Psychophysiological correlates of emotional processes in children who stutter

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Autonomic Arousal: A physiological correlate of emotional arousal characterized by activation of the sympathetic nervous system, which prepares the organism for action

- Increased heart rate
- Increased blood flow
- Activation of sweat glands

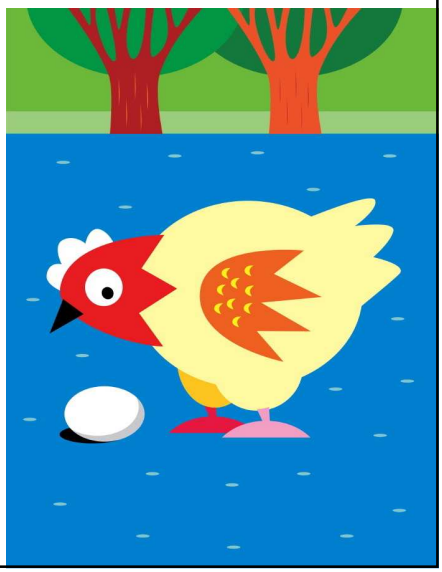
(Pinel, 1997)

Stuttering and Autonomic Arousal in Adults

Are people reacting emotionally to their stuttering or are the emotions impacting the occurrence of stuttering?

For adults who stutter, sympathetic arousal appears to be associated with

•Occurrence and severity of stuttering, even *prior* to the onset of the utterance for adults who stutter (Weber & Smith, 1990).
•Decreased speech motor coordination (Caruso, Chodzko-Zajko, Bidinger, & Sommers, 1994)



What about kids?

- Typically developing children also demonstrate sympathetic arousal when performing a speech task in front of an audience (Buske-Kirschbaum et al., 1997)
- For school-age kids (CWNS), increased autonomic arousal elicited by a Stroop task prior to speech production is related to increased variability in speech motor output (Kleinow & Smith, 2006).

This suggests that autonomic arousal may negatively impact speech motor control, disrupting child's speech output.

Autonomic Correlates of Speech and Stuttering in Children who Stutter

Purpose: To assess whether autonomic arousal differs between CWS and children who do not stutter (CWNS) prior to, during, and after speech and non-speech task performance.

It was also the purpose of this study to assess whether autonomic arousal is related to the occurrence of speech disfluencies in CWS.

Participants

•Eight 7-9 year old CWS and eight age-matched CWNS (all boys).
•Fitted with infrared photoelectric plethysmograph transducer on the distal phalange of the middle finger to measure peripheral blood flow.
•Two electrodes were attached to the palm to measure electrodermal activity (i.e., skin conductance) (Dawson, Schell, & Filion, 2007).

From Arnold and MacPherson (in prep)

Non-Speech Conditions

(adapted from Weber & Smith, 1990)

1) JAW, a repeated vertical jaw movement task - 5s/trial

A low arousal task

2) VAL, a Valsalva, or effortful breath-holding task - 5s/trial

A high arousal task

- 40 second baseline recording made at the beginning of each condition
- 20 second recovery period occurred between each trial

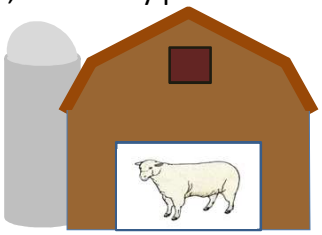
From Arnold and MacPherson (in prep)

Speech Conditions

(adapted from Weber & Smith, 1990)

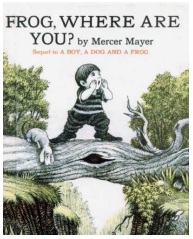
3) SENT, 3 simple sentence productions/trial, elicited by pictures

A low arousal, low linguistic difficulty task

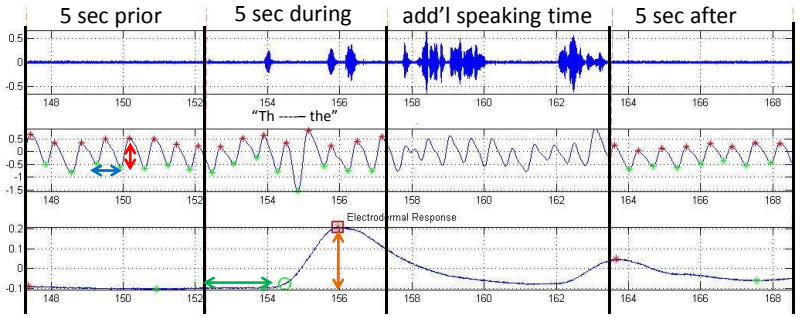


4) NARR, spontaneous speech production elicited by the text-free storybook, *Frog Where Are You* (Mayer, 1969).

A high arousal, high linguistic difficulty task



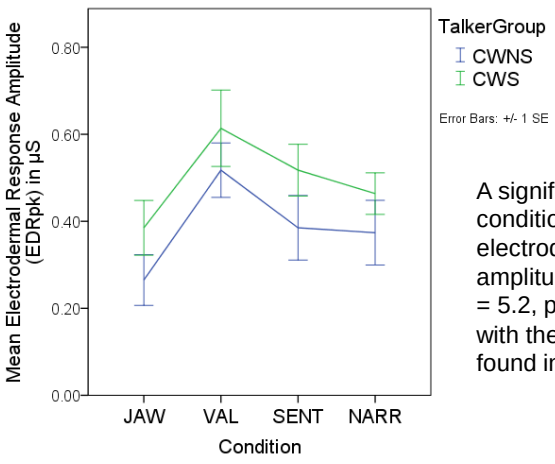
Autonomic Measures for One Trial

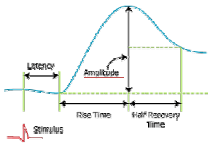


Data from 8-year old boy who stutters

1. Pulse Volume - % change from baseline in mean peak-to-peak amplitude (in volts) of pulse cycles.
2. Heart Rate (HR) - % change from baseline in mean HR.
3. Electrodermal Activity (EDA) - Mean EDA per epoch minus mean EDA for baseline.
4. Electrodermal Response (EDR) - Amplitude (in µS) of the largest EDR per trial
5. Temporal Relation of EDR onset – When the largest within-trial EDR begins relative to the task as well as stuttered moments.

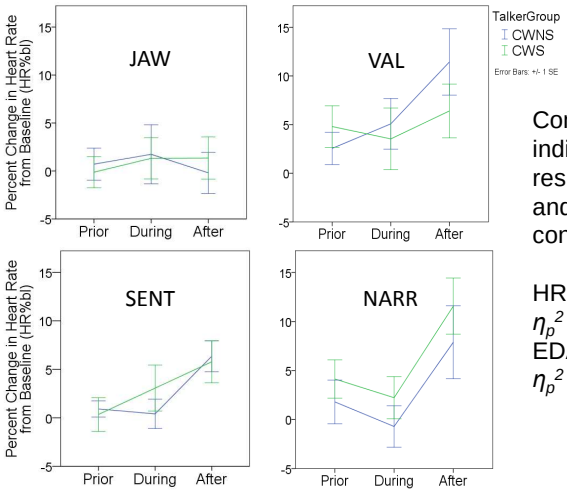
Effect of task on autonomic measures





A significant main effect of condition found for electrodermal response amplitude (EDRpk), $F(3, 42) = 5.2$, $p = .008$, $\eta_p^2 = .270$, with the largest amplitudes found in the VAL condition

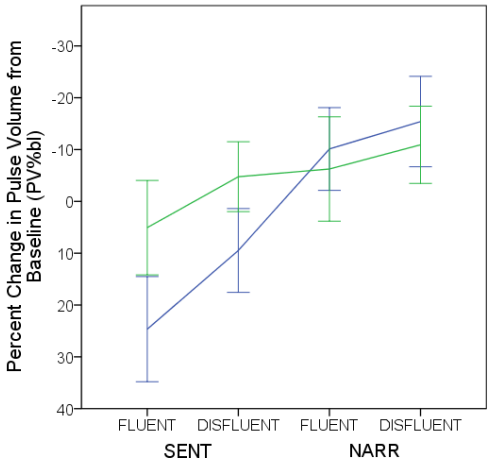
Effect of task on autonomic measures



Condition x interval interactions indicating a different pattern of responding across prior, during, and after intervals between task conditions.

HR%bl, $F(6, 84) = 5,2$, $p < .001$, $\eta_p^2 = .270$
EDA-bl, $F(6, 84) = 3.0$, $p = .016$, $\eta_p^2 = .177$

Speech task effects on autonomic arousal



When the two speech tasks, SENT and NARR, were compared, there was a significant main effect of condition for PV%bl, $F(1, 14) = 8.2$, $p = .012$, $\eta_p^2 = .370$, indicating a lower PV%bl (greater vasoconstriction) for NARR compared to SENT.

No differences between CWS and CWNS across all tasks.

Trial by Trial Analysis of Electrodermal Responses

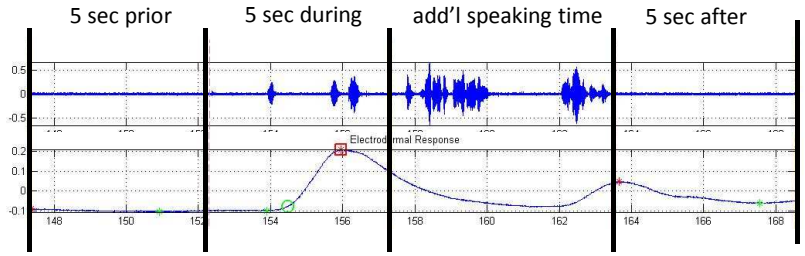
- Electrodermal responses (EDRs) allow for moment-to-moment changes in sympathetic arousal to be observed.
- Thus, we examined when EDRs occurred relative to speech and stuttering.

Electrodermal Responses (EDRs) for Speech Trials

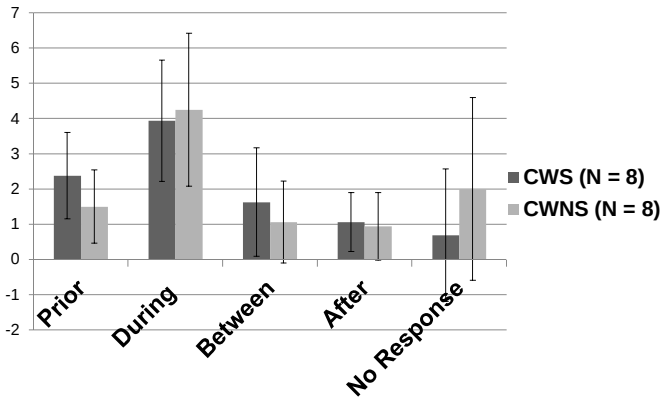
- Measureable electrodermal responses (EDRs .05 μS or greater) occurred for 87% of the first 10 speech trials (10 SENT, 10 NARR)
- CWS had measurable EDRs for 93% of speech trials
- CWNS had measurable EDRs for 80% of speech trials (no significant group differences in electrodermal response rates)

Timing of EDR onsets

To assess when electrodermal responses tended to begin relative to speech, the largest measurable EDR was chosen for each of the first 10 speaking trials per condition (SENT, NARR).



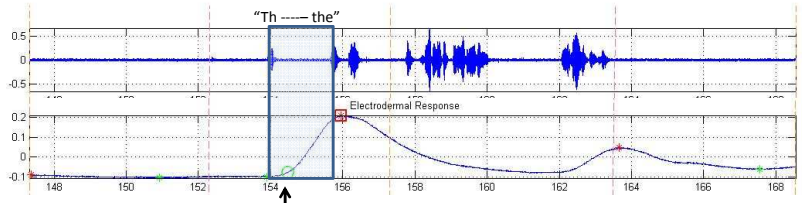
Timing of EDR onsets



- Significant effect of time period $F(4, 56) = 8.74$, $p < .0001$
- Overall, EDRs began during the first 5 seconds of the speech task

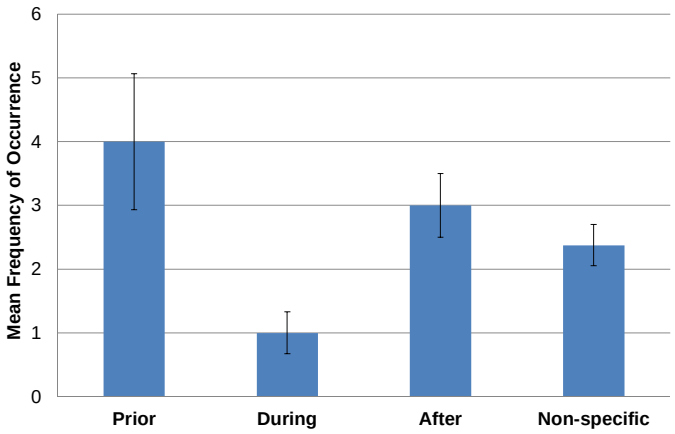
Timing of EDR onsets

- For the 8 CWS, we examined onset of EDRs relative to stuttering.
- CWS stuttered, on average, during 36% of SENT trials and during 61% of NARR trials ($p < .05$).



EDR began *during* the stutter

EDR relative to stuttering (N = 8)



- There was a significant effect of time period, $F(3, 21) = 3.30$, $p < .05$, with EDR onsets occurring significantly more *prior* to stuttering than after ($p = .05$)

Discussion

- Does autonomic arousal differ between school-aged CWS and CWNS?
  - Evidence indicates that these two groups do not show different patterns of sympathetic arousal across speech and non-speech tasks using blood volume, pulse, and electrodermal measures (Caveat: N).
- Is autonomic arousal related to stuttering in CWS?
  - The largest within-trial electrodermal responses tended to occur *prior* to a stutter than in any other time period.
  - Thus, at school age, sympathetic arousal may disrupt speech-language planning and production processes rather than being a reaction to an instance of stuttering.

Collaborators

Anne Smith and Megan MacPherson,

Purdue University

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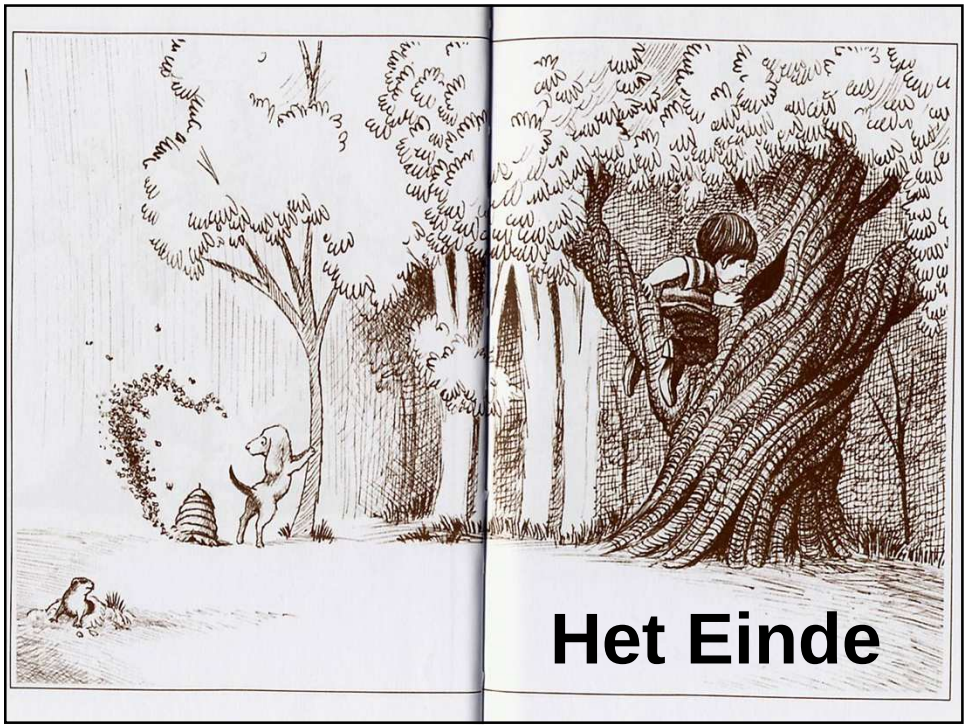
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