The Role of Bottom-up and Top-down Processes in the Development and Treatment of Childhood Stuttering

Presentation by:

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Overview of the talk

- Introduce bottom-up and top-down processes
- Discuss behavioral inhibition and attentional biases as two bottom-up processes relevant to childhood stuttering.
- Discuss executive function skills (top-down process) and how to support their development in preschool-age children who stutter.

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Bottom-up and top-down processes

- Two fundamental cognitive processes that develop in early childhood.
- Bottom-up processes:
  - the sensory information that is processed by the brain in a hierarchical and sequential manner, starting with basic sensory input and progressing to more complex perceptual processes.
  - these include stimulus-driven emotion, attention, and physiological stress reactivity.
- Top-down processes:
  - Top-down processes are abilities used to regulate information and to organize thinking in goal-directed activities. In other words, top down processes allow a child to regulate their reactivity to stimuli including regulation of their stimulus-driven emotion and attention.the higher-level cognitive processes that are driven by prior knowledge and expectations.
  - top-down processes can be thought of as executive control of thought and behavior and include cognitive aspects of regulation (e.g. executive functions).

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Bottom-Up Process
1) Behavioral Inhibition (BI)

- One of the most stable temperamental characteristics in childhood (Fox et al., 2005; Schwartz et al., 2012).
- Temperamental trait that influences how children approach (or withdraw) from new people, situations, and life events
- Physiological mechanism that controls the experience of anxiety in response to novelty and potentially threatening stimuli
- Behaviorally inhibited children are hyper-vigilant to their environments and prone to exhibit a heightened sensitivity to novelty (Kagan, Reznick, & Snidman, 1987), particularly if it is social in nature (Biederman et al., 2001)

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Behaviorally inhibited children

- Slow-to-warm-up
- Do not respond well to changes
- Builds tolerance for novelty slowly

Ellen M. Kelly (2012)

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Behaviorally UNinhibited children

- Does not know a 'stranger'
- May talk nonstop without breaking for pauses or turns

Ellen M. Kelly (2012)

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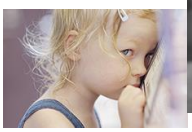
Children on the ends of the BI continuum may be at risk for increasing in stuttering

low BI with impulsivity: those who are extremely behaviorally **un**inhibited; may be restless, impulsive, strong willed, and inattentive. They are at risk of developing **externalizing problems** later.



high BI: those who are extremely behaviorally inhibited; may be shy, self-conscious, and quiet. They are at risk of developing **internalizing problems** later.

Resilient (low-to-mid BI without in those who are open, self-confident, a reliant, and cooperative.

Asendorf & van Aken (1999). Resilient, overcontrolled, and undercontrolled personality prototypes in childhood. *Journal of Personality and Social Psychology, 77*, 815-832

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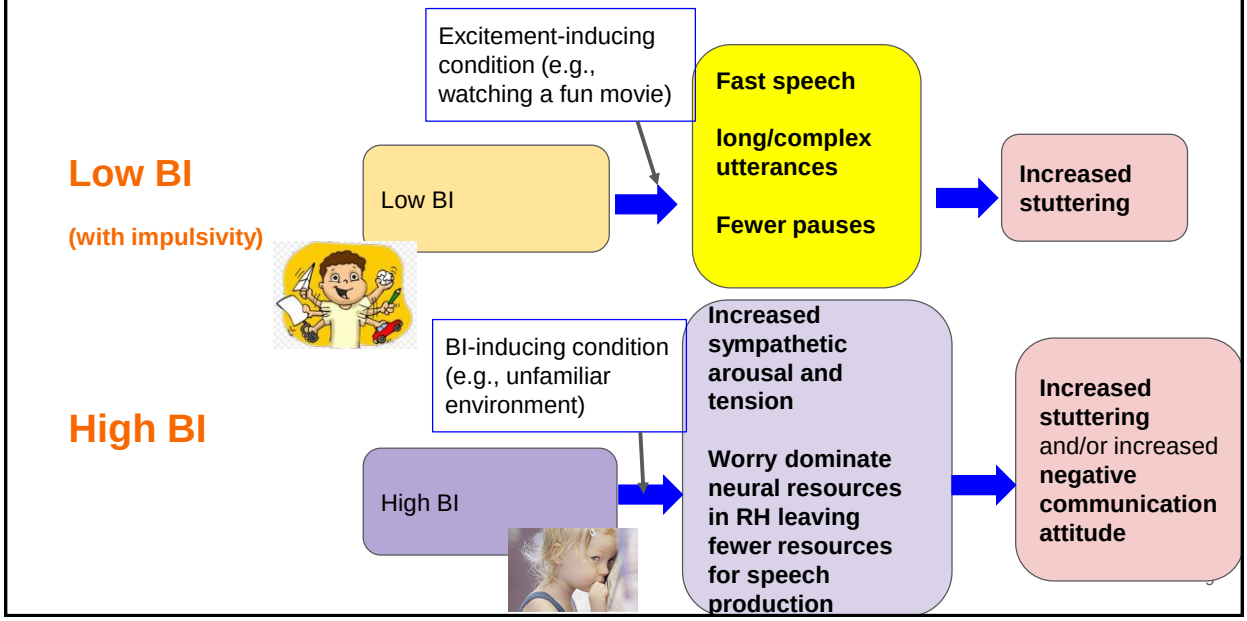
Different (Hypothesized) Mechanisms



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Summary of the BI findings

- **CWS vs. CWNS** In general, no significant difference in the prevalence of high BI among CWS compared to CWNS (Choi et al., 2013; Tumanova et al., 2020; but also see Ntourou et al., 2020)
- **Within CWS** Higher BI was associated with
  - Greater stuttering frequency (Choi et al., Ntourou et al, cf. Tumanova et al.; Akers & Choi, only for CWS ages 4 - 6 years as opposed to 3 years old)
  - Greater amount of physical behaviors that can accompany moments of stuttering (Tumanova et al., independently from stuttering severity per SSI4).
  - Greater stuttering-related consequences, and more negative communication attitudes but only for CWS ages 4-6 years as opposed to 3 year-olds (Ntourou et al.).

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Bottom-Up Process: 2) Attentional Bias/Threat Detection

More Stimulus-Driven DETECTION More Goal-Driven

- Error monitoring (e.g., Flanker)
- Feedback Processing (e.g., monetary incentive delay)
- Conflict monitoring (e.g., Go/No-Go)

- Salience detection (e.g., face processing tasks)
- Threat detection (e.g., dot probe)
- Novelty detection (e.g., Oddball)

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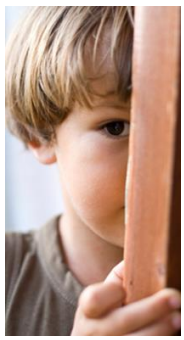

Figure adapted from Fox, N. A., Zeytinoglu, S., Valadez, E. A., Buzzell, G. A., Morales, S., & Henderson, H. A. (2023). Annual Research Review: Developmental pathways linking early behavioral inhibition to later anxiety. *Journal of Child Psychology and Psychiatry, 64*(4), 537-561.

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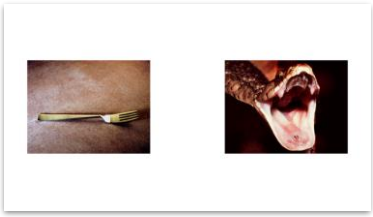
Vigilance/Threat Detection

Participants: 22 CWS & 22 age- and gender-matched CWNS
Task: Eye-tracking passive viewing task
Stimuli: 20 Neutral-Negative, 20 Neutral-Positive picture plates (nonsocial stimuli)
Outcome measure: "Probability of first fixation on emotion picture"
Results: CWS were more likely than CWNS to look at the emotion picture first, both for the negative-neutral (p = .0014) and the positive-neutral (p = .016) trials.



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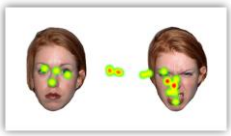
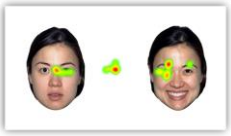
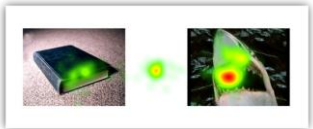


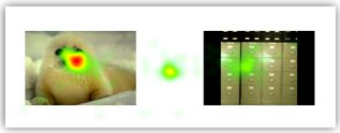
Maintenance of threat detection



Participants: 22 CWS & 22 age- and gender-matched CWNS
Tasks: Eye-tracking passive viewing tasks (social & nonsocial)
Stimuli: 20 Neutral-Negative, 20 Neutral-Positive picture plates
Outcome measure: "Percentage of fixation duration on emotional picture"
Results:

1. Girls who stutter presented with greater attentional bias to angry faces compared to girls who do not stutter (p = .048)
2. Girls who stutter presented with greater attentional bias to positive nonsocial pictures compared to girls who do not stutter (p = .025)





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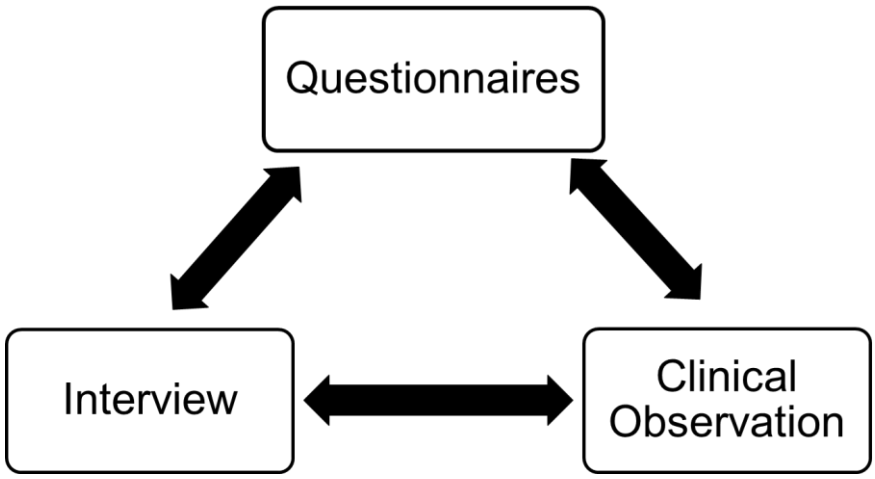
Assessment of Bottom-up processes



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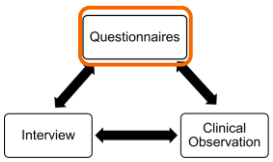
Questionnaires



Parent-report questionnaires:

- Shyness factor score from the **Children's Behavior Questionnaire**: 13 items (CBQ; Rothbart et al., 2001) or 6 items (CBQ-SF; Putnam & Rothbart, 2006)
- **Short Behavioral Inhibition Scale** (SBIS; Ntourou et al., 2020): 5-item questionnaire
- **Behavioural Inhibition Questionnaire** (BIQ; Bishop et al., 2003): Social Novelty Inhibition (14 items), Situational Novelty Inhibition (16 items)
- Behavioral inhibition scale (6 items) and sensory sensitivity scale (6 items) from the **Integrative Child Temperament Inventory** (ICTI; Zentner & Wang, 2013)

Teacher-report questionnaire:

- **Behavioural Inhibition Questionnaire** (BIQ; Bishop et al., 2003): Social Novelty Inhibition (14 items), Situational Novelty Inhibition (14 items)

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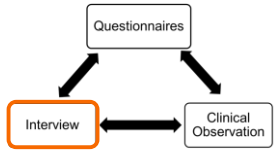
Sample Parent Interview Questions



Parent-report questionnaires:

- Does your child get easily upset?
- Does your child startle easily to sounds?
- Is your child a picky eater?
- Is your child sensitive to sounds or textures (e.g., clothing)?
- Would you say that your child is sensitive, or not particularly?*
- How does your child react if he gets something wrong of makes mistakes?*
- Is your child usually shy when meeting new people?
- Does your child separate easily from you in new environments/when meeting new people?

*Kelman, E., & Nicholas, A. (2020). *Palin parent-child interaction therapy for early childhood stammering* (2nd ed.). Routledge.

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Top-Down Processes

	Cold executive functions				*Hot* executive functions			
domains / tasks	major domains		major tasks		major domains		major tasks	
	working memory	set shifting	n-back / digit span	attention shifting	emotion regulation	self-referential	ERT	self attribution task
	response inhibition	multi-tasking	Go/No-Go / SST	task-switching	reward processing	social cognition	reward-based tasks	theory of mind
	attentional control	error detection	Stroop / AX-CPT	conflicting tasks	delay discounting	any cold executive function domain with emotional or motivational features	monetary decision	any cold executive function task with emotional or motivational features
	problem solving	performance monitoring	Tower of London	Stroop	risky decision making		Iowa gambling task	
	cognitive flexibility		remote associate test		affective decision		emotion tracking task	
brain structures	cortical		subcortical		cortical		subcortical	
	dorsolateral prefrontal cortex		hippocampus		medial prefrontal cortex		amygdala	
	lateral prefrontal cortex		basal ganglia		ventrolateral prefrontal cortex		insula	
	anterior cingulate cortex				orbitofrontal cortex		limbic system	
	inferior frontal cortex						striatum	

Figure adapted from Salehinejad, M. A., Ghanavati, E., Rashid, M. H. A., & Nitsche, M. A. (2021). Hot and cold executive functions in the brain: A prefrontal-cingular network. *Brain and neuroscience advances, 5*, 23982128211007769.

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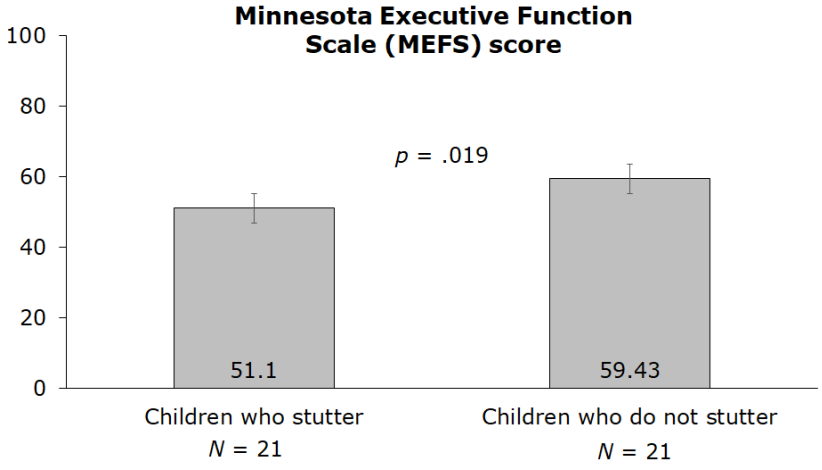
Minnesota Executive Function Scale (MEFS App™; Carlson & Zelazo, 2021)



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NIH Toolbox Assessment

28 3-to-5 y/o children participated: 18 CWNS (6 F; 12 M) and 10 CWS (4 F; 6 M).

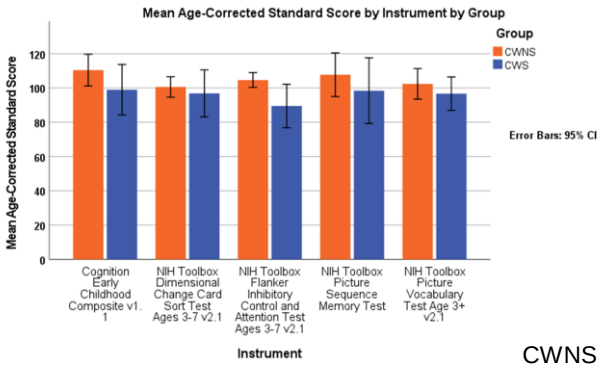


Figure 1: Dimensional Change Card Sort

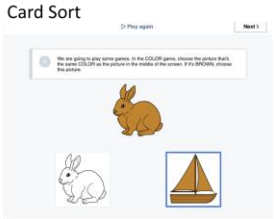


Figure 2: Flanker Inhibitory Control Test

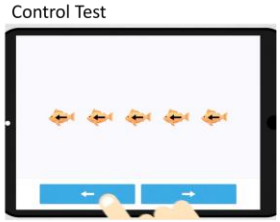


Figure 3: Picture Sequence Memory Test

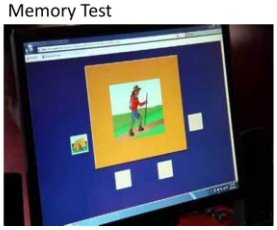
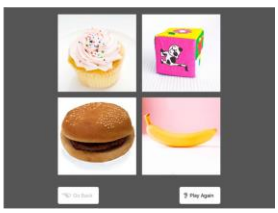


Figure 4: Picture Vocabulary Test



CWNS scored higher than CWS on all the tests (p=0.003)
Boys scored lower than girls (p=0.015).

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Assessment of Executive function (Cool & Hot) Skills

Questionnaires:

- Behavior Rating Inventory of Executive Functions (BRIEF-P; Gioia et al., 2002).
- CBQ Attention focusing, Attention Shifting, Inhibitory control, and Impulsivity subcales (Rothbart et al., 2001)
- ADHD Rating Scale-IV: Preschool Version (McGoey et al., 2007)
- Integrative Child Temperament Inventory (Zentner & Wang 2013)
- Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997).
- ASQ: Social Emotional, Second Edition (ASQ:SE-2; Squires et al., 2015)
- Parental Assistance with Child Emotion Regulation (PACER; Mancini et al., 2023)
- Emotion Regulation Checklist (Shields & Cichetti, 1997)

Tasks:

- Delay of gratification tasks (e.g., gift delay–wrap task, marshmallow tasks)
- Rabbit-turtle task (Kochanska et al., 2000)
- Non-word repetition task (Dollaghan & Campbell, 1998)

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Assessment of Executive function (Cool & Hot) Skills

Standardized Tasks & Tests

- Minnesota Executive Function Scale (MEFS App™; Carlson & Zelazo, 2021)
- Early Years Toolbox (EYT; Howard & Melhuish, 2017).
- NEPSY-II (Korkman, Kirk, & Kemp, 2007)
- Flanker Inhibitory Control and Attention Test, Dimensional Change Card Sort Test, and List Sorting Working Memory Test (NIH Toolbox)
- Continuous Performance Test - Preschool (CPT; Kerns & Rondeau, 1998)

Interview

- Does your child have difficulty with changes in routine, or with transitions from one activity to another?
- Does your child take a long time to become comfortable in new situations?
- Is it easy for your child to calm themselves when upset or overly excited?

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Clinical Implications

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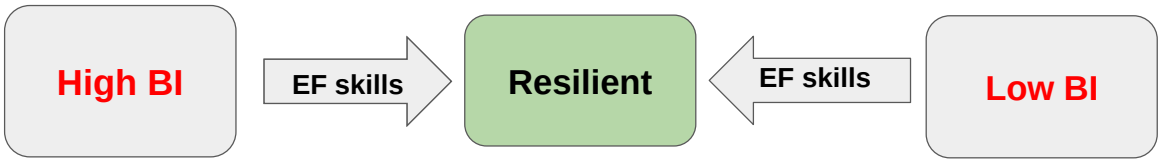
To make children more resilient, different EF skills may be needed for High BI vs. Low BI children



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Different EF skills may be more beneficial to high BI vs. low BI kids

- For High BI kids, the following EF skills may be beneficial.
  - **Cognitive flexibility**: the capacity to switch between different tasks, adapt to changes, and see things from different perspectives
  - **Self-Initiation**: the ability to carry out plans.
- For Low BI kids, the following EF skills may be beneficial.
  - **Inhibition or regulation of actions** : the ability to control impulsive behaviors, resist distractions, consider consequences of their actions, and adjust one's own behavior in response to feedback

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EFs skills for Low BI children

- **Inhibition or regulation of actions**: Teach children strategies to pause and think before acting, resist temptation and make more thoughtful decisions. (e.g., pausing, slowing down speech rate, taking turns, listening to others)

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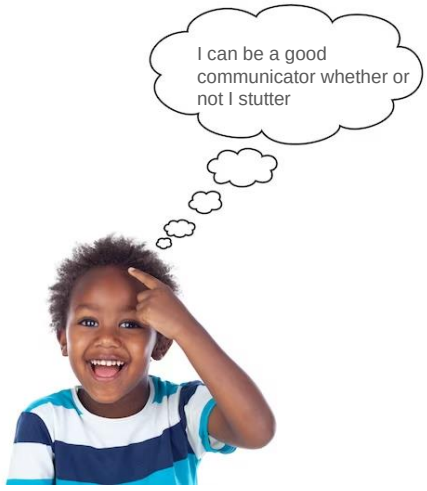
EFs skills for High BI children

Cognitive flexibility:

- High BI children may struggle with rigid thinking pattern (e.g., “I have to be fluent all the time”; “stuttering is bad”; “I can’t be a good communicator if I stutter”, “If I stutter, they might perceive me as unintelligent”)
- Help them to consider alternative perspectives (e.g., stuttering is just an inconvenience, not a bad thing” “I can be a good communicator no matter whether I stutter”, “I cannot control how other think about me, but I can control how I think about myself”, “stuttering doesn’t define me”)



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EFs skills for High BI children

Self-Initiation

- It can help them overcome hesitation.
- Encourage children to participate in social activities that they would not try by themselves in fear of making mistakes. (e.g., participating in a camp for children who stutter, volunteering to present in front of class; attempting to contribute to discussions)

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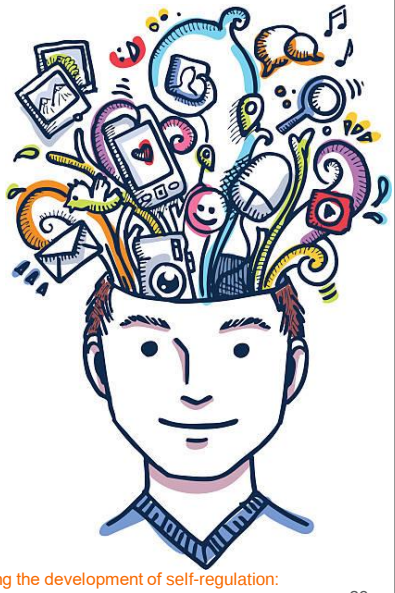
Increase Child's Self-Regulation

- **Self-regulation**: ability to recognize, monitor, and manage your internal states (e.g., stress, energy, emotions) in order to attain/maintain optimal levels of biological, emotional, and cognitive arousal
- Examples of self-regulation:
  - a child recognizes that he needs a break to replenish energy after engaging in a cognitively challenging reading task;
  - a child noticing and moving away from distractions in his environment with the goal of focusing his attention to his work;
  - a child recognizing that her tension (tense lips/jaw) might be impacting her speech fluency, and therefore engaging in relaxation techniques to reduce tension.



Binns, A. V., Hutchinson, L. R., & Cardy, J. O. (2019). The speech-language pathologist's role in supporting the development of self-regulation: A review and tutorial. *Journal of Communication Disorders, 78,* 1-17.

Source: https://www.istockphoto.com

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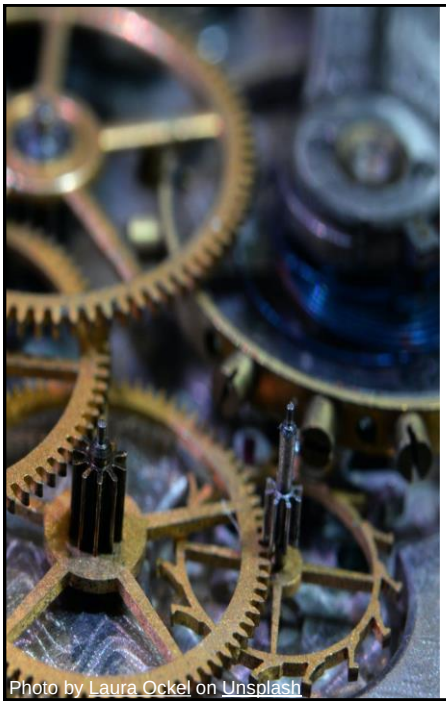

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CO-REGULATION

- Co-regulation helps develop self-regulation
  - co-regulating strategies mitigate the negative impact of stress and should be considered prior to working on cognitively taxing speech-language goals or working toward developing specific executive functions skills involved in self-regulating
- Modify the environment (minimize or remove stimulation that can elicit stress)
- Modulate exposure (slow down your own speech rate)
- Add elements of predictability
- Be warm and responsive
- Acknowledge the child's intent to communicate
- Follow the child's lead

Binns, A. V., Hutchinson, L. R., & Cardy, J. O. (2019). The speech-language pathologist's role in supporting the development of self-regulation: A review and tutorial. *Journal of Communication Disorders, 78,* 1-17.

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Work to support self-regulation

- Develop the child's vocabulary for expressing emotions, physiological states (learn the words to express your feelings)
- What does it mean for you to feel calm
- Engage children in problem solving
- Involve children in decision processes (e.g., developing rules for games, activities, or social situations) and provided children with opportunities to select their own activities
- Alert Program (Williams & Shellenberger, 1996)
- Zones of Regulation (Kuypers, 2011)

Binns, A. V., Hutchinson, L. R., & Cardy, J. O. (2019). The speech-language pathologist's role in supporting the development of self-regulation: A review and tutorial. *Journal of Communication Disorders, 78*, 1-17.

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Thank You!

Questions?

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