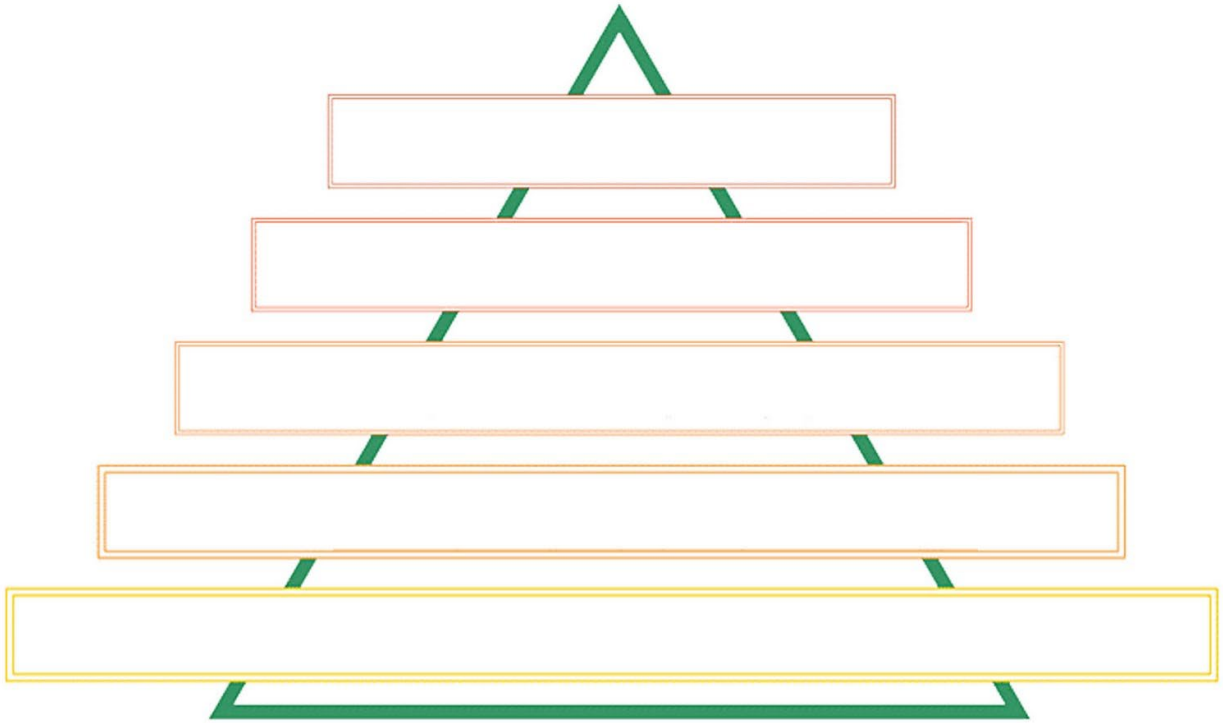
CIs provide a spectrotemporally “degraded” signal - improved auditory performance with a CI when MSI is used (Rouger, 2007)

When multimodal input used & speech is presented with visual supports → gains in both auditory and visual abilities (5 yrs post-implantation (Bergeson, Pisoni, & Davis, 2005).

Providing visual input isn’t cheating!

Reconsidering the Listening Hierarchy

- Assumes that auditory skills are built on increasingly complex auditory tasks
- Sound awareness to Comprehension
- First proposed by Hirsch (1970) as an auditory rehabilitation protocol for the adult population
- Widely used, but not based in neuroscience



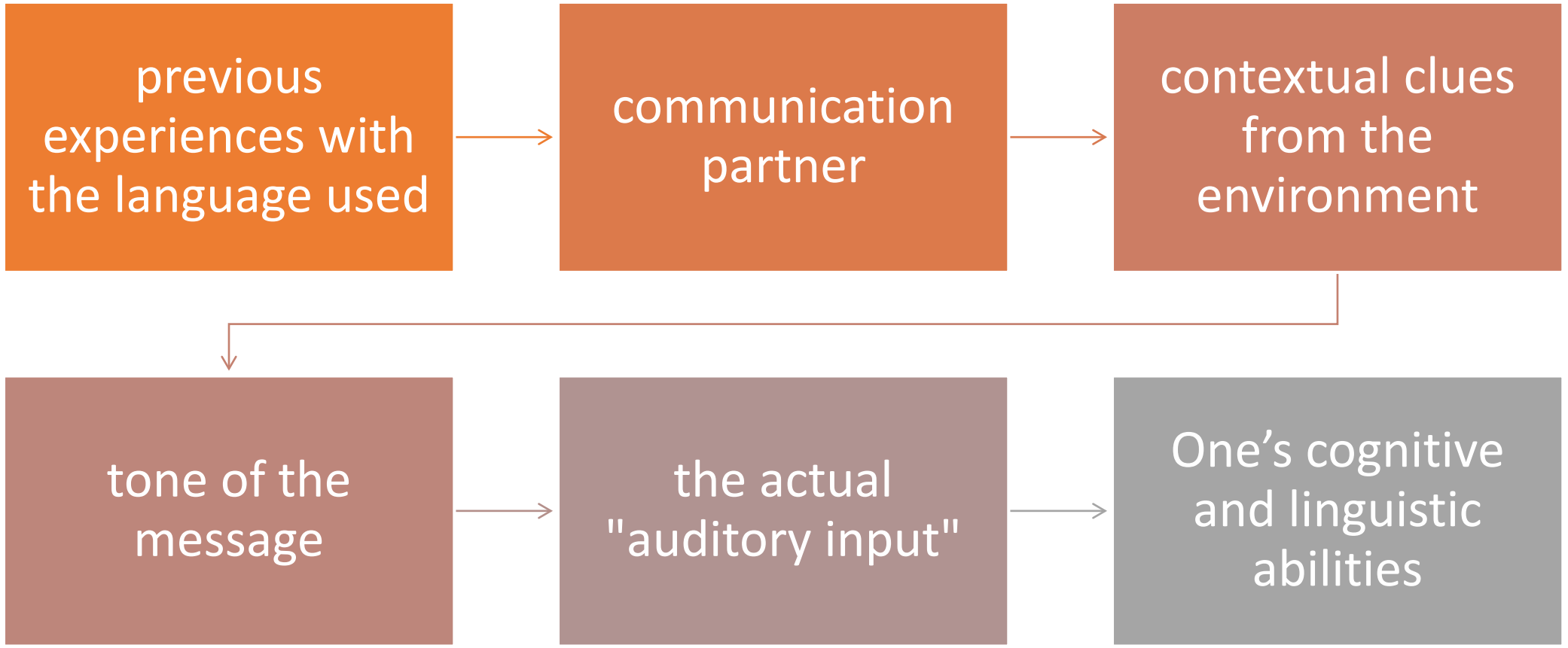
How the Brain Makes Sense of Sound

Various areas of the brain are employed simultaneously

After reaching the cortex, electrical impulses travel to secondary and higher-order areas that combine features of the signal into meaningful representations (Kral, 2013; Kral & Eggermont, 2007).

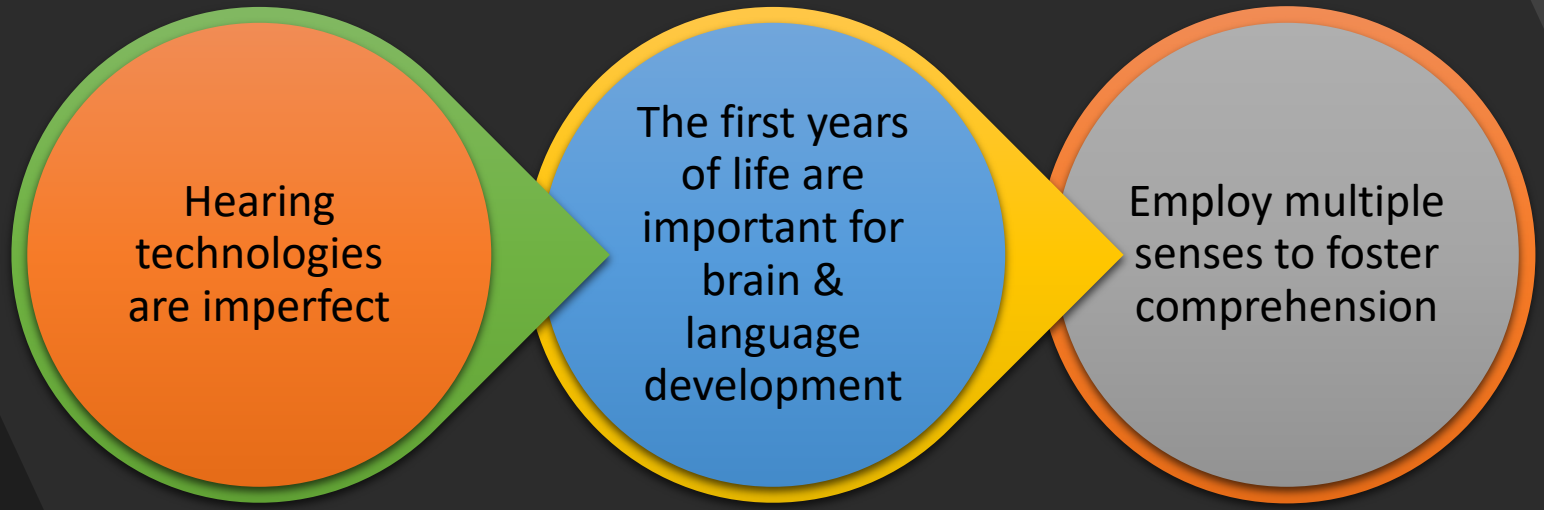
These higher-order areas include neurons that respond to multiple senses (e.g., auditory, tactile, visual).

Importantly, the brain relies on both top-down and bottom-up processes, transforming the stimulus to a unique pattern of neural activity (Bhatnagar, 2012).



Making Sense of Auditory Input

Clinical Considerations:
The Time Has Come to Change Practice



Consistent & Accessible Early Language

Forms the neural connections associated with positive linguistic and cognitive developmental outcomes.

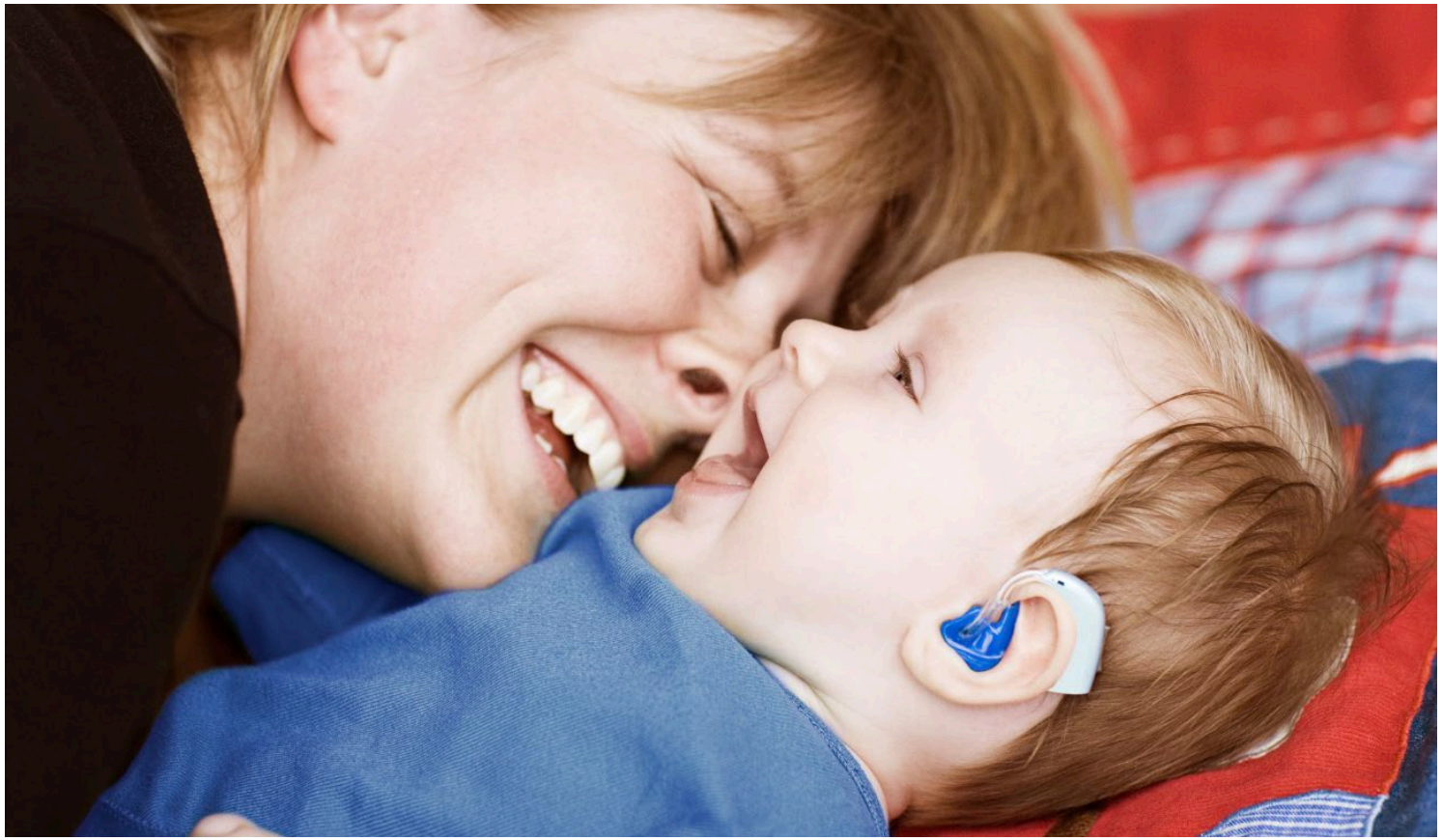
For infants who have hearing levels that do not allow them to obtain sufficient access to language through hearing, a visual language, as well as gestures and visual prompts, should be used.

MSI is important for brain development

Integration of sensory information → development of perception and higher level cognitive functioning.

Auditory information is not only processed in the auditory cortex, but across many different cortical areas.

Our brains learn best when information is provided using more than one sense.



MSI promotes social development

- The social brain “gates” language development. Babies use social cues and connections to comprehend their role in this social world.
- Social interaction triggers infants’ brain networks and are essential to learning language.
- MSI promotes parental responsiveness and caregiver-child reciprocal communication, including in infants who are DHH.

Therapy Should be Multimodal

If the brain thrives on multisensory input, shouldn’t the therapeautic approaches used to aid children with reduced hearing go beyond focusing on hearing alone?


Leedsth.nhs.uk


Pintrest.com


Etsy.com

Use All Those Tools in Our Toolkits!

The Brain Does Not Work in a Linear Manner

- Habilitation approaches should be informed by cognitive/neuroscience
- The brain does not “add sounds together to lead to comprehension”
- Other factors facilitate understanding:
  - previous experience with the language
  - world knowledge
  - familiarity with the communication partner
  - contextual environmental clues

Rehabilitation Should Minimize the Use of Discrete Skills

- Understanding the role of discrete skills assessment
- Limit ”Say ____” and “Show me _____”
- Child-led interactions

Continuum of Communication Opportunities:

- Ensure language exposure & access
- Follow the child's lead
- Monitor progress & adjust as needed

Parting Thoughts

Research continues to inform us on how infants and children learn language and the brain processes involved.

We need to be cognizant of these findings and adapt our rehabilitation techniques to better meet the needs the children we are privileged to support.

Here Is a Good Read!

- Mumby Gibbons, S. and Szarkowski, A. (2019). One Tool in the Toolkit is Not Enough: Making the Case for Using Multisensory Approaches in Aural Rehabilitation of Children with Reduced Hearing. *Perspectives of the ASHA Special Interest Groups, 1-11.* https://pubs.asha.org/doi/10.1044/2018_PERS-SIG7-2018-0005

We appreciate your attention

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