Auditory Traits and Audiologic Intervention for Autism Spectrum

Ali A. Danesh, PhD*
Erin Cocchiola, BA, AuD-C**

* Florida Atlantic University, Boca Raton, FL
**Nova Southeastern University, Ft Lauderdale, FL

AUDIOLOGY NOW!
American Academy of Audiology Convention
San Diego, CA
Friday April 16 2010

AUTISM

- Autism Review

(History, Theories, Pathophysiology, Classes)

- Audiologic Traits and Characteristics

(Hearing, tinnitus, hyperacusis, Balance, etc.)

- Audiologic Evaluation of ASD population
- Current Research Findings
- Future Goals

Some Facts about Autism and Autism Spectrum Disorder (ASD)

- 673,000 children ages 3-17 in the United States have an Autism Spectrum Disorder.
- **One out of every** 100 children will be diagnosed with ASD
- Intensive early intervention can significantly improve outcome.
- Average age of ASD diagnosis is 4 years, 10 months which is later than optimal.

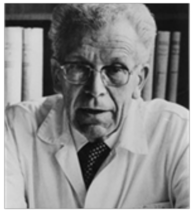
Autism

- Autism is a general term that includes a spectrum of neuro-developmental disorders often referred to as **Autism Spectrum Disorders (ASD)**
- In the DSM-IV, the Autism Spectrum Disorders are called **Pervasive Developmental Disorders (PDD)**

  The terms Autism Spectrum Disorders (ASD) and Pervasive Developmental are similar and used interchangeably.

Historical Perspective

- Leo Kanner, John Hopkin's psychiatrist, described autism in 1943.



- Hans Asperger, Austrian pediatrician, described similar cases with normal language and cognition in 1944.
- "Refrigerator Mothers" 1960s, erroneous blame
- Recognition of milder cases, improved detection and focus on earlier intervention, 1990s – present

Autism Spectrum Disorders (ASDs)

- Consist of five neurodevlopmental disorders (**DSM-IV category**)
  - Autism
  - Asperger's syndrome (AS)
  - Rett's Disorder
  - Childhood Disintegrative Disorder
  - Pervasive Developmental Disorder Not Otherwise Specified (PDDNOS)

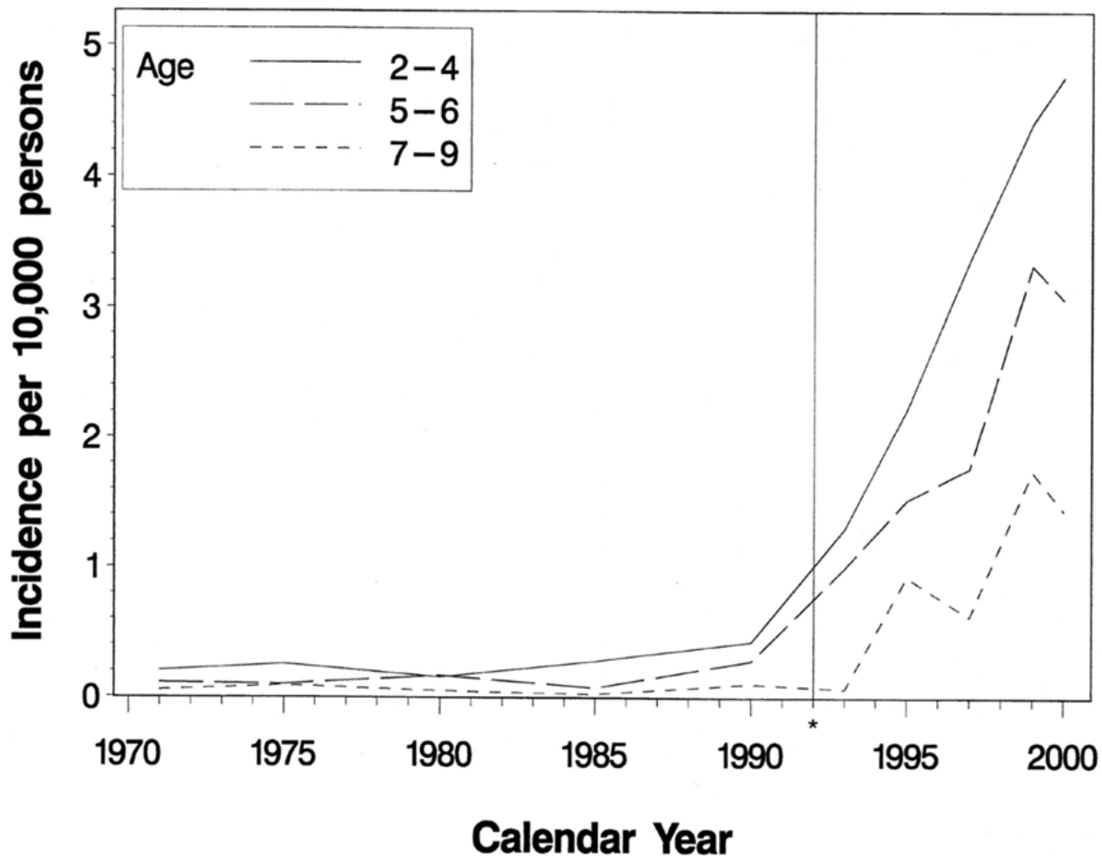
Spectrum of Severity

Wide range in severity:

Severe presentation: a 3 year old child with no expressive language, mental retardation, no eye contact, pervasive hand flapping

Mildest presentation: a child of normal verbal and nonverbal intelligence with restricted interests and poor peer interactions

Fig 1. Incidence of autism by age and calendar year



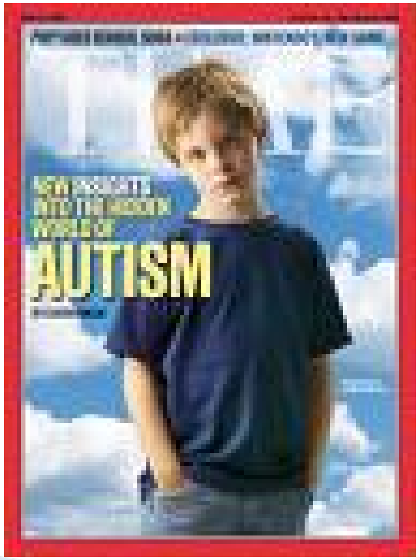
Madsen, K. M. et al. Pediatrics 2003;112:604-606

Autism Epidemic?

Explanations of Higher Prevalence

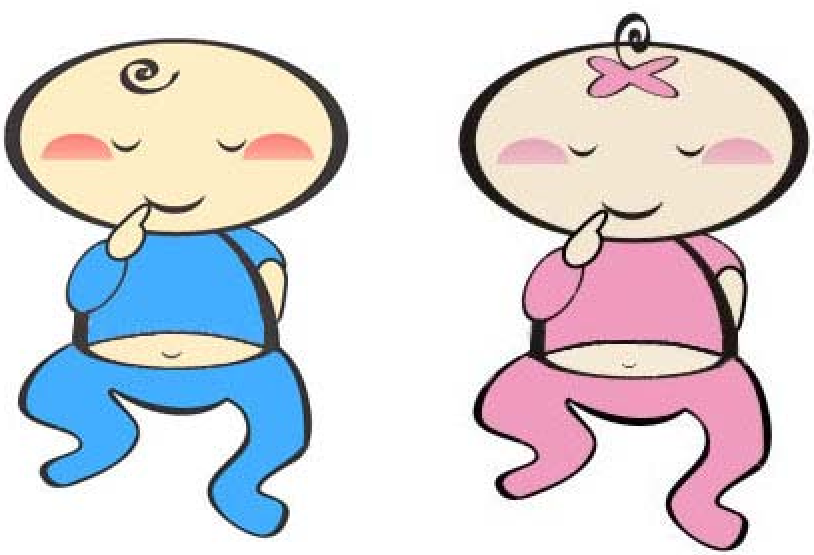
- Increased media coverage, public awareness bringing cases to clinical attention
- Improved screening and diagnostic tools resulting in earlier and improved identification
- Broadening of diagnosis to “Autism Spectrum Disorders” which includes milder cases (Asperger’s Disorder and Pervasive Developmental Disorder NOS)

AUTISM SPEAKS
It's time to listen.



Gender Distribution

- ASDs are more common in boys
- Autistic Disorder and PDD NOS, boys 4x > girls
- Exception: Rett's Disorder – girls exclusively



Associated Cognitive Impairment in Autism Spectrum Disorders

- Up to 75% are cognitively impaired (IQ < 70)
- more recent studies < 50% (better assessment and recognition of milder spectrum)
- IQ and language skills predict outcome
- Lower IQ increases risk for developing seizures

Autism Etiology

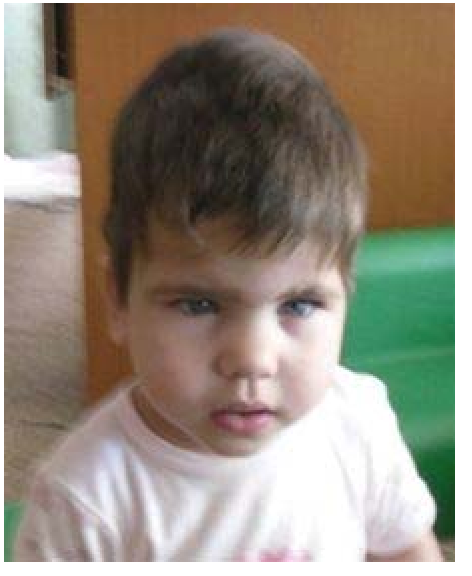
- Hypotheses
- genetic (multiple genes, large phenotypic variation) (likely region of an autism gene on chromosome 17)
- infectious (maternal Rubella)
- toxic exposures (valproic acid, thalidomide, pesticides)
- vaccines (refuted – The Lancet fully retracted 1998 study linking autism with MMR vaccine)

Associations

- Advanced maternal age and paternal age (Feb 2010 study, women >40 nearly 2x risk)
- Elevation in levels of serotonin
- Prenatal and obstetrical complications, but none are consistently found or specific to autism

Etiology

- Majority of cases are idiopathic (primary ASDs)
- <10% are associated with a known medical disease (secondary ASDs)
- secondary ASDs have increased association with the presence of severe mental retardation and dysmorphic features

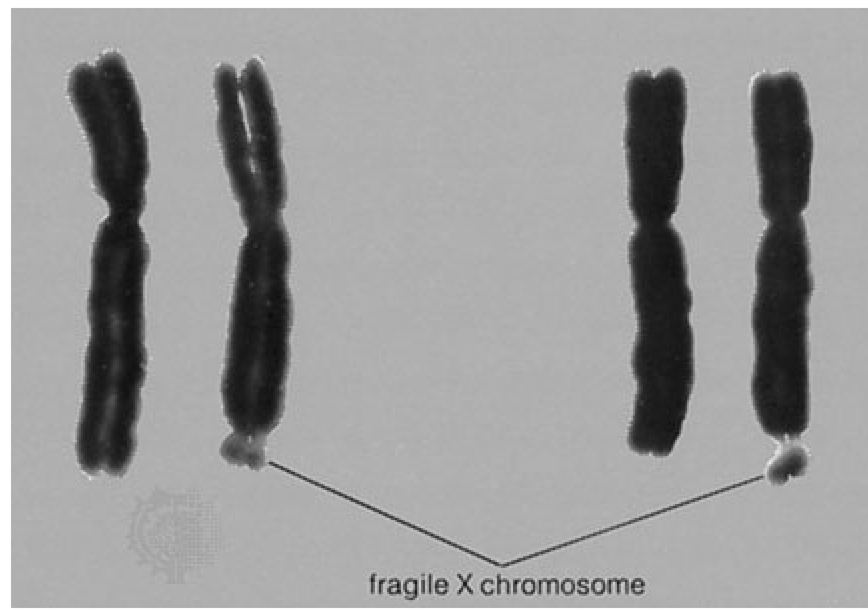


Etiology

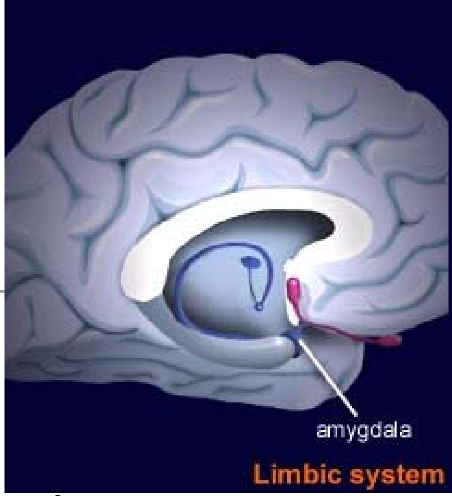
- ASDs are considered to be a complex heritable disorders involving multiple genes and demonstrating great phenotypic variation.
- ASDs are highly heritable and genetic factors play key roles on their pathogenesis
- Higher rates in MZ twins compared to DZ twins
- Environmental factors may affect the expression of autism or function as a “second hit” phenomenon on fetal brain development

Medical Syndromes Associated with ASDs

Fragile X Syndrome
Tuberous Sclerosis
Phenylketonuria
Fetal Alcohol Syndrome



Neuropathology



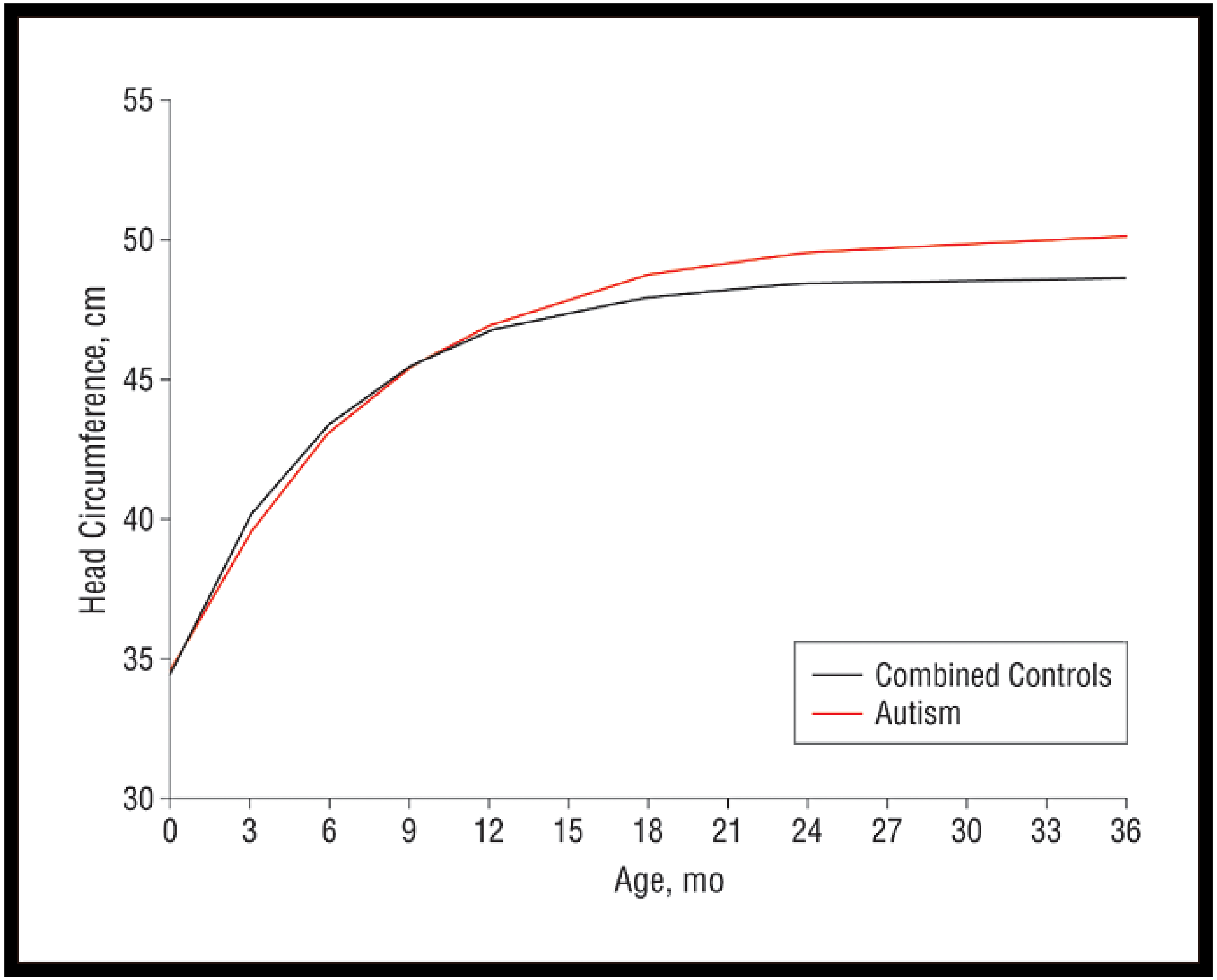
Autistic brains are slightly larger and heavier (correlates with increased head circumference in a subgroup)

Limbic system – increased numbers of cells and cells smaller than normal

Abnormal Purkinje cells in the cerebellum

Anatomic differences consistent with developmental problems occurring at < 30 weeks gestation

Social cognition problems consistent with abnormalities in the limbic system – amygdala and orbital frontal cortex



Growth trajectory of head circumference by group

Autistic Disorder – DSM-IV Criteria

Three core sets of symptoms

- impairment in social interaction
- impairment in communication
- restrictive, repetitive and stereotyped patterns of behavior, interest and activity

Onset by age 3

Characteristics of ASDs

- Significant deficits in socialization and communication skills
- Possible delays in language skill development
- Exaggerated body movements
  - sometimes triggered by environmental sounds.
  - complete unresponsiveness to the external environment
- Frequent recurring behaviors
- Limited number of interests

(APA,2004)

Autistic Disorder Diagnostic Criteria

Impairment in social interaction:

- Marked impairment in non-verbal behaviors such as eye contact, body postures and gestures to regulate social interaction
- Failure to develop appropriate peer interactions
- Lack of spontaneous seeking to share enjoyment or interests with other people
- Lack of emotional or social reciprocity

(APA,2004)

Autistic Disorder Diagnostic Criteria

Impairment in Communication

- Delay in or lack of spoken language
- Impaired ability to initiate or maintain conversation
- Stereotypic, repetitive or idiosyncratic use of language
- Lack of communication necessary for pretend play (stereotyped, ritualistic play)

Autistic Disorder Diagnostic Criteria

Restricted, repetitive and stereotyped patterns of behaviors, interests and activities

- Inflexible adherence to specific nonfunctional routines or rituals
- Persistent preoccupation with parts of objects
- Stereotyped and repetitive motor mannerisms (eg hand or finger flapping, twirling, rocking or complex whole-body movements)
- Intense preoccupation with stereotyped interests

Autistic Disorder: Sensory Symptoms

- Hypo or Hypersensitivity to sensory stimuli
- Auditory aversion (cover ears with noise, loud noises or types of music)
- Pain insensitivity. Do not complain of pain.
- Olfactory aversion
- Tactile aversion to certain fabrics (tags on clothing, position of socks)

Case Studies Autism

- http://www.youtube.com/watch?v=FDMMwG7RrFQ

Asperger's Disorder

- Historically called "high functioning autism" or "Little Professor" ("Rain Man", savants)
- Normal IQ required for diagnosis
- Impaired social interaction
- Lack of interactive play and communication
- Stereotypic, repetitive mannerisms
- No delays in language and cognitive development

Asperger’s Disorder

- Normal or very mild speech delay (if there is a significant language delay, it is not Asperger’s)
- Often unrecognized until school, when can’t make friends
- Pedantic, overly formal, odd, monotone speech.
- Often very verbal about restricted interests.
- Impaired ability to respond to social cues.
- Impaired abstraction: doesn’t get metaphors, humor, irony, sarcasm.

Asperger's Disorder

- Normal or even superior intelligence
- Some may exhibit outstanding skills in mathematics, music and computer sciences
- Physical symptoms may include early childhood motor delays, clumsiness, fine motor difficulty, gait anomalies and odd movements.
- Typically diagnosed at much older ages than autism (average age 11)
- Targeted interventions to improve social competence (conversational skills etc)

Intense Restricted Interests in Aspergers

- Tommy is an honor-roll student who likes math and science and video games. He's also a world-class expert on Animorph and Transformer toys. "They're like cars and trains and animals that transform into robots or humans — I love them!" he shouts exuberantly.

Early Recognition of Autism Spectrum Disorders

- No pathognomonic feature
- No diagnostic laboratory tests
- Physical exam usually normal
- Look for language delays and parental concerns about social development

Red Flags

- No babbling or pointing by 12 months
- No single words by 16 months
- No 2 word spontaneous (non-echolalic) phrases by 24 months
- Loss of language or social skills at any age

Who Gives a Diagnosis

- Ideally a team-based approach consisting of some of the following professionals:
  - Family (a must)
  - Pediatrician
  - Neurologist
  - Psychiatrist
  - Psychologist
  - School psychologist
  - Speech and Language Pathologist
  - Audiologist
  - Social Worker

Medical/Psychiatric Assessment

- History: prenatal, obstetric complications, developmental milestones, developmental regressions
- Family history
- Hearing and vision testing
- IQ testing
- Speech and language assessment

Differentiating DSM-IV Subtypes of Pervasive Developmental Disorders

- Look at language
  - Delay – suggests Autism or PDD NOS
  - Normal language development – suggests Asperger's
- Regression – suggests Rett's or CDD

Rett's – microcephaly, females only

Treatment – Non-pharmacologic

- Psycho-education
- School Interventions
- Speech and Language Therapy
- Occupational and Physical Therapy
- Behavior Modification
- Supportive therapy in higher functioning individuals – social coaching

Treatments with Insufficient Research

- Chelation therapy
- Hyperbaric medicine
- Mega-vitamin
- Diets
- Equine therapy (Hypotherapy)
- Dolphin therapy
- Sensory integration therapy


AUTISM
Persons with autism may possess the following characteristics in various combinations and in varying degrees of severity.
Inappropriate laughing or giggling
No real fear of dangers
Apparent insensitivity to pain
May not want cuddling
Sustained unusual or repetitive play; Uneven physical or verbal skills
May avoid eye contact
May prefer to be alone
ARE YOU GOING?
ARE YOU GOING?
Difficulty in expressing needs; May use gestures
Inappropriate attachments to objects
Insistence on sameness
Echoes words or phrases
Inappropriate response or no response to sound
Spins objects or self
Difficulty in interacting with others
1-800-3AUTISM
Autism Society of America
7910 Woodmont Avenue, Suite 650 Bethesda, MD 20814-3015
January is National Autism Awareness Month.
Adapted from original by: Professor Rendle-Short, University of Queensland, Brisbane Children's Hospital, Australia

Auditory and Audiologic Manifestations in ASD Population

Importance for Audiologists

- Due to deficits in language development, communication skills, and possible impact of environmental sounds.
- These children will be in the office for an audiologcial evaluation
- It is important for audiologist to have an understanding of the auditory skills and what to expect to see during testing in individuals with ASDs

(APA,2004; Konstantareas & Homatidis, 1987)

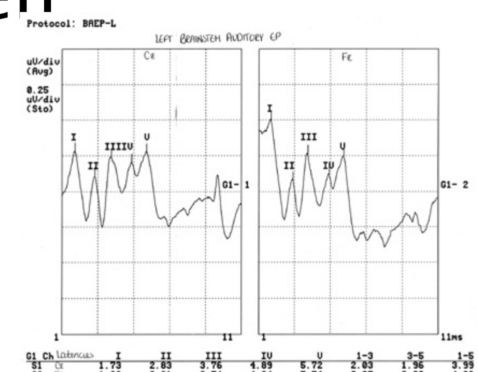
Prevalence of hearing loss and ASDs

- There is much debate over prevalence of hearing loss in children with ASDs.
- Audiometric testing of children with ASDs can be particularly challenging.
- Children with ASDs are not cooperative during testing (Klin, 1993)
- Children with ASDs do not respond to environmental stimuli making traditional audiometry almost impossible (Tas, Yagiz, Tas, Esme, Uzun & Karaslihoglu, 2007)
- Mental status of children with ASDs can also influence audiometric testing (Gravel, Dunn, Lee & Ellis, 2006; Tas et al., 2007)

(Klin, 1993; Tas et al., 2007;
Gravel et al., 2007)

Audiologic Assessment

- Audiological evaluation should be included in the comprehensive evaluation of a child suspected of having an ASD (APA, 2004; Rosenhall et al., 1999; Tas et al., 2007)
- Audiological evaluation should include behavioral and electrophysiological evaluations (APA, 2004; Rosenhall et al., 1999; Tas et al., 2007)
- Hearing impairment should be ruled out in the differential diagnosis of children suspected of an ASD (APA, 2004)



Hearing loss and ASDs

- Hearing loss and autism can co-occur
- It is possible that one diagnosis will occur later or will possibly be missed altogether
- Symptoms of one disorder can mask the presence of the other disorder
- Diagnosis of autism occurred later in children with autism and hearing loss than in children with autism and normal hearing.

(Romper et al., 2003)

Hearing loss and ASDs

- Romper et al. (2003) studied typical behaviors in three groups of children
  - Autism
  - Autism and hearing loss
  - Hearing loss and learning disabilities
- This study did not identify any key behaviors that could have indicated the presence of both autism and hearing loss, which could have led to an early diagnosis

Sensorineural hearing loss (SNHL) and ASDs

- Numerous possible audiometric configurations
  - Sloping high frequency,
  - Steeply sloping isolated to the 4-8 kHz region,
  - “Reverse cookie-bite”,
  - Flat configurations
- Degree of hearing loss can range from mild to profound and either unilateral or bilateral.

(Rosenhall et al., 1999)

Clinical Auditory Behaviors

- The most common symptom is hyperacusis
- Lack of acoustic reflex? Not sufficient data in the literature
- Poor Auditory filtering?
- Efferent auditory pathway?

Hyperacusis

- The sensitivity to sounds might possibly cause a heightened response from children with autism. [Frith and Baron-Cohen (1987) (as cited in Khalfa et al., 2004)]
- May be the cause of the excessive body movements expressed by children with autism, such as arm flapping behavior or "covering their ears" (Khalfa et al., 2004)

Prevalence of Hyperacusis

- In general public, it is unknown. Estimates of 10–15%.
- 18% in children with autism (N=199) (Rosenhall et.al, 1999)
- 46% in a pediatric otolaryngology clinic (Coelho & Sanchez, 2004)
- Up to 40% of children with autism (Autism Research Institute)
- Smaller auditory dynamic ranges in autistic group associated with increased perception of loudness (Khalfa et al., 2004)

Hyperacusis and ASDs

- Rosenhall et al. (1999) identified the possible presence of hyperacusis in children with autism.
- These children could not tolerate 80 dB nHL click stimuli despite having hearing sensitivity within normal limits.
- Children with autism are more sensitive to sounds than typically developing peers.

Hyperacusis and ASDs

- Khalfa et al. (2004) studied the perception of loudness in children with ASDs.
- Children with ASDs showed significant lower loudness discomfort levels, as well as a reduced dynamic range when compared to children with typical development.
- Loudness discomfort levels were below 80 dB HL across all frequencies, which is consistent with hyperacusis.
- In addition, children with ASDs rated the perception of loudness of pure tones significantly louder than typically developing children.

Hyperacusis and ASDs

- Children with ASD subjectively rate sounds louder than their typically developing peers (Khalfa et al., 2004).
- Children with ASD have a decreased tolerance for both click and pure tone signals (Khalfa et al., 2004; Rosenhall et al., 1999)
- Children with ASD are more sensitive to sounds, and therefore it is possible for children with ASD to experience hyperacusis (Khalfa et a;., 2004; Rosenhall et al., 1999).

Electrophysiologic Evaluation

- ABR is the most common tool
- Sedation may be necessary
- Sleep deprivation approach may not help
- OAE is extremely valuable

Electrophysiologic and Brainstem Function in ASD Population

- Common ABR findings in children with ASDs
  - Prolonged absolute latency on wave I especially in the right ear
  - Prolonged wave V
  - Prolonged interpeak I–III, III–V, and I–V

ABR

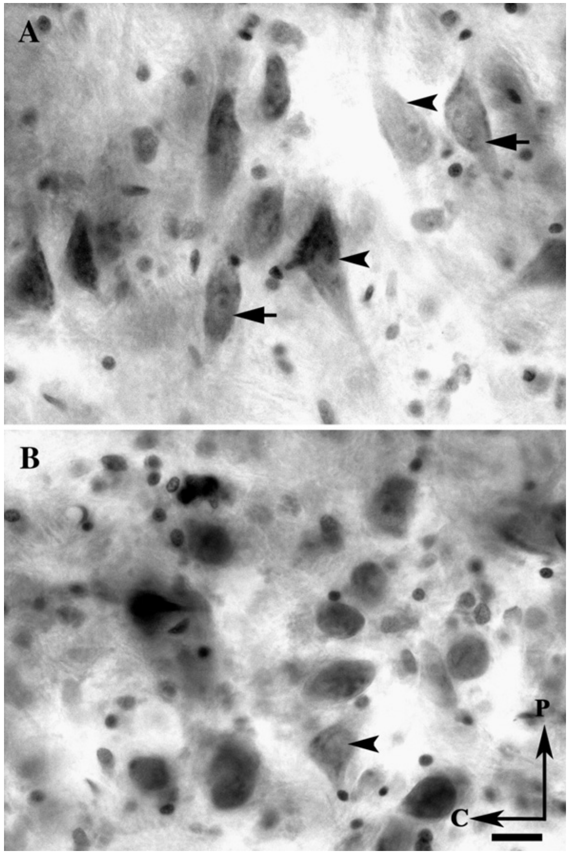
- Wong and Wong (1991) reported on ABR results for four groups of children
  - children with infantile autism
  - autism
  - mental retardation
  - normal children
- The children with autism and infantile autism showed delays in the absolute latency of wave V and interpeak latencies when compared to normal children.
- Results indicated prolonged absolute latencies for absolute waves III and V and interpeak intervals I-III and I-V in children with infantile autism.

ABR (Wong & Wong, 1991, Classical study)

- Prolonged latencies were a unique characteristic to children with autism and not related to cognitive delays
- Prolongation of interpeak intervals indicates a slowed auditory neural trasmission time up the brainstem
- Prolongation suggests that children with ASDs demonstrate abnormalities of the auditory structures within the brainstem.

Histological studies of Central Auditory Areas in ASD

- Kulesza and Mangunay (2008) examined the medial superior olive (MSO) using histological slides
- Significant difference within the MSO of those with autism and normal controls
- Morphological differences included:
  - smaller and rounder cell bodies within the MSO



MSO neurons in autistic brains display a significantly different morphology. Shown in A is a group of MSO neurons from the control specimen, sectioned in the parasagittal plane. These neurons are either fusiform (arrows) or stellate (arrowheads) and have a long axis oriented in the coronal plane. Shown in B is a group of MSO neurons from an autistic brain (AUT04). These neurons are much smaller and round and few of them show a preferential orientation; occasional stellate neurons are observed (arrowhead). C = caudal, P = posterior; the scale bar is equal to 15 μm.

Brainstem involvement

- Abnormalities of the auditory brainstem structures suggest low-level central auditory processing deficits.
- These abnormalities cause distortion of auditory information during critical development periods, resulting in the classic characteristics seen in children with ASDs including delays in language and communication, poor social interactions, and cognitive delays (Tanguay & Edwards, 1982; Wong & Wong, 1991).

Cortical Processing

- Two methods to assess cortical function

1. Imaging studies, which assesses area of cortical involvement under different conditions (Boddaert et al., 2004; Zibovicius et al., 2000)
2. Behavioral test, which are complex central auditory processing skills that require cortical processing (Alcantara, Weisblatt, Moore & Bolton, 2004)
   - speech-in-noise tasks
   - speech prosody tasks

Imaging Studies

- Positron emission tomography (PET) imaging studies have identified temporal lobe dysfunction in children with autism (Boddaert et al., 2004; Zilbovicius et al., 2000)
- Children with mental retardation are used as a control group because rCBF studies are not complete on typically developing children

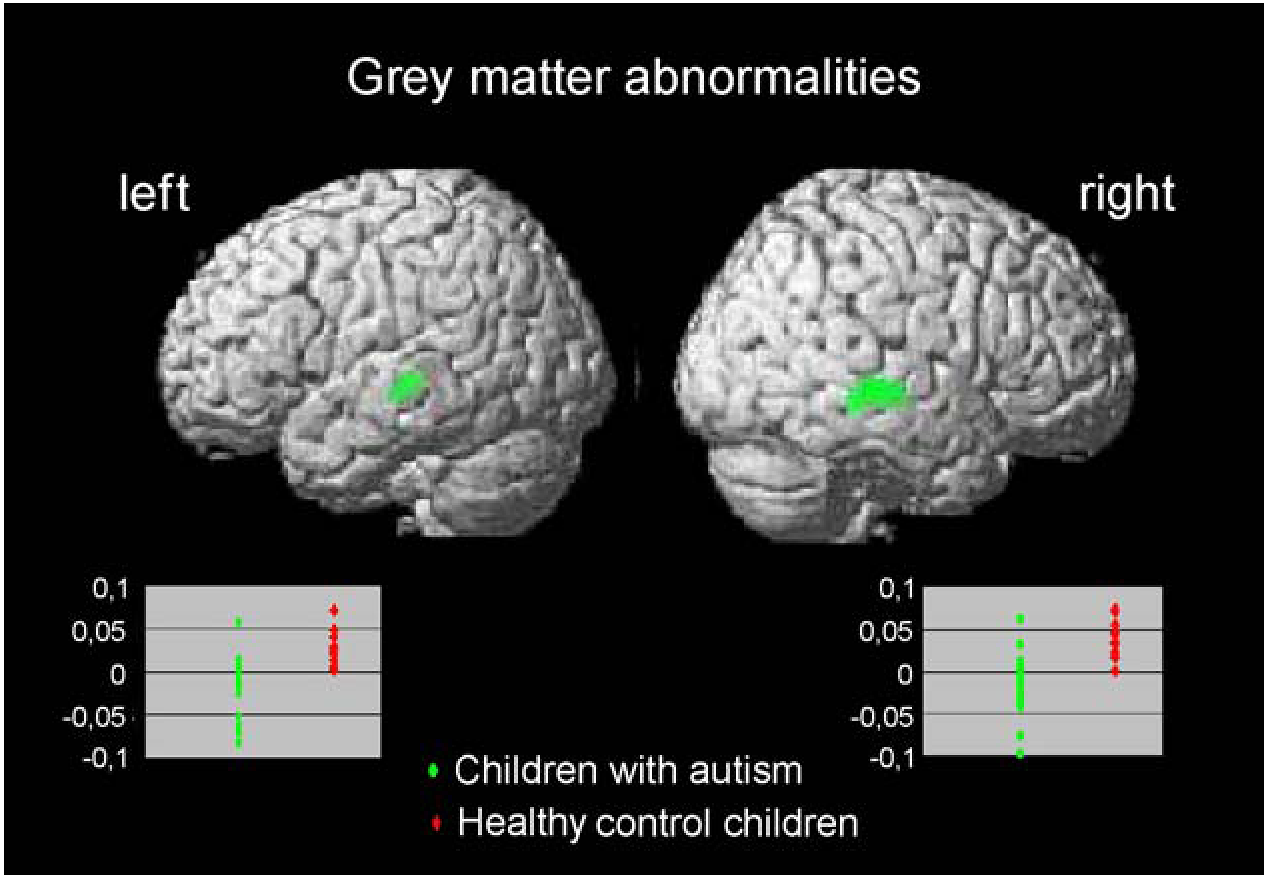
Imaging Studies

- Zilbovicius et al. (2000) researched regional cerebral blood flow (rCBF) of 21 children with autism
- Children with autism showed a decrease in blood flow in both the left and right temporal lobes.
- The left superior temporal gyrus had the least amount of cerebral blood flow in children with autism

Imaging Studies

- Boddaert et al. (2004) researched rCBF of autistic children during resting state and listing to speech noise.
- Children with mental retardation and autism demonstrated an increase in activity of the left and right superior temporal gryi when listening to speech noise.
- Children with mental retardation demonstrated more activation within the left temporal lobe compared to the right temporal lobe.
- Children with autism did not show an increase of activity in the left temporal lobe.

Disorders of Central Auditory Areas in ASD (Superior Temporal Sulcus Abnormalities)



MRI grey abnormalities in autistic children. Brain areas with significant grey matter decreases in autistic children compared to normal control children are superimposed on left and right lateral surfaces of a rendering of the T1-weighted anatomical template image in Talairach space. A statistical threshold of $Z > 3.15$ ($P < 0.001$) was used for display purposes; peaks reaching statistical significance are listed in Table 2. Plots show relative normalized grey matter concentration for each autistic child (green dot) and for each normal child (red diamond).

Boddaert et al., 2004

Imaging Studies

- Children with autism exhibited an increase in activation of cortical areas outside temporal lobe in both resting state and when listening to speech noise (Boddaert et al., 2004; Zilbovicius et al., 2000).
- Activation of multiple cortical areas could be the reason for excessive behaviors in response to environmental sounds demonstrated in children with autism (Boddaert et al., 2004)

Imaging Studies

- It is possible that dysfunction in the superior temporal gyrus could be an underlying cause of language delay and communication difficulties in children with autism (Heschl's gryus and Wernicke's area, are located at the vicinity of the superior temporal gyrus).

(Boddaert et al., 2004; Zilbovicius et al., 2000)

Behavioral Tests

- *Speech in Noise*
  - The ability to understand speech-in-noise is a complex task that requires central auditory processing capabilities.
  - To understand speech in the presence of background noise, an individual needs to be able to attend to the signal of interest during brief gaps in the background noise.
  - The signal of interest fluctuates in frequency from the background
  - The ability to make use of spectral cues is another cortical skill.
  - This type of evaluation can be potentially very useful in the ASD population.

(Alcantara et al., 2004)

Speech-in-noise

- Alcantara et al. (2004) researched speech-in-noise understanding of adolescents and adults with AS, HFA, and normal hearing age-matched controls.
- The speech signal of interest consisted of typical English sentences.
- Five different background noise signals
  - speech noise
  - speech noise with temporal dips
  - speech noise with spectral dips
  - speech noise with both temporal and spectral dips
  - competing speech signal

Speech-in-noise

- The AS group had more difficulty than the control group in understanding speech in the presence of background noise, especially with the background noise contained temporal dips

(Alcantara et al., 2004)

Speech-in-noise

- Adults and adolescents with HFA and AS have difficulty making use of the small lower intensity gaps in the background noise.
- Deficits in temporal resolution
- Adults and adolescence with HFA and AS may also have poor "top-down processing" skills
  - Understanding speech in background noise, an individual needs to be able to "fill in" the information that was missed due to the background noise.

(Alcantara et al., 2004)

Behavioral Tests

- Prosody
- Underlying tone and stress of an utterance, which is an important feature of pragmatic skills and social interaction.
- Words can change meaning depending on the placement of stress within the word,
- Prosody is an important feature of pragmatic skills and social interaction

Jarvinen-Pasley & Heaton, 2007; Korpilahti et al., 2007; Linder & Rosen, 2006; Shriberg et al., 2001)

Prosody

- Shriberg et al (2001) researched the production of prosodic features in conversation speech in individuals with HFA and AS.
- A 30-minute speech sample was transcribed
- Individuals with HFA and AS exhibited deficits in three key prosodic feature
  - rate of speech,
  - stress, and
  - phrasing.

Prosody

- Adults and adolescences with HFA demonstrated a slower rate of speech than controls and those with AS.
- Individuals with HFA and AS demonstrated incorrect placement of stress.
  - misplace stress within an utterance more than they misplace stress within a signal word.
- HFA and AS demonstrated inappropriate phrasing of utterances
- Individuals with HFA and AS had more
  - Syllable repetition
  - Word repetition
  - Word revisions

(Shriberg et al., 2001)

Prosody

- Differences in the production of speech prosody in typical conversational speech can result in
  - misinterpretation of emotions
  - poor social interactions
  - lack of social acceptance

(Shriberg et al.,2001)

Pitch Perception

- Jarvinen-Pasley and Heaton (2007) assessed perceptual pitch identification in 19 children with autism and AS.
- The children were to listen to different sets of auditory stimuli and indicate if they thought the sets were "same" or "different."
- The auditory signal included:
  - music-music
  - speech-speech
  - music-speech
- The children were told to disregard the information in the speech and listen only to the changes in pitch

Pitch Perception

- Children with autism and AS were able to detect differences in pitch in the speech-speech and music-speech condition more accurately than typically developing peers.
- Children with autism and AS focus less on the information presented in a speech signal and focus more on the overall intonation of the signal

(Jarvinen-Pasley & Heaton, 2007)

Pitch Perception

- Less focus on linguistic context, could result in the delayed language development of children with autism and AS
- Children with echolalia may also be focusing on the intonation of the word or phrase rather than the actual meaning of the word

(Jarvinen-Pasley & Heaton, 2007)

Balance Function in ASD Population

Postural Control

- Molloy, Dietrich, and Bhattacharyarya (2003) studied postural stability of children with ASDs compared to normal controls.
- 8 boys in each group between the ages of 5-12 years old
- “AccuSway Plus force platform” was used
- Postural stability was assessed using measures of sway area and sway length in four conditions

Test Condition	Primary Input from Specific Systems
Standing on platform with eyes open	Visual, Vestibular, Somatosensory
Standing on platform with eyes closed and blindfold	Vestibular and Somatosensory
Standing on three inch foam on top of platform with eyes open	Visual and Vestibular
Standing on three inch foam on top of platform with eyes closed	Vestibular

Postural Control

- Children with ASDs showed more sway in all conditions where input from one or more systems was changed.
- Children with ASDs had the most sway in conditions where vision with denied.

(Molloy et al., 2003)

Postural Control

- Children with ASDs are heavily dependent on visual input for postural stability
- Children with ASDs have deficits in integrating sensory input for postural control

(Molloy et al., 2003)

Dynamic Posturography

- Minshew, Sung, Jones, and Furman (2004) used dynamic posturography to assess postural control in individuals with ASDs
- Compare individuals with HFA to normal controls
- Examine the development of postural control of individuals with HFA
- 79 individuals with HFA ages ranging from 5–52 years old
- Group of normal age matched controls

Minshew et al. (2004) Table 1

Term	Condition
Condition 1	Normal vision with stable surface
Condition 2	Vision denied with stable surface
Condition 3	Changing vision reference with stable surface
Condition 4	Normal vision with changing surface
Condition 5	Vision denied with changing surface
Condition 6	Changing vision reference with changing surface

Dynamic Posturography

- HFA group had reduced postural stability than normal controls
- HFA group showed the most difficulty with changing somatosensory information
  - Conditions 4, 5, and 6

- Individuals with HFA show delay in the development of postural controls and never reach full adult control.
- HFA do not show improvements in postural stability until 12 years of age

(Minshew et al., 2004)

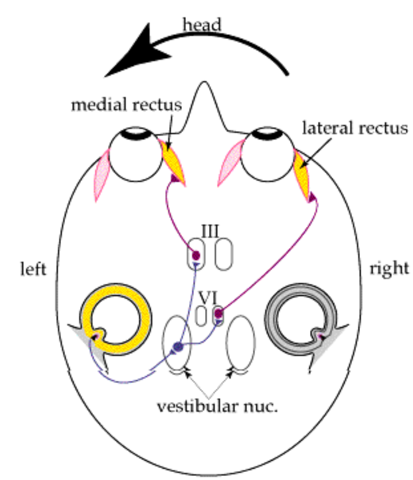
Postural Control

- Individuals with HFA develop postural control slower than peers.
- Postural control in individuals with HFA is underdeveloped compared to peers.
- Poor postural control is due to deficits in integrating multiple sensory inputs.

(Minshew et al., 2004; Molloy et al., 2003)

Vestibulo-Ocular Reflex (VOR)

- Goldberg, Landa, Lasker, Cooper, and Zee (2000) studied the VOR function in children with HFA.
- 13 children with HFA and 10 normal controls
- Rotary chair in complete darkness
- Post rotary nystagmus was measured with head forward and head tilted down



VOR

- No significant difference in the amount of post rotary nystagmus suppression with head tilt.
- No difference in the vestibular responses
- Children with HFA have normal VOR function

(Goldberg et al., 2000)

Summary: Auditory Traits

- ASDs exhibited difficulty in

1. Understanding and processing prosodic speech cues
2. Producing correct prosodic changes in conversational speech

Summary: Auditory Traits

- These deficits in the processing and production of prosodic changes in speech may play a role in

1. delayed language development
2. misunderstanding emotions
3. poor social interaction

Summary of audiologic test results

- Audiologists should be aware of the characteristics of ASDs and the possible results of audiometric testing for this population
  - Most common test results include:
  - Prolongation of ABR III-V interpeak intervals
  - Decreased loudness discomfort levels
  - Tinnitus
  - Poor speech-in-noise understanding
  - Poor prosody

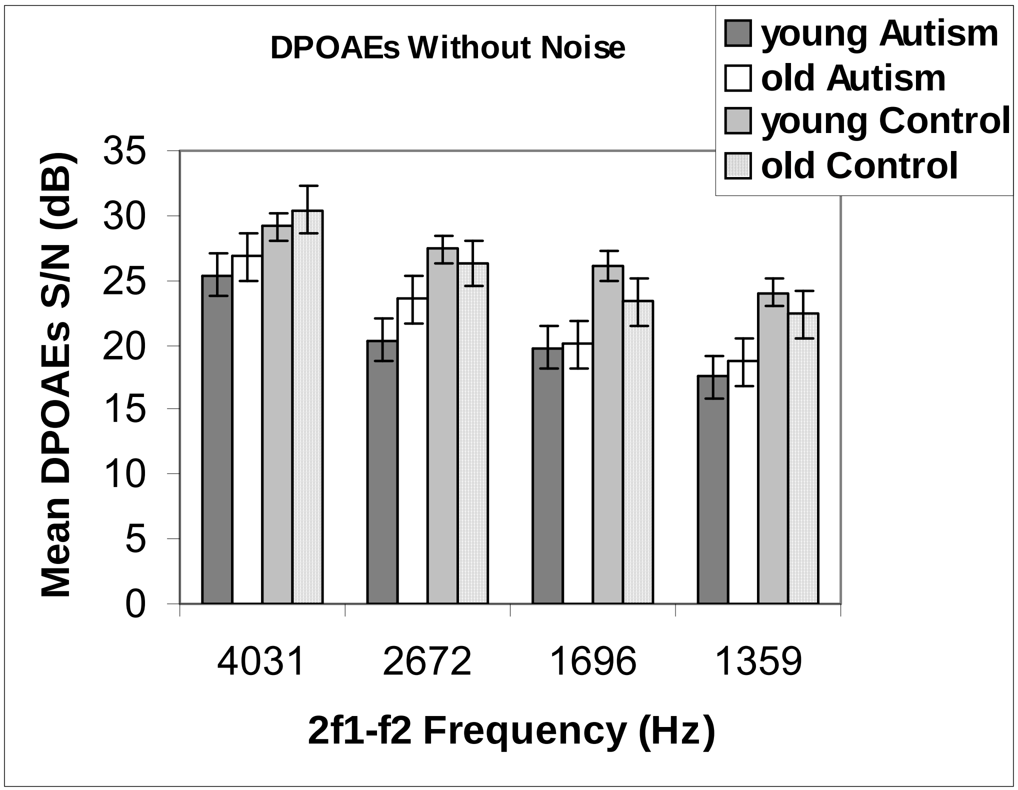
Summary: Characteristics of ASDs and Auditory Skills

- Brainstem involvement & decreased activity of auditory and language area of the temporal lobe can be major reason for the delays in language development and poor communication skills
- Hyperacusis may be a major cause of hyper-responses/hypersensitivity to environmental sounds
- Deficits in speech-in-noise understanding, expressive and receptive prosody can have negative impact on social skills

Recent studies from our lab

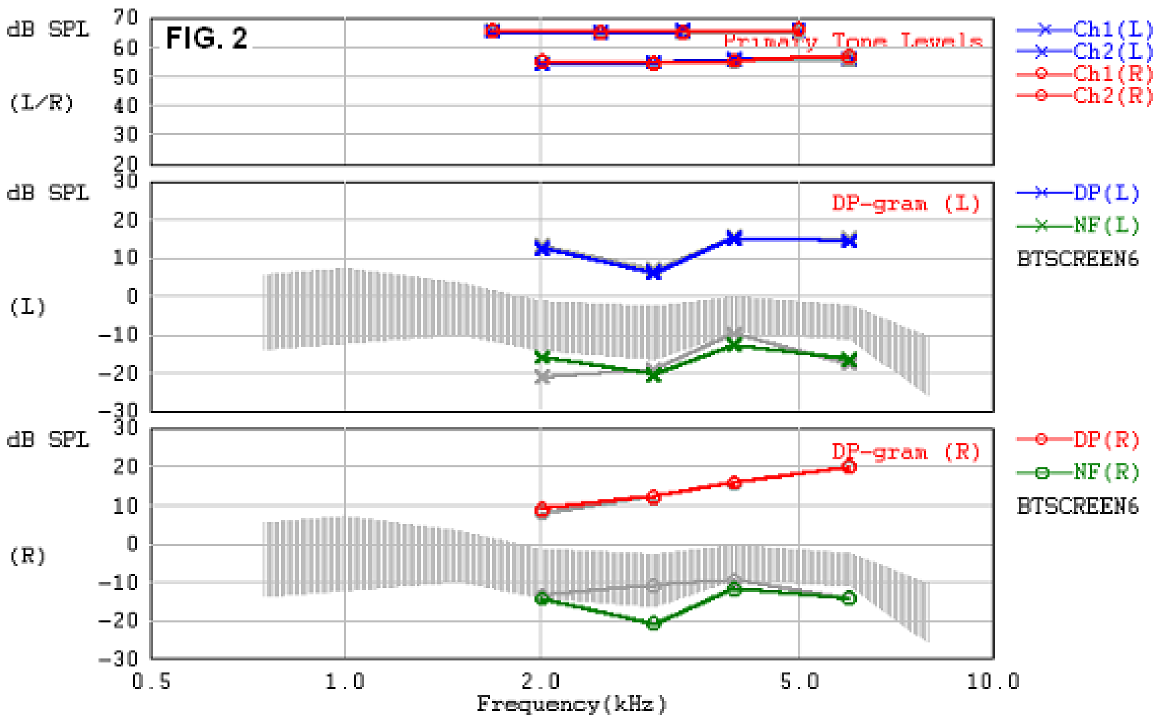
- DPOAE findings in Children with Autism (Danesh, Kaf, et al. 2007)
- DPOAE and contralateral Suppression in Asperger's Syndrome (Danesh,Kaf et al., 2008)
- Prevalence of tinnitus and hyperacusis in Asperger Syndrome (Andreassen, Danesh et al., 2008)
- Central Auditory Processing Characteristics in Asperger's Syndrome (Cocchiola, Saul & Danesh, current)

DPOAE Findings in Autism (Danesh & Kaf)

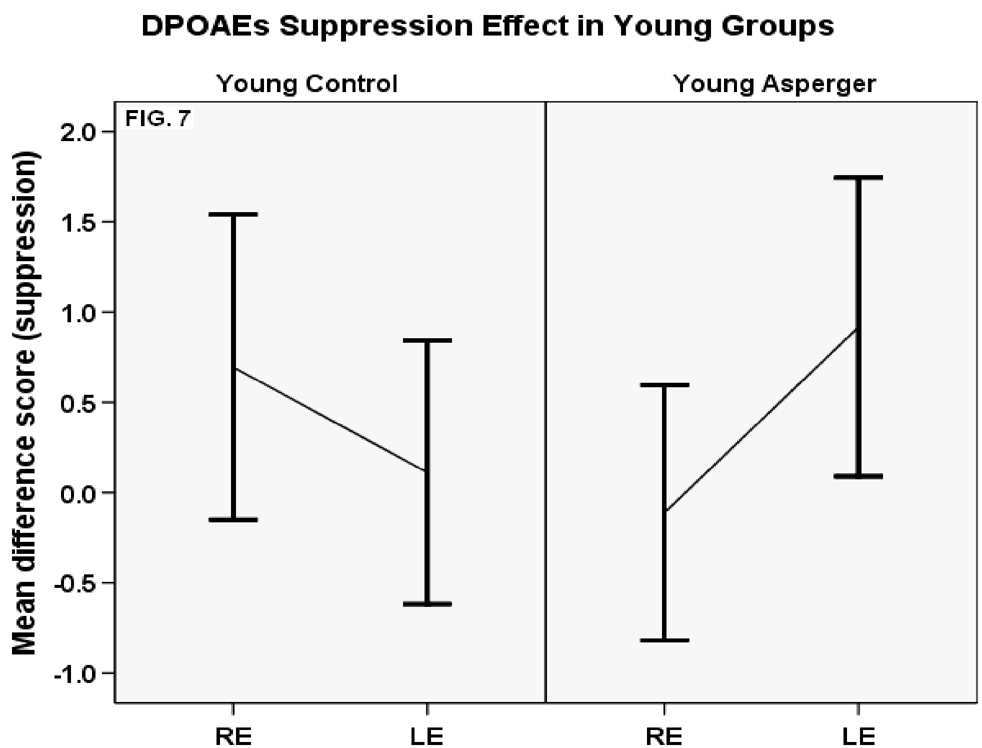


Means (± 1 SE) DPOAEs S/N ratios are larger in the young control (gray bars) and the old control (dotted bars) compared to the Autism group at all 2f1-f2 frequencies. The figure also shows that the responses are larger at higher 2f1-f2 frequency compared to lower frequency.

DPOAE findings in AS (Danesh & Kaf)



DPOAE and Contralateral Suppression findings in AS (Danesh & Kaf)



Means and standard error bars (± 1 SE) of the overall DPOAEs difference score (suppression) in both ears of the young subgroup (control and Asperger). Young control had larger right ear suppression than that of left ear and than right ear suppression in the Asperger. While the left ear suppression of the Asperger group was larger than the left ear suppression of the control group. Suppression was determined by subtracting the DPOAEs SNR without contralateral stimulation from DPOAEs SNR with contralateral stimulation. Suppression is expressed as a positive value; the larger the positive value, the greater the MOCB activity and the greater the suppression.

Tinnitus and Hyperacusis in Asperger Syndrome

- Andreassen & Danesh et al. (2008) administered the Tinnitus Reaction Questionnaire [TRQ], Tinnitus Handicap Inventory [THI], and the Hyperacusis Questionnaire [HQ]) to individuals with AS
- These tools categorize subjective response (severity) to tinnitus and hyperacusis.

Prevalence of Tinnitus

- Prevalence of tinnitus in adults (general public) falls in the range of 10% to 15% (Brown, 1990;Sindhusake et al., 2003).
- The prevalence of tinnitus in children with normal hearing has been reported to be between 6% and 36% and much higher in children with hearing loss. Data from 964 children, tinnitus was reported by 12% (Kajsa-Mia Holgers, 2004)
- Prevalence of tinnitus in a pediatric otolaryngology clinic was 40.5% (Coelho & Sanchez, 2004)
- No current data available for ASD and AS.

Results from Andreassen & Danesh et al (2008)

- 69% reported hyperacusis, with an average HQ score of 20.7 (corresponding to 50% annoyance)
- 35% reported perceiving tinnitus, with average scores of 27 for the TRQ and 23 for the THI
- 15% reported hearing words or music
- 11% reported tinnitus accompanied by hearing words or music

Results

- The four situations reported by individuals with AS on the HQ were difficult "a lot" of the time:
  1. Trouble reading in a noisy place or loud environment (55%)
  2. Trouble concentrating in noisy surroundings (52%)
  3. Difficulty listening to conversations in noisy places (43.2%)
  4. Noise and certain sounds causing irritation (41%)

Tinnitus and Hyperacusis in AS Population

- Tinnitus appears to be an integral part of AS.
- Prevalence of tinnitus is higher than in the general public.
- Some parents report improvement with hyperacusis behavior
- A significant lower prevalence of hyperacusis in children with AS was not noticed as they aged.
- Hyperacusis remains with the same prevalence across age groups in this population. This finding can be related to neuro-developmental aspects of AS.

(Danesh et al., year)

Future Research for Tinnitus and Hyperacusis

- Further data analysis may provide insight into the possible correlation between tinnitus and hyperacusis symptoms and the abnormal social interactions observed in this group.
- Our current research has led us to consider tinnitus and hyperacusis management protocols for this population using appropriate sound therapy and habituation techniques.
- Use of noise cancellation devices or custom made sound tracks can facilitate the process of desensitization to sound in this population.

Thanks to the following collaborators and contributers

- Kyle Bennett, Ed.D. (Center for Autism & Related Disabilities, Florida Atlantic University)
- Madeleine Stam, M.D. (University of Miami)
- Wafaa Kaf, M.D., Ph.D. (Missouri State University)
- William Andreassen, Au.D. (Labyrinth Audiology)
- Mirjana Pavlovic, M.D., Ph.D. (Florida Atlantic University)

Thank You.

Ali A. Danesh, PhD
(danesh@fau.edu)
Erin Cocchiola, BA, AuD-C
(cocchiol@nova.edu)