Executive Function and Theory of Mind: An Auditory Perspective

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Topics Covered
• Definition and description of Executive Functions
• Definition of ToM, and relationship to child development and to children with hearing loss
• Relationship of ToM to language development, tracking of conversations, and intensity of social/language exposure
• Relationship of ToM to distance hearing and incidental learning

Executive Functions

Description of Executive Functions
• Executive Function (EF) is an umbrella concept that includes a collection of interrelated functions that are responsible for purposeful, goal directed, problem-solving behavior.
• Specifically, EFs are a collection of processes that are responsible for guiding, directing, and managing cognitive, emotional and behavioral tasks, especially during novel problem solving.
• EF is the ability to sustain an appropriate problem solving set for accomplishment of a future goal.
• The EFs pertain not only to cognitive control; they also involve regulatory control of emotional response and behavioral action.

Center on the Developing Child: Harvard University

• Enhancing and Practicing Executive Function Skills with Children from Infancy to Adolescence – clip about Executive Function
  http://developingchild.harvard.edu/resources/multimedia/videos/inbrief_series/inbrief_executive_function/

Neurological Issues for EF
• The developmental route of EFs follows the prolonged course of neurological development, chiefly with respect to the pre-frontal regions of the brain.
• The neurological nature of the frontal lobes is their dense synaptic connectivity with other cortical and subcortical regions of the brain.
• The prefrontal system is highly and reciprocally interconnected through bidirectional connections with the limbic (motivational) system, the reticular activating system (arousal), the posterior association cortex (perceptual/cognitive processes,) and the motor regions (action) of the frontal lobes.
Neurological Issues for EF

- A disorder within any component of the frontal system network can result in executive dysfunctions.
- There is no such thing as an Executive Function disorder -- there are disorders in Executive Function.
- Therefore, disorders in executive function can arise from insults to the primary prefrontal regions as well as from damage to the densely interconnected posterior or subcortical areas.
- So, if the brain is disrupted anywhere, a disorder in Executive Functions could occur.

Pre-frontal Cortex Electrical Activity

- Slow pre-frontal lobe electrical activity was certified, in 2013 by the FDA (USA Food and Drug Administration), as a biomarker of ADHD (Attention Deficit Hyperactivity Disorder).
- This slow electrical activity in the prefrontal cortex leads to poor executive function because the “rational brain” lacks proper control over the “emotional brain”.

Developmental Stages of Executive Function

- At birth, babies have inhibitory control, e.g. they have to inhibit inappropriate mouth behaviors in order to nurse.
- From 3 to 24 months -- the beginning of non-verbal working memory.
- Verbal working memory develops from 2-13 years.
- Emotional modulation goes from 3 years -- ???
- Plan/organize/monitor -- 3 to 32 years.
- Because of their complex, higher order nature, the maturation and development of EF is prolonged.

More about EF Development

- To summarize, the development of attentional control, future-oriented intentional problem solving, and self-regulation of emotion and behaviors begin in infancy and continue into the preschool period.
- However, executive control (EC) at these early ages is variable, fragile and tied to the external stimulus situation; increasing stability is achieved between 18 and 30 months of age.
- Girls have greater EC as preschoolers, and draw upon EC to a greater degree to regulate their behavior.

Behaviors Observed in Disorders of Executive Function

**If a child has difficulty inhibiting ineffective behaviors, the child may:**
- Be impulsive
- Have difficulty stopping when being silly
- Have to be supervised, closely
- Not think before acting

**If a child has difficulty with emotional control, the child may:**
- Overact to small problems
- Have angry outbursts — be explosive
- Tear up easily and have frequent mood changes

**If a child has difficulty with working memory, the child may:**
- Be absent minded
- Remember only the first or last item when given 3 things to do
- Have trouble with multistep chores

**If a child has difficulty self-monitoring, the child may:**
- Not notice when he causes others to feel bad or become angry until it is too late
- Not understand why, when people seem upset with her -- and not ask for help when needed
Overlapping Conditions, Symptoms and Behaviors

The following Executive Function difficulties or symptoms can occur with or because of a language disorder, ADHD, CAPD, learning disability, or hearing loss with limited auditory/linguistic exposure and practice:

- Attention; Language; Verbal Memory
- Following directions; Listening
- Processing speed
- Academics
- Behavior Problems

Treatment for Problems with EF

Neuropsychologists can assist in designing treatment plans based on the child's EF profile, such as one obtained from the BRIEF-P -- Behavior Rating Inventory of Executive Function -- Preschool Version (Gioia, Espy, & Isquith, 2003). Sample of strategies:

- facilitating inhibitory control by controlling antecedents to the impulsive behaviors;
- allowing meaningful and consistent consequences to happen;
- give "2 minute" warnings when tasks are about to change;
- practice appropriate emotional reactions;
- and reduce exposure to overly stimulating environments.

Treatment for Problems with EF

Sample of strategies for working memory:

- encourage self-talk (private speech) to assist in regulating emotions and their expression as well as remembering tasks;
- parent/clinician speaks slower to allow the child to rehearse and think about the communication;
- Mostly the parent/clinician/teacher takes on the role of Executive Function Manager until the child can learn that role for herself.

The Marshmallow Study

- This is a study of self control and deferred gratification – Executive Function.
- [http://www.youtube.com/watch?v=amsqeYOk](http://www.youtube.com/watch?v=amsqeYOk)

Theory Of Mind (ToM)

“The capacity to infer other people's mental states, and to use this information to predict behavior, is a central cognitive ability that emerges early in human development” (Pyers and Senghas, 2009).
**Definition and Description of ToM; An Aspect of Social Cognitive Development – Emotional Understanding**

- A "Theory of Mind" (often abbreviated in ToM) is a specific cognitive ability to understand others as intentional agents.
- It also means one must be able to maintain, simultaneously, different representations of the world.
- ToM appears to be an innate cognitive potential in humans, but one requiring social/linguistic and other experience over many years to bring it successfully to adult fruition.
- It has been commonplace in philosophy to see ToM as intrinsically dependent upon our linguistic abilities.
- As each child's ToM matures, he or she is able to gauge others' beliefs, desires, perspectives, and intentions, and perhaps predict their behavior.

**Definition and Description of ToM -- More**

- Having a ToM allows children to understand many aspects of human social life such as surprises, secrets, tricks, manipulation, negotiation, mistakes and lies.
- As children age and gain more social and language skills, a ToM forms the basis for inference, perspective taking, social reasoning, and empathy.
- A ToM is critical for academic development, especially in collaborative educational environments.

**What are Mirror Neurons?**

- A mirror neuron is a neuron that fires when a person acts, and also when the person observes the same action performed by another.
- Mirror neurons are thought to be in the pre-frontal cortex and inferior parietal cortex and are important for language development and for growth of Theory of Mind skills.
- Talking activates mirror neurons – texting does not.

**The Science: Mirror Neurons**

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- **Talking activates mirror neurons – texting does not.**

**We can’t help copying others, especially if we are emotionally in-tune!**

**ToM and Children**

- A workable ToM doesn’t develop before the age of 4 years; by that age, a child should be able to distinguish between what is so and what people believe is so.
- One of the most important milestones in theory of mind development is gaining the ability to attribute false belief; that is, to recognize that others can have beliefs about the world that are wrong.
- A new model of sex differences in the mind suggests females, on average, show a stronger drive to empathize; empathy is broader than "theory of mind" because it not only involves identifying the mental states of the other person, but also responding to these mental states with an appropriate emotion.
Theory Of Mind And Children With Hearing Loss

- The language skills in children with hearing loss are directly related to their Theory of Mind skills, however, it isn’t general language skills but rather specific vocabulary skills.
- That is, if a child can understand sentences such as, “He thought his cake was in the cupboard,” he is more likely to understand and predict behavior premised on a false belief.
- One important way that children gain an understanding of other’s thoughts is by attending to the back and forth viewpoint exchange of family members; therefore, the child must be able to track multi-talker conversations – a skill that demands the maximum possible auditory access to soft speech at a distance – in the same language as those in the environment.

Summary Comments: ToM

- Language, not just social experience, is required for development of an understanding of false-belief.
- Nevertheless, social experiences and language likely function together to build a mature ToM.
- The child needs to use/produce as well as hear mental-state verbs (e.g. think, know) which leads to a meta-awareness of those internal processes that can affect human action.

Use Casual Explanatory Talk

- Because.....
- Ask, “How do you know?”
- Seeing is knowing
- Hearing is knowing
- Smelling is knowing

Examples of Mental-State Words and Phrases for Desire, Emotion, Modulation of Assertion, Thinking and Knowing

- What if...?
- I wonder...
- What do you think?
- When I was....
- You won't believe...
- Bet you can't guess...
- What do you see?
- Remember....
- This reminds me
- Possibly
- Could be
- If I were...
- One time...
- Would you believe??
- How do you think she feels?
- What could happen next?
- Why did she....?
- Want
- Like
- Disappointed

Imagine a “Think Bubble” over the child’s head to Facilitate Adult-Child ToM. Think about what the child might be thinking.
Summary Comments: ToM

- To compete academically, children need to be able to know and have the confidence to express their feelings in presenting arguments.
- Children require knowledge about the subtle social rules for communication—and these rules are learned incidentally—by participating in conversations and by overhearing the conversations of others.
- Lack of social competence impedes academic progress.
- Language and speech delays impede social relationships.

Incidental Learning And Distance Hearing

Acoustic access at a distance and for soft speech (in the same language as others in the environment) is critical for the development of ToM!!

Incidental Hearing

- Hearing is a distal sense.
- Hearing enables us to monitor what is happening in the environment—to gain “free information”…not direct instruction.
- Hearing enables us to learn casually, incidentally, and passively.
- Hearing enables us to learn about our culture, about social conditions, about human interactions—by “over-hearing” the conversations and transactions of others.

We must extend a baby/child’s distance hearing as much as possible, as often as possible, to access “Free Information” and to assist in the social and linguistic access and practice that is necessary for development of ToM.

Children must be able to “overhear” conversations!

It’s All About The Brain

Hearing loss is not about ears; it’s about the brain!

Hearing aids, RM systems and cochlear implants are not about ears; they are about getting auditory information to the brain!

They are “brain access tools”.

Specific Strategies for Parents: How To “Grow” Your Child’s Brain for Speaking, Listening, Reading, Learning and Making Friends
Calculating the Time Children Spend at Home vs. at School, From Birth to Age 18

- Assume that a child sleeps 8 hours/day
- 24 hours/day - 8 hours sleeping = 16 waking hours/day
- 6,570 days x 16 waking hours/day = 105,120 waking hours by age 18
- Average 6 hours per day at school.
- Average 180 school days/year
- 180 school days/year x 6 hours/school day = 1,080 hours per school year.
- 1,080 hours/school year x 13 school years (1 year kindergarten + 12 years through H.S.) = 14,040 school hours
- 14,040 school hours / 105,120 waking hours = .13356 or ...

Just 13.36% of waking hours by age 18 are spent in school!

PARENT ENGAGEMENT MATTERS!!!!

Adapted from “Nine Truths about Parent Engagement” (Wherry, 2014)

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For Parents: How To Grow Auditory Brain Centers – Always explain the “Brain Why”

- Above all, love, play, and have fun with your child!
- Once your child receives a hearing aid or cochlear implant, make sure he/she wears it every waking moment (at least 10-12 hours/day – eyes open, technology on). The auditory brain centers need consistent access to clear, complete sound in order to develop. Use a RM System.
- Check your child’s technology regularly. Equipment malfunctions, often. Without auditory brain access, talk to the floor.

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For Parents: How To Grow Auditory Brain Centers – Always Explain the “Brain Why”

- Minimize background noise. Turn off the T.V.
- Sing to your child! Fill their days with all kinds of music and songs; promotes interhemispheric transfer. And, “bounce”.
- Speak slowly, clearly and in full sentences with correct grammar and with lots of melody. Stay close!
- Focus your child on listening. Call attention to sounds around the room. Point to your ear. Use listening words such as “you heard that”, and “you were listening”.
- Emphasize sound before vision for auditory enrichment.

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For Parents: How To Grow Auditory Brain Centers – Always Explain the “Brain Why”

- Read, Read, Read aloud every day. Try for 10 books per day. We should be reading chapter books to 4-year-old children. “Write” notes.
- Name objects in the environment as you encounter them in daily routines.
- Talk about and describe how things sound, look, and feel.
- Compare how objects or actions are similar and different in size, shape, smell, color, or texture.

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Tip: Have the Family make Experience Books, paper or apps -- one page every day -- a wonderful conversational tool!
Tips About Making an Experience Book

• [Hyperlink](http://www.twodalo.com/make-an-experience-book-to-build-language/)

References for ToM


General References


Handbook of Acoustic Accessibility
Best Practices for Listening, Learning, and Literacy in the Classroom

$39.99

Thieme Medical Publishers, Inc.
Order toll-free: 1-800-782-3488
Fax: 1-212-947-0108
www.thieme.com

A practical, reliable reference that helps audiologists and teachers achieve acoustic accessibility in the classroom.