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Auditory Skills Assessment (ASA): Administration, Scoring, Interpretation

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Learning Objectives

- After this course, participants will be able to:

1. Identify critical auditory and listening stages for young children.
2. Describe benefits of early testing and intervention due to brain neuroplasticity.
3. Identify a measure to evaluate young children's auditory skills for early intervention.

What Has Been Done to Assess Auditory Skills in Young Children?

Allen & Nelles, 1996

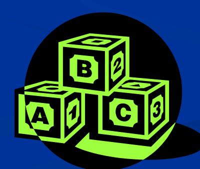
- Found that the ability of normal hearing children ages 4–7 years on an auditory discrimination task improved with increasing age until age 7 at which time performance was adult-like
- The 7-year-olds and the adults were able to discriminate the sequence of tonal pairs with component frequencies
- As the sequences were increased, the 4- to 6-year-olds as a group were not able to perform the task

Jensen & Neff, 1993

- Children's ability (ages 4–6 years) to discriminate between stimuli that vary along single acoustic dimensions is much poorer than that of adults
- Intensity discrimination was adult-like by age 5
- Frequency and duration improved with age, but remained poorer than adults' discrimination for many 6-year-olds
  - This may be reflected in general music skill development, as in the commonly observed difficulties of young children to stay "on tune" or in rhythm

Boets, Wouters, van Wieringen, & Ghesquière, 2007 Katholieke University ▪ Leuven, Belgium

- Found that the children who presented significant pre-school deficits in phonological awareness, rapid automatic naming, speech-in-noise perception and frequency modulation detection were those who had increased family risk and literacy impairment at the end of first grade



Torgesen & Mathes, 1998

- Found that children can detect and compose rhymes by kindergarten
- By the end of kindergarten, they can isolate and pronounce the beginning sounds in a word
- Midway through 1st grade, they can isolate and pronounce all the sounds in two- and three-phoneme words

Torgesen & Mathes, 1998

- By the end of 1st grade, children can isolate and pronounce the sounds in four-phoneme words containing initial blends
- Although some children may acquire some rudimentary phonological awareness skills as early as 2½ to 3 years of age, more advanced skills are not mastered until the end of 1st grade

Kraus, Koch, McGee, Nicol, & Cunningham, 1999

- Auditory discrimination skills are developed by age 6
- They used just noticeable differences (JND) and mismatch responses for synthetic syllables that differed in formats. This does not require a behavioral response or attention
- Many aspects of auditory perception of nonspeech and speech stimuli are largely mature by school age but perception continues to develop during school-age years, which can be modified by auditory experience

Burt, Holm, & Dodd, 1999
United Kingdom

- Children as young as 3 years of age can be aware of onsets and rimes, and a strong relationship has been established between the knowledge of nursery rhymes and the development of intrasyllabic awareness skills (Maclean et al., 1987)
- Phoneme isolation and segmentation have the best predictive validity for later reading skills (Liberman & Shankweiler, 1985; Yopp, 1988)

Burt, Holm, & Dodd, 1999
United Kingdom

Normally developing preschool children can:

- Produce consistent phonological representations
- Imitate nonwords
- Produce lexical items in imitation, naming, and connected speech with low variation and high accuracy
- Segment words into syllables (older and upper socioeconomic status children have the best ability)
- Demonstrate awareness of rime (upper SES children have the best ability)
- Demonstrate awareness of onset (older and upper SES children have the best ability)

Burt, Holm, & Dodd, 1999
United Kingdom

- Early identification of children with poor phonological awareness would allow appropriate intervention to be offered
- Intervention could prevent reading and spelling failure and the negative consequences commonly associated with literacy difficulties

Auditory Skills in Special Populations

- Children with reading impairments show subtle speech perception deficits in quiet but very significant deficits in background noise (Ziegler, Pech-Georgel, George, Alario, & Lorenzi, 2005)

Auditory Skills in Special Populations

- Children with a learning disability perform more poorly and are more adversely affected by degrading signal-to-noise ratio on speech in noise tasks (Chermak, Vonhof & Bendel, 1989; Bradlow, Kraus, & Hayes, 2003)
- Children (2–4 years old) with a receptive language problem showed poor performance on a nonsense word repetition task (Roy & Chiat, 2004)
- Showing that poor performance on a nonsense word repetition task may be indicative of a wider language problem, at least in young children

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Which Auditory Skill Areas Should be Assessed

Auditory Skills to be considered for Assessment

Auditory Skills

Speech Discrimination in Quiet	Speech Discrimination in Noise	Memory	Phonological Awareness	Nonspeech Processing
Sound Mimicry			Segmentation Sound Blending Rhyming	Tonal Discrimination Tonal Patterning

Limitations of Testing Young Children

- Memory and attention
- Many do not have intelligible speech
- Age-appropriate instructions and response requirements
- Concept limitations
- Difficult to test and obtain consistent responses
- Poor reliability

Administration Procedures Employed to Minimize Response and Concept Limitations

- Select words likely to be recognized by young children
- When picture pointing response is required, picture-word association training is provided.
- When mimicry response is required, provide items that are easily articulated.
- Every effort was made to introduce and explain tasks in a way that young children would understand (child-friendly, scripted examiner text).
- Practice items are provided to ensure that children knew how to do the tasks.
- Teaching provided after failed practice items.

Auditory Skills Tested in Tryout Studies

1. **Speech Discrimination in Quiet** (27 items)
   - For each item, one stimulus word is played from a stimulus CD
   - Child must point to the one picture from a set of four that illustrates the word
2. **Speech Discrimination in Noise** (27 items)
   - For each item, one stimulus word is played against a background of conversation-like noise from a stimulus CD
   - Child must point to the one picture from a set of four that illustrates the word
3. **Mimicry** (24 items)
   - For each item, a nonsense word that follows conventional English sound patterns is played from a stimulus CD
   - Stimulus words are 1–4 syllables long
   - Child is asked to repeat the word

Phonological Awareness

4. **Blending** (24 items)
   - For each item, phonemes of a common vocabulary word, separated by brief pauses, are played from a stimulus CD
   - Part 1: Child points to the one picture from a set of six that illustrates the word
   - Part 2: Child is asked to say the blended word (no visual clues)

Phonological Awareness

5. **Segmentation** (18 items)
   - Concept of "first" and "last" sound taught through examples and practice items
   - For each item, a one-syllable nonsense word is played from a stimulus CD
   - Items 1–9: Child is asked to say the first sound in the nonsense word
   - Items 10–18: Child is asked to say the last sound in the nonsense word

6. **Rhyming** (15 items)
   - Concept of rhyming taught through examples and practice items
   - For each item, a pair of words is played from a stimulus CD
   - Child is asked if the two words rhyme (yes/no)

Auditory Verbal Memory

7. **Memory** (12 items)
   - For each item, a set of 2–4 unrelated, common vocabulary words are played from a stimulus CD
   - Child is asked to repeat the words in the same order
   - Responses were scored according to the number of correct words repeated (content score), plus a bonus point if words were given in the correct sequence (sequence score)

Non-speech Processing

8. **Tonal Discrimination** (12 items)
   - For each item, a pair of musical tones are played from a stimulus CD: either (1) one oboe and one piano, or (2) two tones from the same instrument
   - Child is asked if the two sounds are the same (yes/no)

9. **Tonal Patterning** (12 items)
   - Concept of "which played last" taught through examples and practice items
   - For each item, two successive tones—one from each instrument (oboe/piano)—is played from a stimulus CD
   - A card with a picture of an oboe and a piano is presented
   - Child points to the picture of the instrument that was played last

Research Questions

1. **At what age can children understand and successfully perform the task** posed in each auditory skill subtest?
2. **At what age can reliable data be obtained** for each subtest?
3. Do the subtests **discriminate sufficiently between clinical and nonclinical** cases?

Administration Procedures

- Studies 1 and 2 began with 49 training items.
- All subtests except Speech Discrimination in Quiet began with several practice items to ensure that children knew how to do the tasks.
- Teaching provided after failed practice items.
- Every effort was made to introduce and explain tasks in a way that young children would understand (child-friendly, scripted examiner text).

Method

Study 1 (May–June 2007)

- N = 547
- Ages 3:6–6:11
- Nonclinical cases of children with no prior diagnosis of hearing loss and no current ear infections
- Subtests: Speech Discrimination in Quiet, Speech Discrimination in Noise, Mimicry, Rhyming, Blending, Segmenting, Memory

Study 2 (July–August 2007)

- N = 209
- Ages 3:6–6:11
- Nonclinical cases of children with no prior diagnosis of hearing loss and no current ear infections
- Subtests: Nonspeech Processing—Tonal Discrimination and Tonal Patterning

Method

Study 3 (Oct–Nov 2007)

- *N* = 45
- Ages 3:6–6:11
- Clinical cases of children judged by SLPs to be at-risk for auditory skill deficits
- Subtests: All subtests from Studies 1 & 2 except Speech Discrimination in Quiet

Research Questions

1. **At what age can children understand and successfully perform various types of tasks** that reflect different auditory skills?
2. **Can reliable data be obtained** for children of a certain age performing particular auditory skills tasks?

Analysis

The following results would suggest that a particular subtest is an age-appropriate assessment tool:

- Fewer than 20% of children with normal hearing acuity score at or near the "guessing" or "chance" level
  - indicates task is comprehensible for children at this age
- Internal–consistency reliability statistics obtained for the subtest for a particular age group are acceptably high
  - indicates subtest is measuring a specific construct

The age group for which both of the above criteria were met for each subtest is circled on the corresponding histogram.

Results

Analysis of the data from Studies 1–3 found that reliable data could be obtained for children as young as 3 years 6 months for the following subtests:

- Speech Discrimination in Quiet
- Speech Discrimination in Noise
- Mimicry
- Memory

Results

Reliable data could be obtained for children as young as 5 years for:

- Mimicry
- Blending
- Rhyming
- Nonspeech Processing—Tonal Discrimination & Tonal Patterning

Reliable data could be obtained for children as young as 5 years 6 months for:

- Segmentation

Research Questions

3. Do the subtests **discriminate sufficiently between clinical and nonclinical** cases?

Results

An analysis of the score differences between the nonclinical samples in Studies 1 and 2 and the clinical sample in Study 3 indicated that all of the subtests compared showed acceptable levels of sensitivity and specificity.

Subtest	Sensitivity	Specificity	Mean z*
Speech Discrimination in Noise	.60	.60	-.56
Mimicry	.60	.59	-.37
Rhyming	.65	.64	-.57
Blending	.65	.62	-.79
Segmentation	.65	.54	-.63
Memory	.65	.62	-.62
Nonspeech Processing	.70	.65	-.98

*Age-based z scores based on the nonclinical sample.

Note. Speech Discrimination in Quiet was not included in Study 3; thus, it is not reported here. Analyses adjusted for sex, SES, and race/ethnicity.

Test Sections Eliminated

- Speech Discrimination in Quiet-- Too easy and not as discriminating as Noise
- Segmentation--Too difficult and unreliable for children under 5 years, 6 months
- Memory--weak retest reliability and lengthy administration
- Reduced total number of test items from 147 to 56

Product Domains/Sections

A DOMAINS AND SECTIONS

ech Discrimination Domain	
tion 1: Speech Discrimination in Noise	Discriminate words heard against a background of conversational nc
tion 2: Mimicry	Repeat a spoken nonword
nological Awareness Domain	
tion 3: Blending	Recognize or say a word after hearing its syllables or phonemes spok
tion 4: Rhyming	Indicate whether two spoken words rhyme
speech Processing Domain	
tion 5: Tonal Discrimination	Indicate if two tones are from the same instrument
tion 6: Tonal Patterning	Indicate which of two tones was presented last

ASA Components

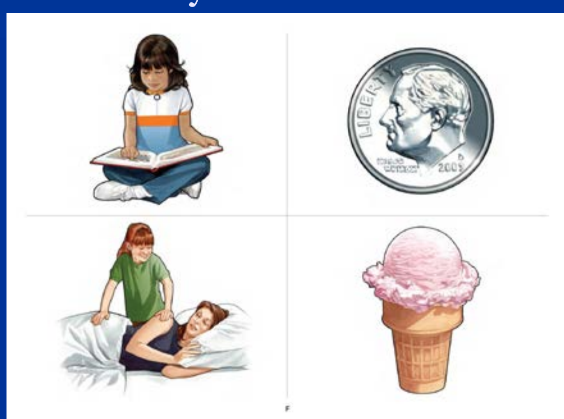
ASA Complete Kit

Test Materials

- Manual
- Stimulus CD
- Stimulus Book
- Response Forms

Before Testing
Picture word training

I will say a word and you point to the picture.
Ready? Point to *cone*.



TESTING

Listen and point to the picture of the word you hear:

cone

Geffner & Goldman, 2007

Rhyming-Introduction

- Say: Listen to these words: man…pan. *Man* and *pan* rhyme-they sound alike at the end. Here are more words that rhyme with *man* and *pan:* fan…tan…ran.

Rhyming – Practice Item A

- Say: Do CAN and Man rhyme?
- If correct, say: Yes. CAN and MAN rhyme-they sound the same. Continue with Practice Item B
- If incorrect, say: CAN and MAN do rhyme. Listen again can…man. Do these words sound the same?

ASA Standardization

- December 2008 through May 2009
- 600 + children at 123 sites
- Final norms based on nationwide sample of 475 children, ages 3 years 6 months through 6 years 11 months
  - Stratified by sex, race/ethnicity, SES (mother's education level), and geographic region.

ASA Standardization

- Norm sample
  - Normal hearing acuity
  - English as primary (most frequently spoken) language
  - Normal vision
  - Free of upper respiratory problems or ear infections at the time of testing

ASA Standardization

- Norm sample **exclusionary** criteria
  - Prior diagnosis of hearing loss
  - History of chronic or recurring ear infections
  - Had PE tubes
  - Receiving Sp.Ed services or a clinical diagnosis that would impact their language or cognitive functioning
  - At risk for auditory skill deficits, including auditory processing disorders

ASA Standardization

- Clinical sample
  - Judged by an audiologist or SLP to have difficulty with auditory skills
  - Normal hearing acuity
  - English as a primary (most frequently spoken) language
  - Normal vision
  - Free of upper respiratory problems or ear infections at the time of testing

ASA Standardization

- Clinical sample **exclusionary** criteria
  - Prior diagnosis of hearing loss
  - History of chronic or recurring ear infections
  - Had PE tubes
  - Receiving SpEd services or a clinical diagnosis of intellectual disability or autism spectrum disorder

ASA Cut Scores

- An overall cut score was determined for each 6-month age group, indicating a cutoff at the total score level between normal and at risk cases based on the norm sample, the clinical sample, and a matched control sample.

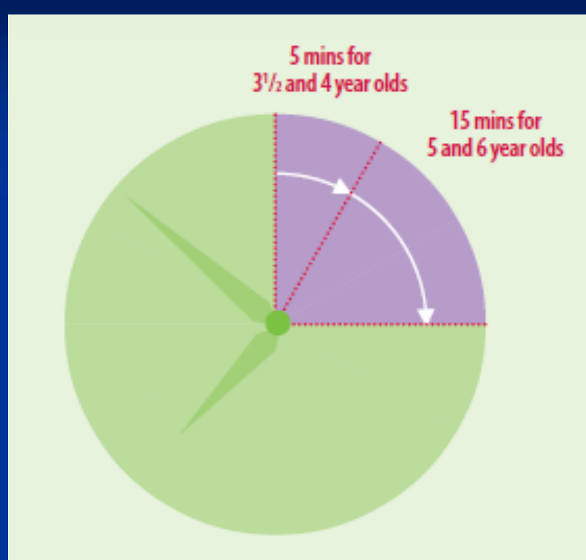
ASA Cut Scores

- The sensitivity and specificity of the cut scores are .77 and .68, respectively
- In setting the cut scores, preference was given to attaining high sensitivity because of the importance of flagging children who truly have poor auditory skills

ASA Clinical Validity

- Compared to the matched control sample, the clinical sample's average scores are significantly lower ($p<.01$) on all ASA domains and the overall total scores for both age ranges reported (3:6-4:11 and 5:0 – 6:11)

Administration Time



What makes ASA different

- Large, full-color illustrations tested to appeal to young children
- No headphones or specialized equipment
- Quick administration

Consultants

- The following experts provided feedback:
- James Hall, Ph.D. III
- Susan Jerger, Ph.D.
- Jack Katz, Ph.D.
- Robert Keith, Ph.D.
- Deborah Ross-Swain, Ed.D.
- Vishakha Rawool, Ph.D.

Test Demonstration

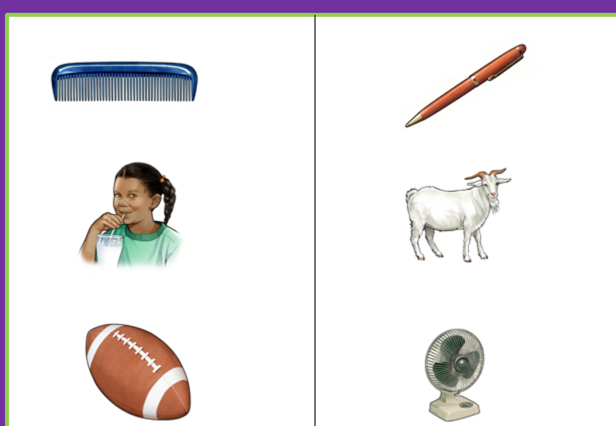
Speech Discrimination in Noise

Mimicry

CORRECT

INCORRECT

Blending



continued™

Blending

CORRECT

INCORRECT

Rhyming

RHYME

DOES NOT RYHME

Tonal Discrimination:

Instructions:

Show the pictures and listen to the sounds of the piano and Oboe

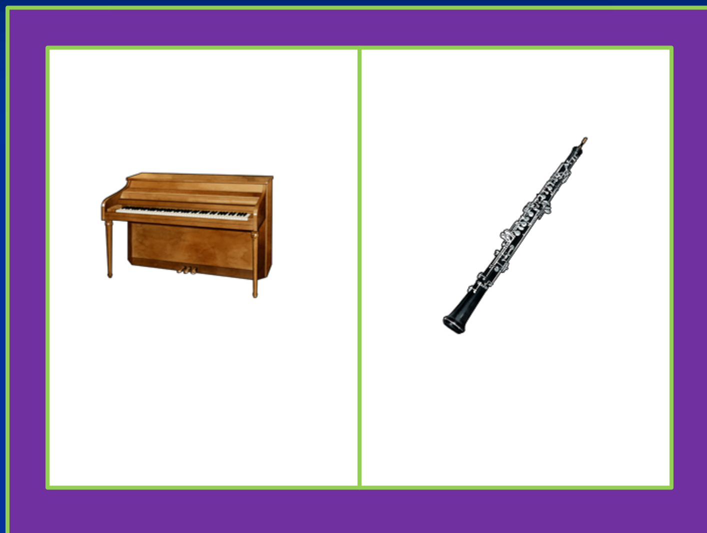
Tonal Discrimination

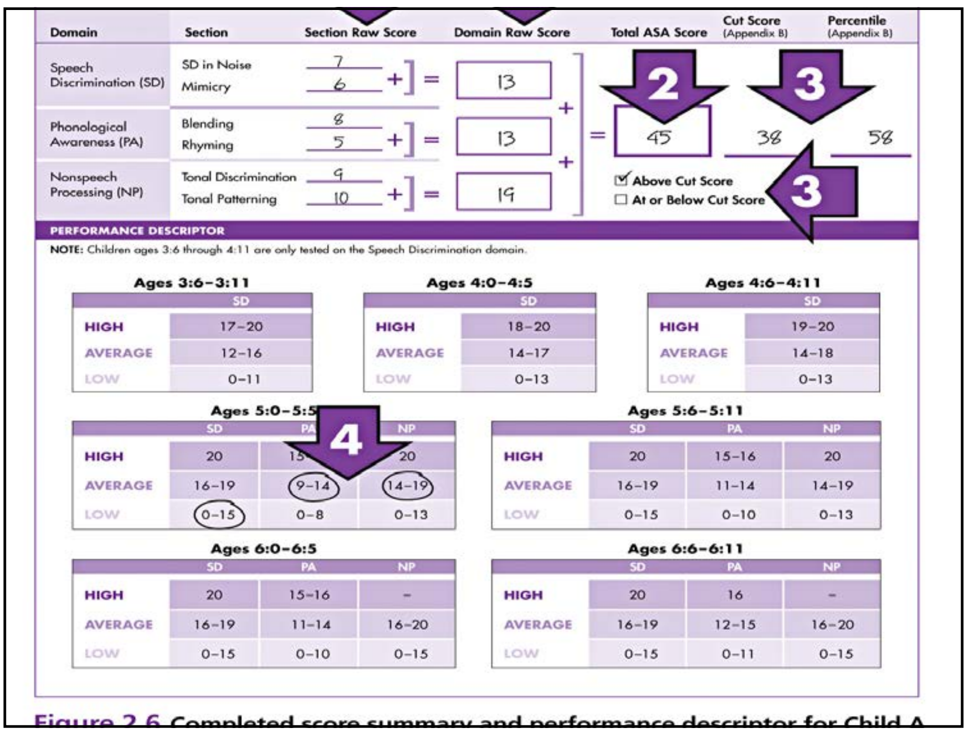
SAME

NOT THE SAME

continued

Tonal Patterning





Domain	Section	Section Raw Score	Domain Raw Score	Total ASA Score	Cut Score (Appendix B)	Percentile (Appendix B)
Speech Discrimination (SD)	SD in Noise Mimicry	7 6	13	45	38	58
Phonological Awareness (PA)	Blending Rhyming	8 5	13			
Nonspeech Processing (NP)	Tonal Discrimination Tonal Patterning	9 10	19			

☑ Above Cut Score
☐ At or Below Cut Score

PERFORMANCE DESCRIPTOR

NOTE: Children ages 3:6 through 4:11 are only tested on the Speech Discrimination domain.

Ages 3:6–3:11

	SD
HIGH	17–20
AVERAGE	12–16
LOW	0–11

Ages 4:0–4:5

	SD
HIGH	18–20
AVERAGE	14–17
LOW	0–13

Ages 4:6–4:11

	SD
HIGH	19–20
AVERAGE	14–18
LOW	0–13

Ages 5:0–5:5

	SD	PA	NP
HIGH	20	15	20
AVERAGE	16–19	9–14	14–19
LOW	0–15	0–8	0–13

Ages 5:6–5:11

	SD	PA	NP
HIGH	20	15–16	20
AVERAGE	16–19	11–14	14–19
LOW	0–15	0–10	0–13

Ages 6:0–6:5

	SD	PA	NP
HIGH	20	15–16	–
AVERAGE	16–19	11–14	16–20
LOW	0–15	0–10	0–15

Ages 6:6–6:11

	SD	PA	NP
HIGH	20	16	–
AVERAGE	16–19	12–15	16–20
LOW	0–15	0–11	0–15

Figure 2.6 Completed score summary and performance descriptor for Child A

continued

Table B-1

Cut Scores, by Age

Age	Cut Score
3:6—3:11	12
4:0—4:5	14
4:6—4:11	14
5:0—5:5	38
5:6—5:11	41
6:0—6:5	43
6:6—6:11	45

3

Figure 2.7 Cut score for Child A

Table B-2

Percentile Ranks Corresponding to Total Test Scores, by Age

%ile Rank	Age 3:6 – 3:11	4:0 – 4:5	4:6 – 4:11	5:0 – 5:5	5:6 – 5:11	6:0 – 6:5	6:6 – 6:11	%ile Rank
>99	20	—	—	56	—	—	—	>99
68	—	—	—	47	—	—	51	68
67	—	—	17	—	—	—	—	67
66	—	—	—	—	48	—	—	66
65	—	16	—	—	—	—	—	65
64	—	—	—	—	—	—	—	64
63	15	—	—	46	—	—	—	[illegible]
62	—	—	—	—	—	49	—	[illegible]
61	—	—	—	—	—	—	—	[illegible]
60	—	—	—	—	47	—	[illegible]	[illegible]
59	—	[illegible]	[illegible]	—	—	[illegible]	[illegible]	59
58	—	[illegible]	[illegible]	45	—	[illegible]	[illegible]	58
57	—	[illegible]	[illegible]	—	—	[illegible]	[illegible]	57
56	—	—	—	—	—	—	—	56
55	—	—	—	—	—	—	—	55
54	—	—	—	—	46	48	—	54
53	—	—	16	44	—	—	—	53
52	—	—	—	—	—	—	—	52
51	—	—	—	—	—	—	49	51

Child A's total test score

Child A's percentile rank

3

Figure 2.8 Percentile rank for Child A

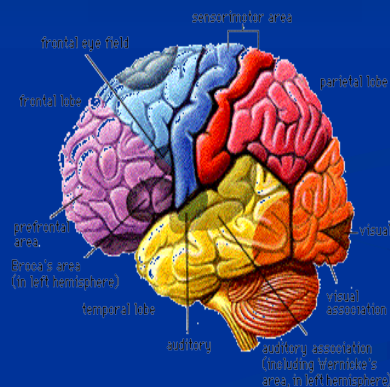
Case Study

Purposes and Uses

- Early identification and intervention
  - Possible candidate for in-depth evaluation and/or intervention
- Universal screening
  - Possible companion to hearing screening
- Progress Monitoring
  - Check progress of intervention

Importance of Early Identification & Intervention

Neuroplasticity



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What is Brain Plasticity?

- The brains ability to exercise its flexible nature.
- It refers to the brain and its ability to change as a result of experiences obtained in the outside environment.

Wesson, K. A., 2003

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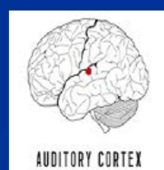
Brain Plasticity

- Myelination of the thalamic fibers, which innervates the auditory cortex, begins around one year of age and progresses until the fourth year
- Expression of cortical neurofilament protein, which forms the basis of the axonal cytoskeleton, continues to change through the ages of 5 to 10 years

Google Images.



Moore, 2002

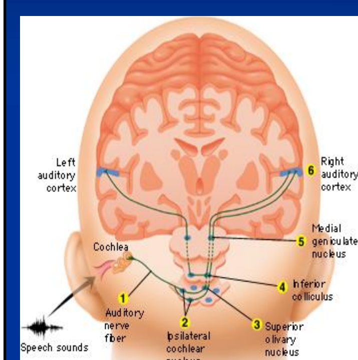
Brain Plasticity

- Neuroplasticity is induced through experience and stimulation and lead to reorganization (i.e., remapping) of the cortex, improved synaptic efficiency, increased neural density, and associated cognitive and behavioral change (Chermack & Musiek, 2007)
- Performance on higher demand listening tasks (e.g., sound localization) may remain immature well into the second decade of life (Moore, 2002)

Brain Plasticity

- There are critical periods in infancy in which language can be acquired more readily than later in life, because early experience leads to neural changes that optimize perception in the native language
- Even musical training has a sensitive period for training on motor performance

Brain Plasticity



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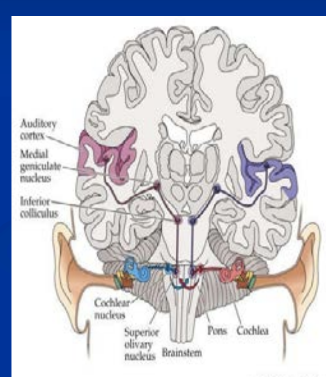
- Sensory experience can modify the way in which the auditory cortex processes its parts over a range of different time scales and throughout life.
- Dahmen and King (2007) found that changes in the acoustic environment can alter response properties of cortical neurons in the developing animal, while having no effect in older animals.
- This particular sensitivity of the infant cortex is observed in other sensory systems (Dahmen & King, 2007).

Neuroplasticity

- Hearing is a first-order event for the development of spoken communication and literacy skills
- Anytime the word 'hearing' is used, think ***auditory brain development***
- Acoustic accessibility of intelligible speech is essential for brain growth
- Signal-to-noise ratio is key to hearing intelligible speech

How Does the Auditory Brain Work?

- The auditory cortex is directly involved in speech perception and language processing in humans (Kretsmer et al., 2004).
- Normal maturation of central auditory pathways is a precondition for the normal development of speech and language skills in children (Sharma et al., 2009).



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Critical Periods

- The cortex matures in stages/columns. The level of maturity depends on the richness of exposure and experience (Merzenich, 2010).
- Level One of the cortex matures at around 12 months of age. This first stage or the "setup" stage for the cortex has the brain "always on".
- In this period, all it takes to develop auditory pathways is exposure to sound. The brain's task is to create a model of the culture the baby has been born into. The baby learns how to control the actions required to survive/thrive in that world (Merzenich, 2010)

Critical Periods

- The Second Stage of cortical development involves the brain controlling its own plasticity as the child masters each skill.
  - This is known as driven changes
- The higher levels of the cortex continue to mature thru ages 17 to 19.
- Neural organization is bottom-up maturation. The quality of the lower level maturation influences the quality of the higher level maturation.
- Adult cortical plasticity is controlled 'from the top'.

Merzenich, 2010.

Importance of Brain Plasticity

- The early interactions of a child directly impacts the way his/her brain gets physically connected, or how it gets "wired up", initially.
- By gaining new knowledge, the brain's elaborate networks and structures go through modification, reorganization, or some degree of cellular alteration.
- These changes can be seen in the chemistry, structures, and functions of the child's brain.

Wesson, K. A., 2003.

Brain Plasticity & Neurons

Google Images.

- Depending on the type and regularity of new tasks which are carried out by neurons, the brain's structures can change.
- However, any unused neural networks can be lost during ones early years.
  - In other words, certain skills may be lost if they are not cultivated during sensitive time periods, especially the first five years of life.

Wesson, K. A., 2003.

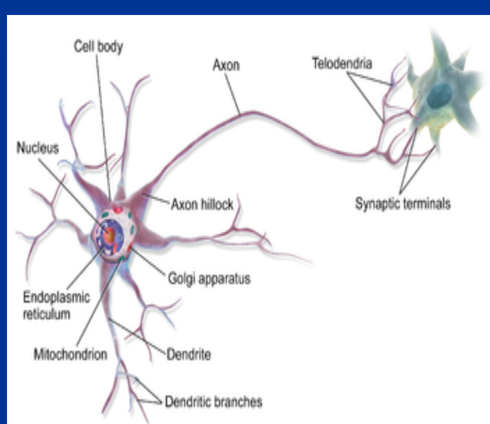
Brain Plasticity & Neurons

- Healthy brain cells perish if they are unable to find a job to carry out during these critical developmental periods.
  - For example, the lack of visual stimuli during infancy may result in a healthy eye losing its ability to see.
  - If a child does not hear words by 10 years of age, he/she will have a hard time learning to speak any new language at all.

Wesson, K. A., 2003.

- Neurons without a role will have two options:

1. They will be recruited to support another function with a different neural circuit
2. They will experience apoptosis (cell death)



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Wesson, K. A., 2003

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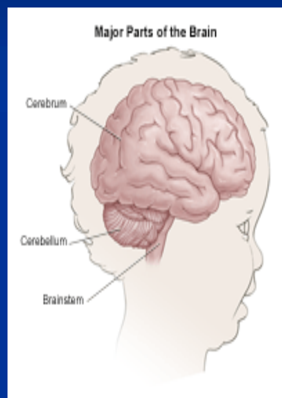
Stages of Brain Plasticity



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- Just as a child may experience growth spurts, a similar event occurs in the brain.
- The human brain undergoes dramatic anatomical changes during 7 key periods.

Wesson, K. A., 2003

Stage 1

- The delicate brain building during the prenatal stages.
  - Prenatal substance exposure can trigger a disruption in these important early processes, i.e., FAS = Fetal Alcohol Syndrome.

Stage 2

- Consists of adjustments to a specific kind of environment. Here, important systems get switched depending on the sensory input received from the environment.

Wesson, K. A., 2003.

Stage 3

- There is a fine-tuning of skills which takes place between the ages of 3 and 6.
  - By age 5 the brain has the average adult volume and is 4 times larger than at birth. These are the years when internal re-wiring takes place in the frontal lobe.

Stage 4

- Occurs between the age of 6 and puberty.
- The parietal lobe begins to show a great amount of activity.

Wesson, K. A., 2003.

Stage 5

- Occurs immediately following puberty.
- Another spurt in brain cell activity takes place in the frontal lobe.

Stage 6

- The "wholesale renovation" occurs during puberty and the teen years.
- This explains why teens need to sleep longer.

Stage 7

- This is the last stage – adulthood.
- The trillions of connections in the brain continue to rearrange themselves despite remaining the same size.

Wesson, K. A., 2003

Implications of Brain Plasticity

- No Time-Out = Our brain develops throughout life. Neural networks take a longer time to establish in older people, however, this can be solved through perseverance and repetition.

Google Images.

Implications for Brain Plasticity. Retrieved from http://www.braintraining4all.com

Implications of Brain Plasticity

- ***Repetition*** = Studies show the repetitive training of musicians and athletes can change their brains in a permanent manner. Certain areas responsible for specific movements (i.e., the hands of a pianist) are rewired for optimization.

- ***Rewiring Possibilities*** = The brain learns to adapt and change itself depending on its environment and the stimulus it receives.

Implications for Brain Plasticity. Retrieved from http://www.braintraining4all.com

Implications of Brain Plasticity

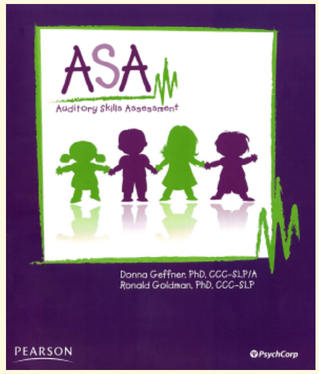
- ***Addiction*** = Brain plasticity also plays a role in addictive properties of certain drugs. For example, one's use of the drug cocaine causes a vigorous degree of brain plasticity that the reward circuits are changed. From then on, the brain seeks out more of the drug to duplicate the same pleasurable sensation

Implications for Brain Plasticity. Retrieved from http://www.braintraining4all.com

Summary of Neuroplasticity

- Greatest in the first 3 ½ years of life
- The younger the infant, the greater the neuroplasticity
- In the absence of sound, the brain reorganizes itself to receive input from other senses, primarily vision – *cross modal reorganization*.

Questions & Answers



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