The brain-body axis in neurodevelopmental conditions

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Interoceptive dimensions

Interoceptive Dimensions		
Interoceptive Accuracy	**Interoceptive Sensibility**	**Interoceptive Awareness**
Objective performance	Subjective performance	Metacognitive performance
Behavioural tests	Self-report	Insight into objective performance
e.g. heartbeat detection tasks	e.g. questionnaires	e.g. confidence-accuracy correspondence

Heartbeat tracking task (Schandry, 1981)

Start	Silent counting	Stop	Report number

Heartbeat discrimination task (Whitehead, 1977)

Start	Tones (250ms or 500ms post R-wave)	Stop	Report in-sync or out-of-sync

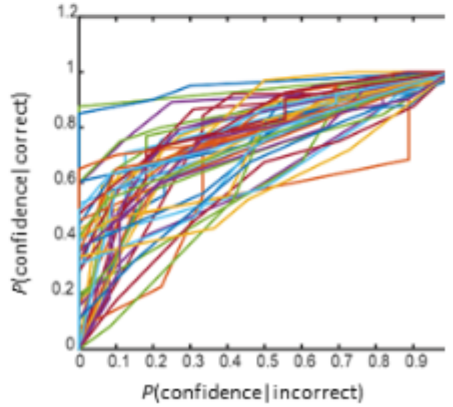
Body Perception Questionnaire (Porges, 1993)

Imagine how you feel your body processes.
Cross out the answer that sounds most like you.
Answer how often you feel the things below:

Most of the time I can feel myself:

Swallowing a lot
Never Occasionally Sometimes Usually Always

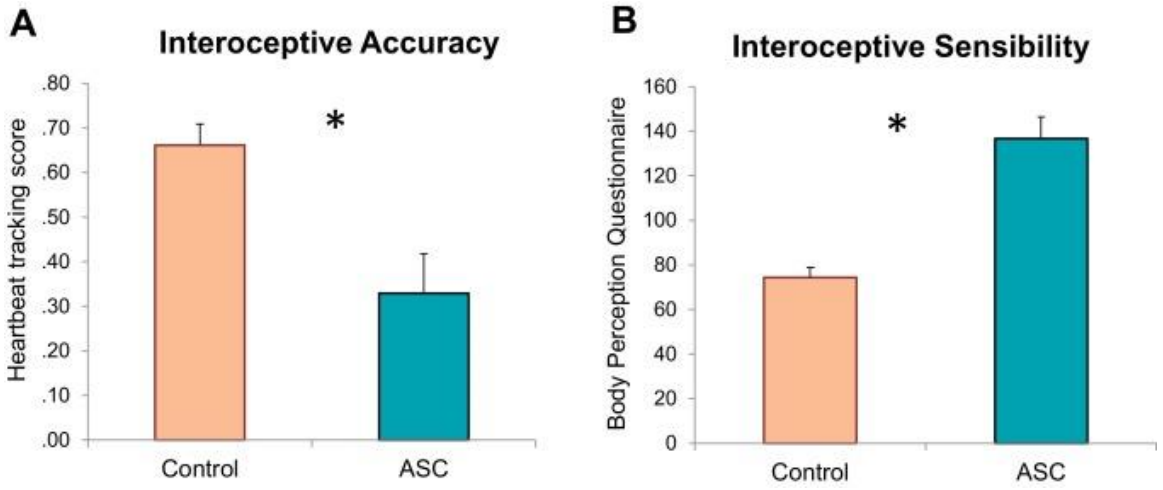
Ringing in my ears
Never Occasionally Sometimes Usually Always



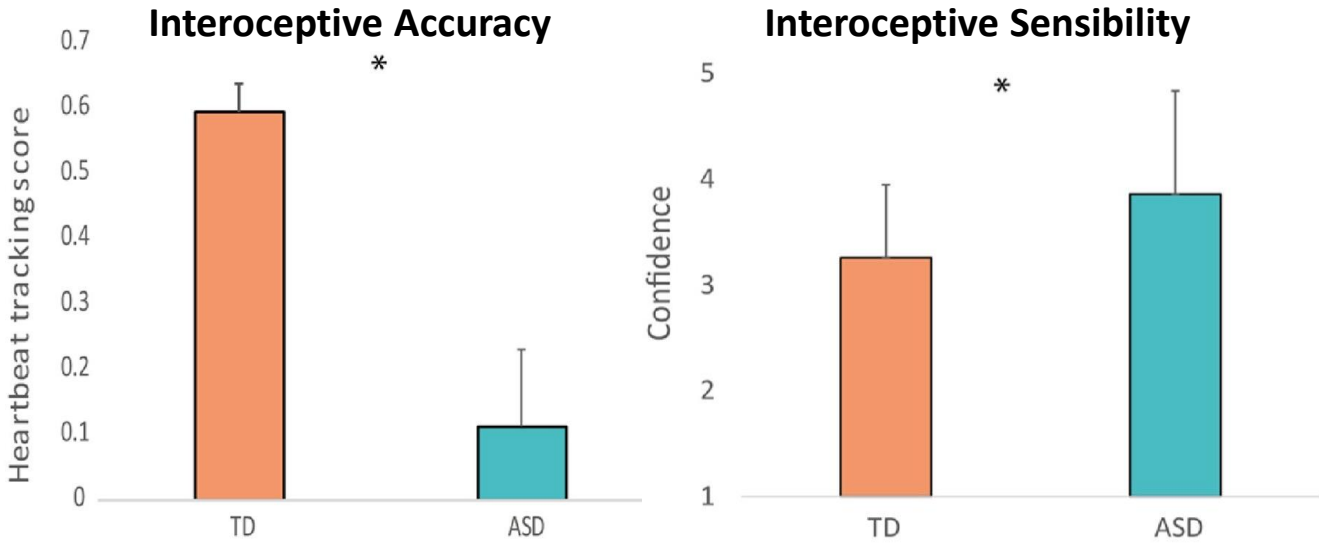
Garfinkel & Critchley, 2013, *SCAN*; Garfinkel et al., 2015, *Biological Psychology*

Discrepancies between interoception dimensions in autism

Adults
(Garfinkel et al., 2016, *Biological Psychology*)

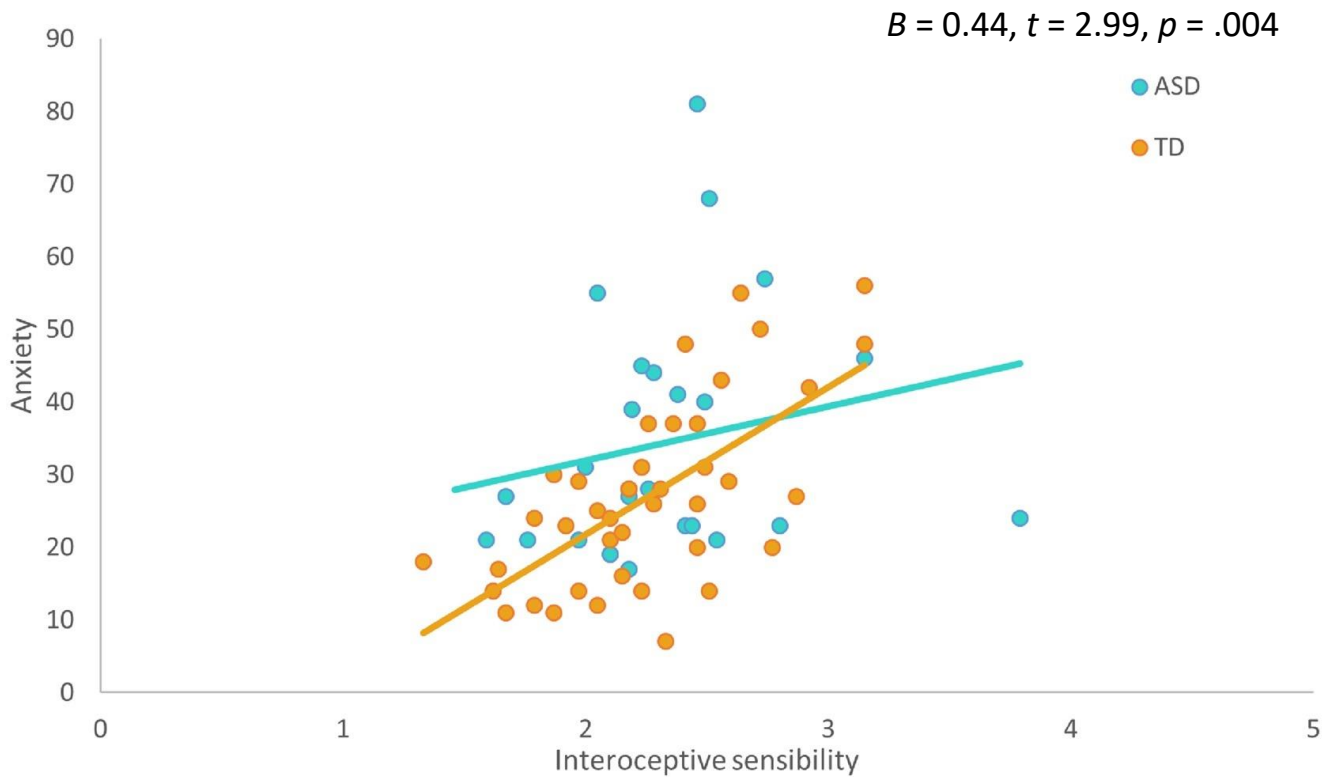


Children aged 6-18 years
(Palser et al., 2018, *Biological Psychology*)



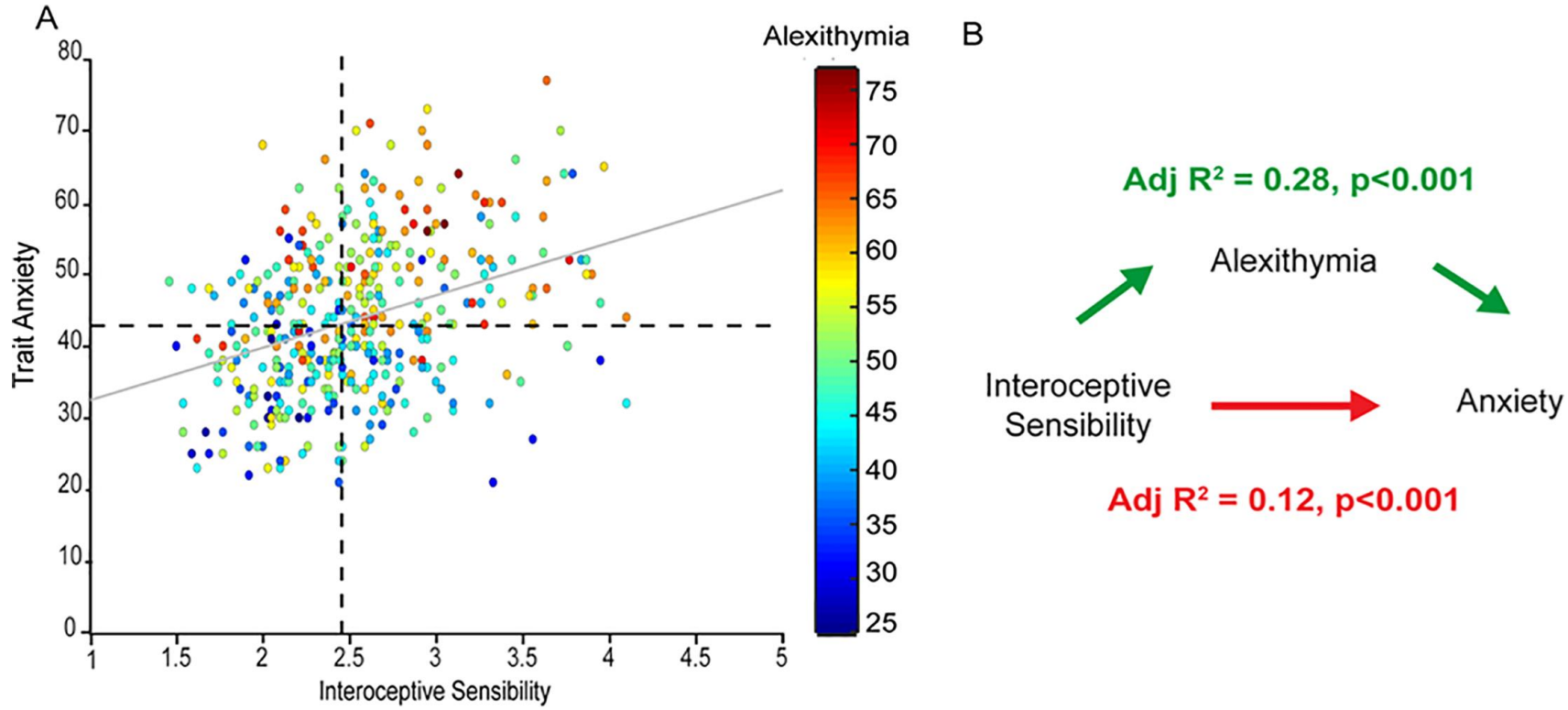
*p<.05

Greater subjective interoceptive sensibility is associated with greater anxiety



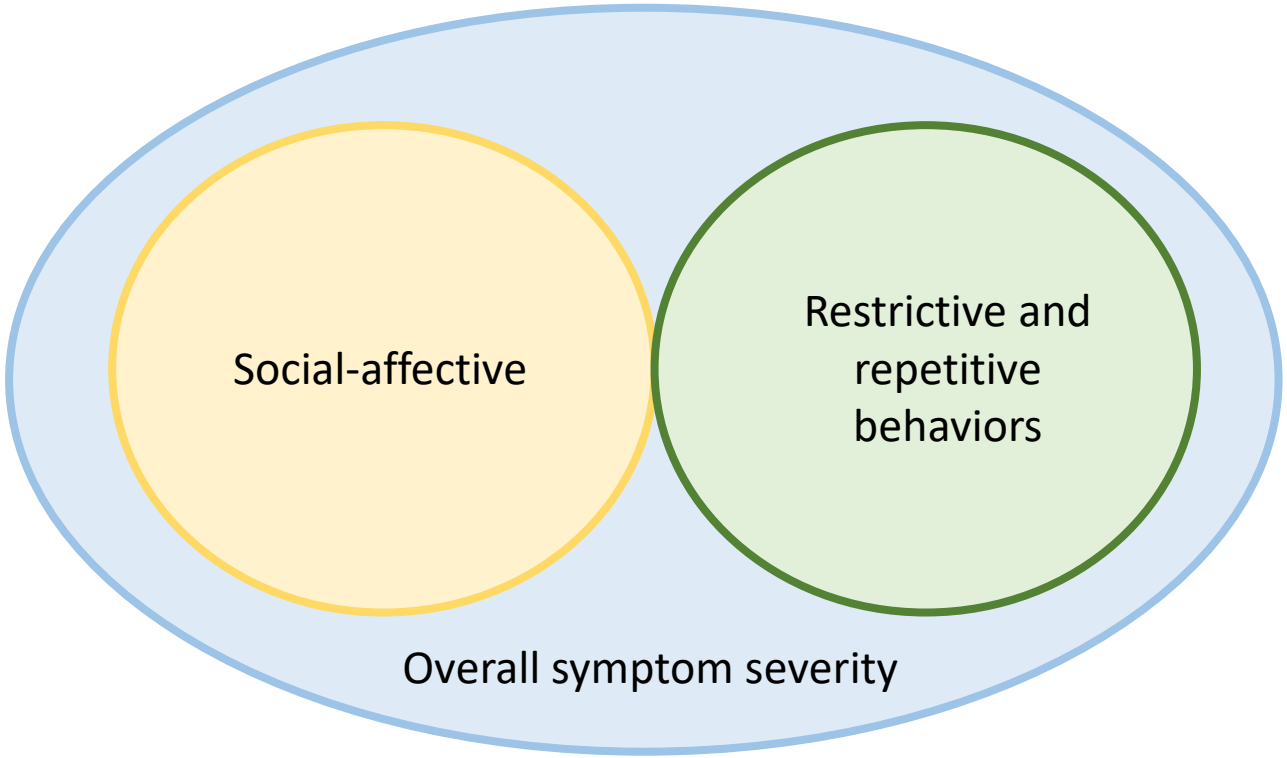
Palser et al., 2018, *Biological Psychology*

Alexithymia mediates link between interoceptive sensibility and anxiety



Palser et al., 2018, *PLOS One*

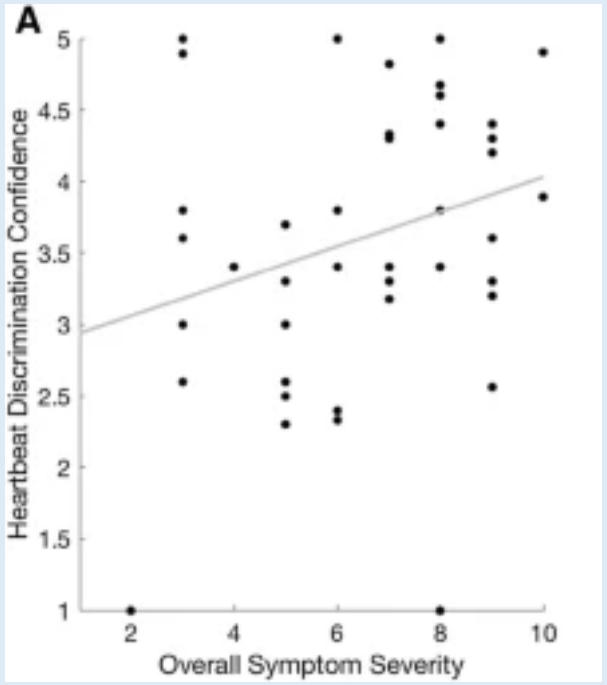
Interoception dimensions and core diagnostic features of autism



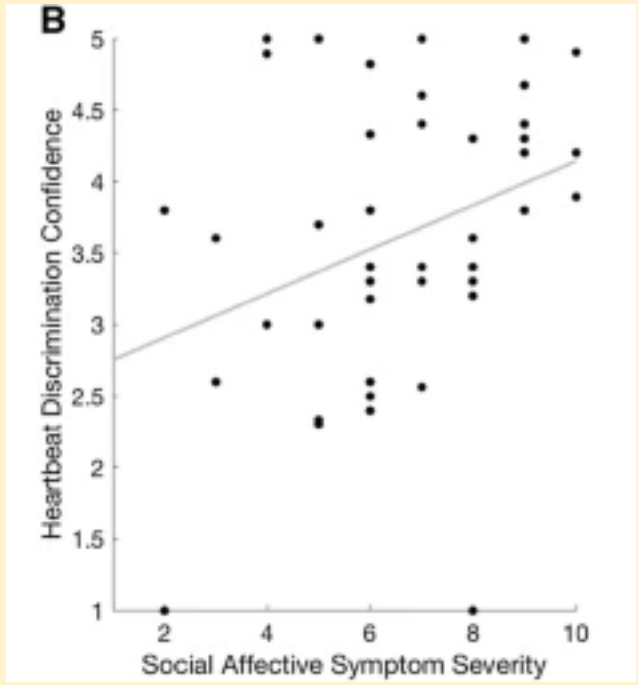
Palser et al., 2020, *JADD*

Interoception dimensions relate to core diagnostic features of autism

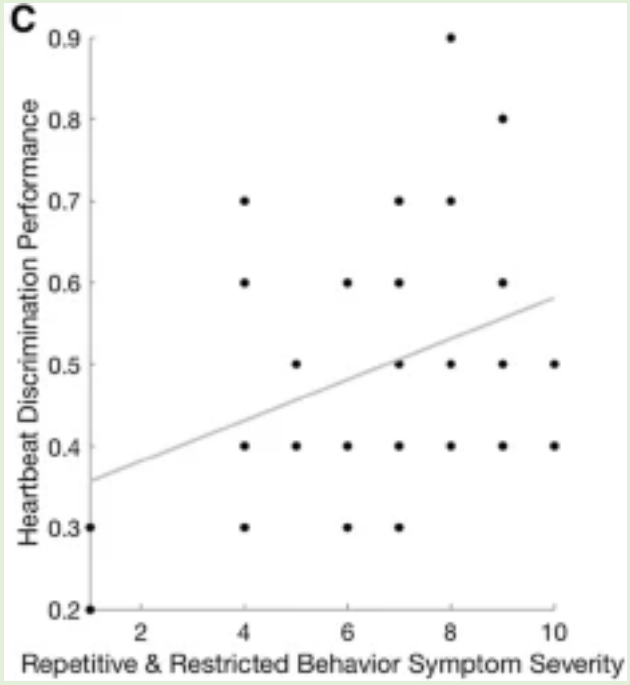
Interoceptive Sensibility



Interoceptive Sensibility

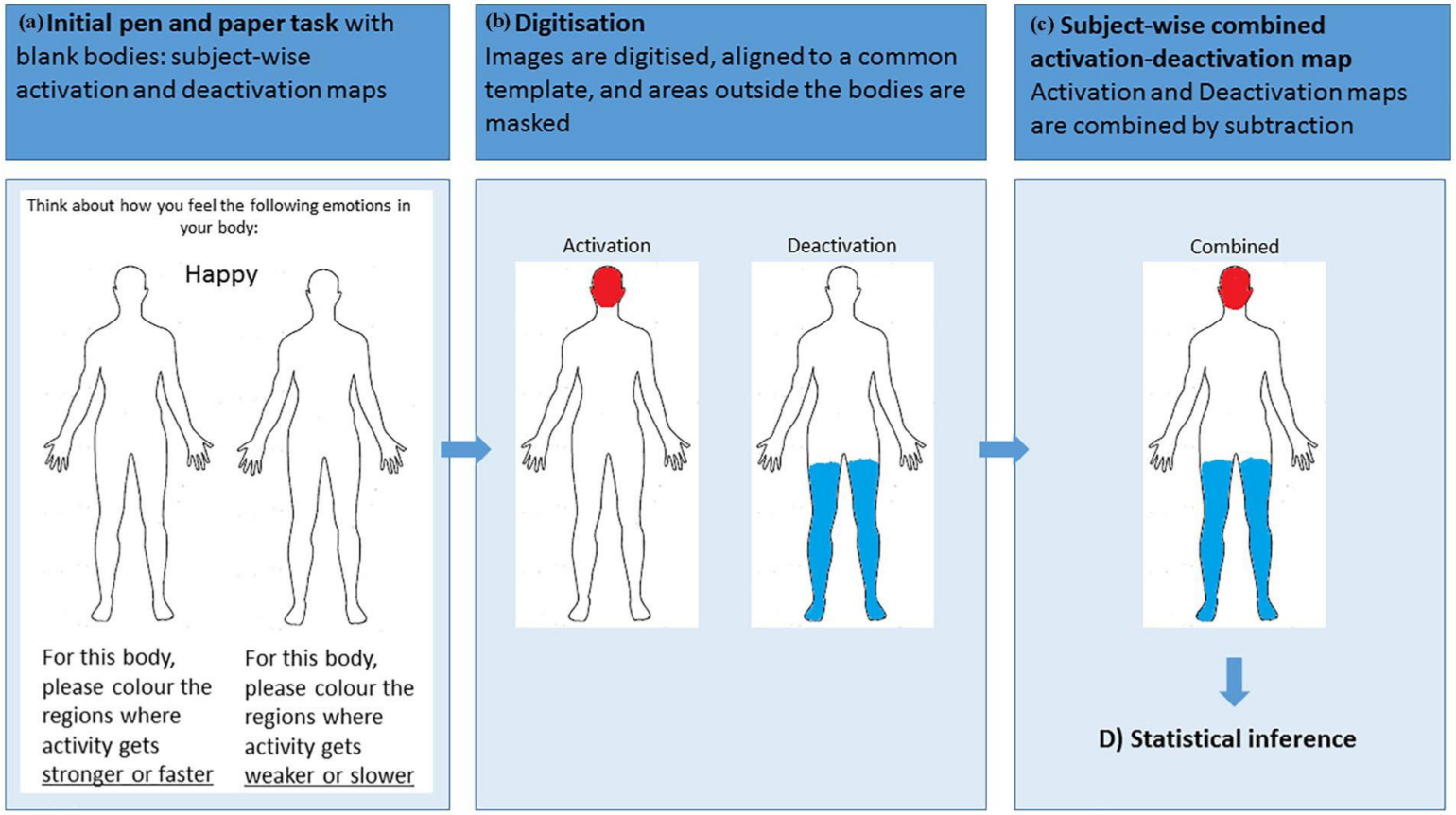


Interoceptive Accuracy



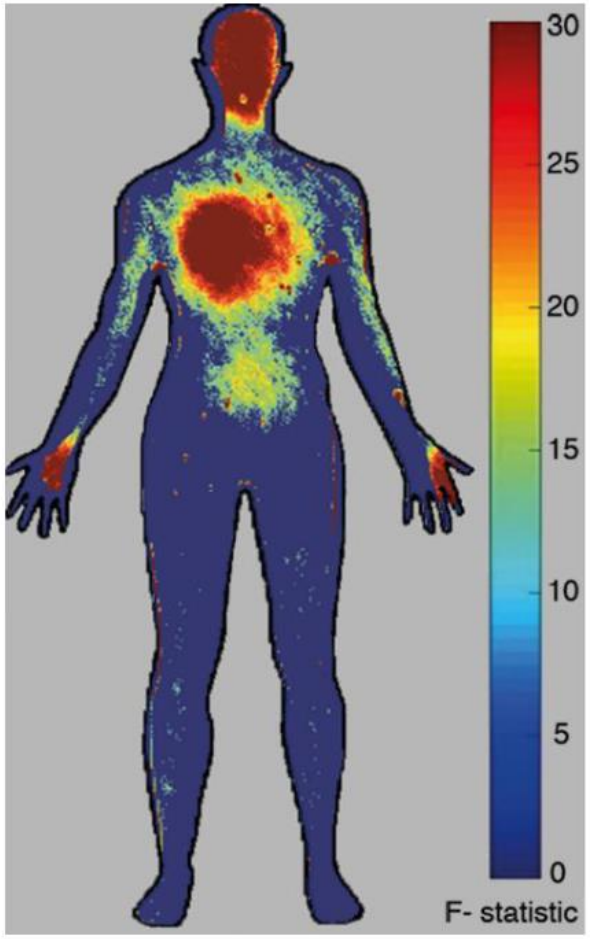
Palser et al., 2020, *JADD*

Differentiation of emotional bodily signals in autism



Palser et al., 2021, *Autism*

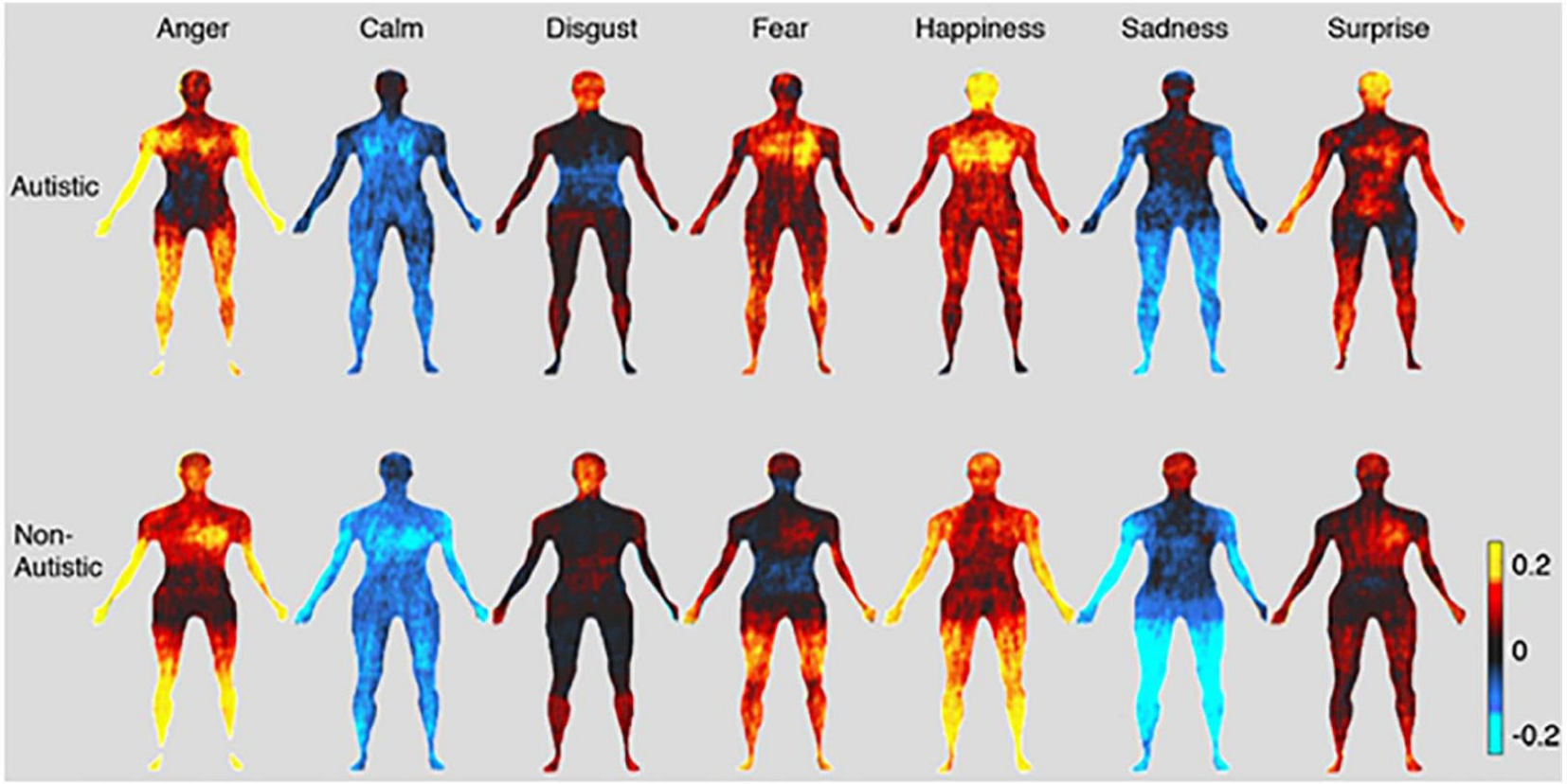
Emotion differentiation in the body



In an independent non-autistic sample of adults, four regions were found to dissociate between different emotions

Palser et al., 2021, *Autism*

Reduced differentiation of emotional bodily signals in autism

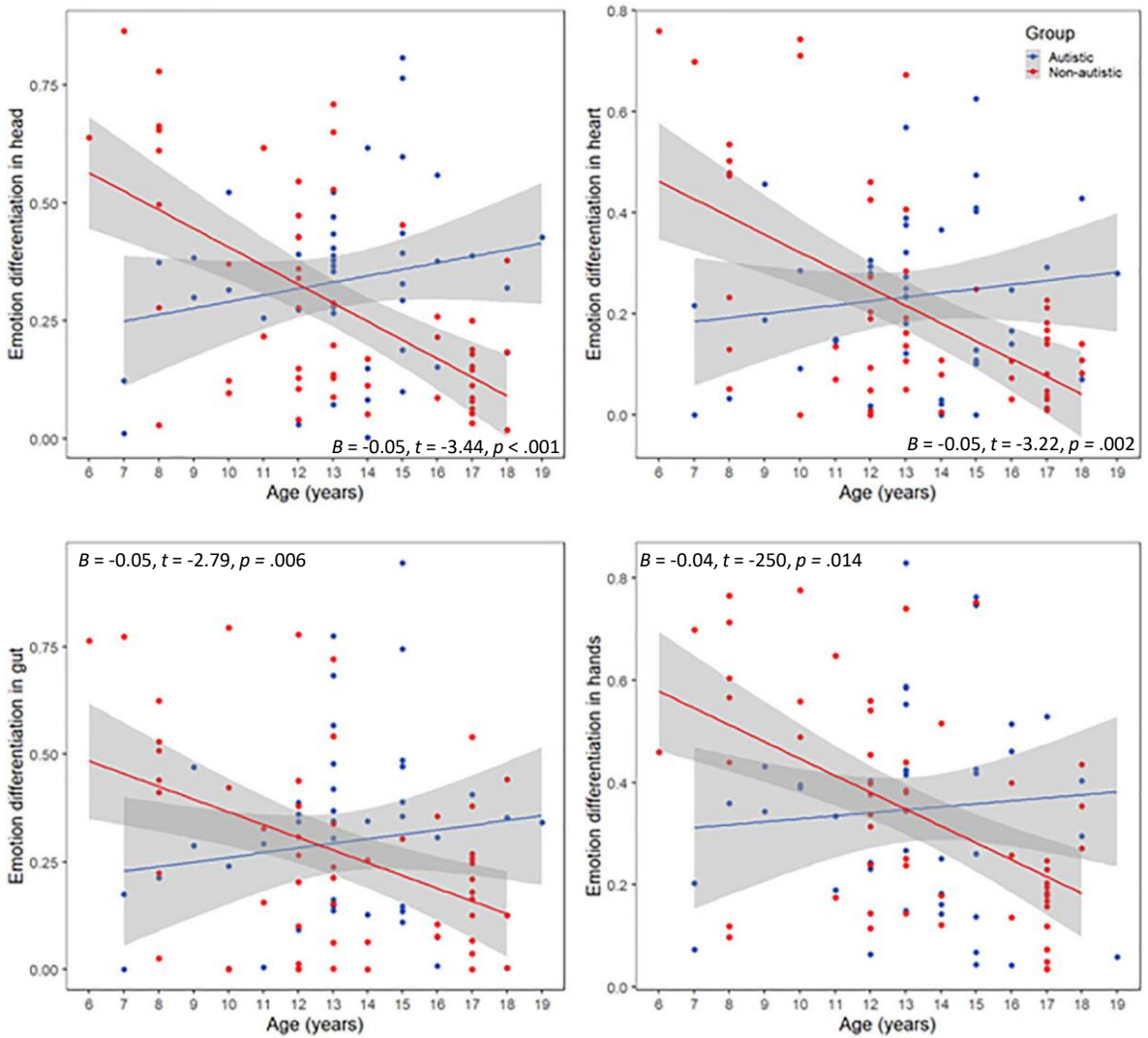


Head
B=1.26, t=3.32, p=.001*
Heart
B=0.73, t=2.03, p=.046*
Gut
B=0.48, t=1.04, p=.303
Hands
B=1.06, t=2.62, p=.010*

In three of the four regions, significantly reduced differentiation between emotions was found in autistic participants, relative to non-autistic participants

Palser et al., 2021, *Autism*

Altered developmental trajectory of emotional bodily differentiation in autism



Palser et al., 2021, *Autism*

Affect in dyslexia

LEFT:

Language

RIGHT:

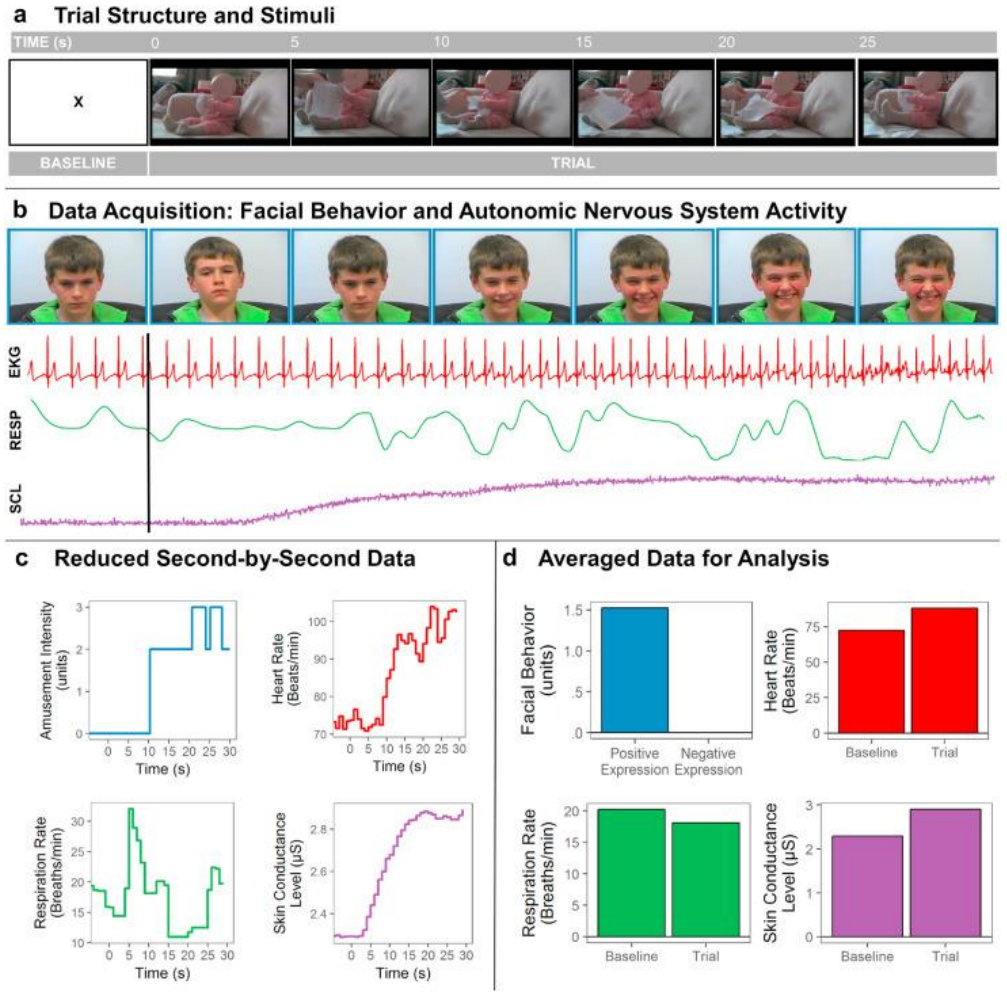
Emotion

***Dyslexia**:*
Reading and
Language Difficulties

***Dyslexia**:*
Emotion
Enhancement?

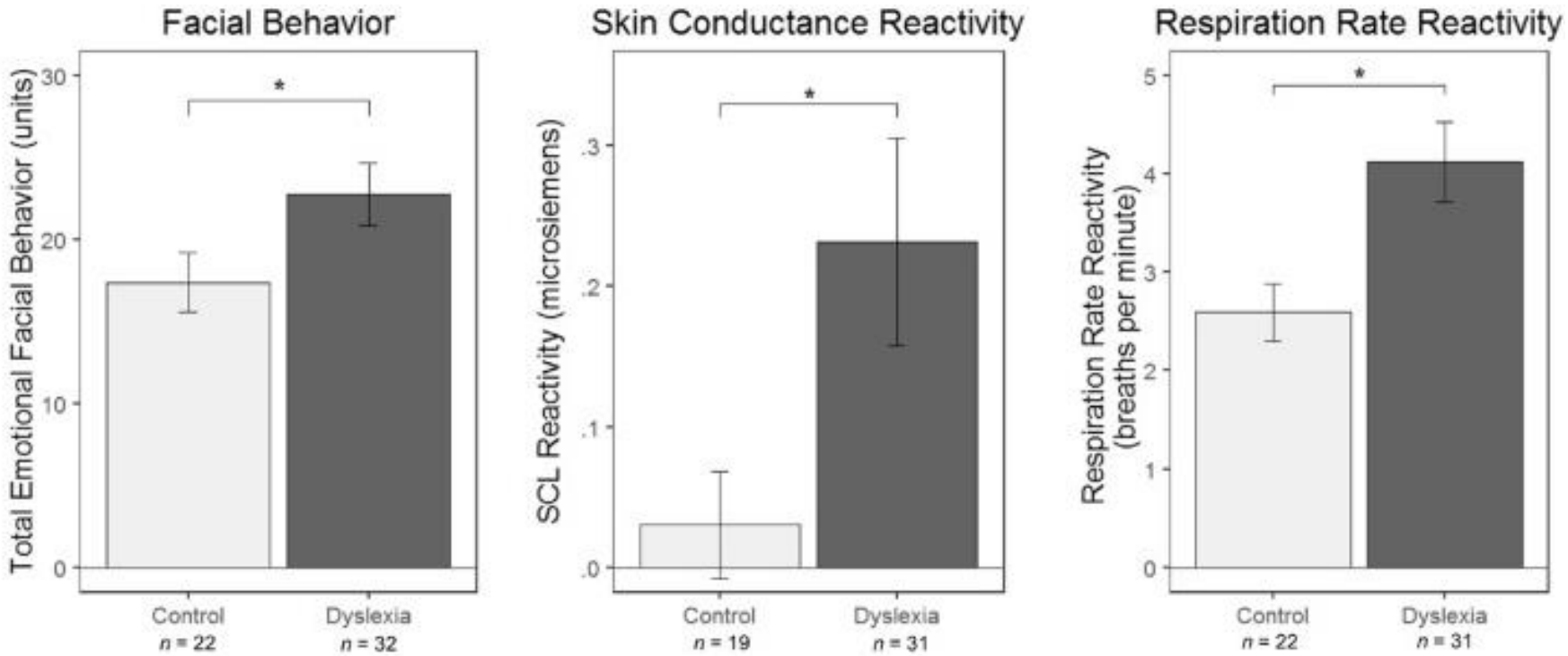
Paradoxical Functional Facilitation

Affect in dyslexia



Sturm…Palser et al., 2021, *Cortex*

Heightened visceromotor emotional responses in dyslexia

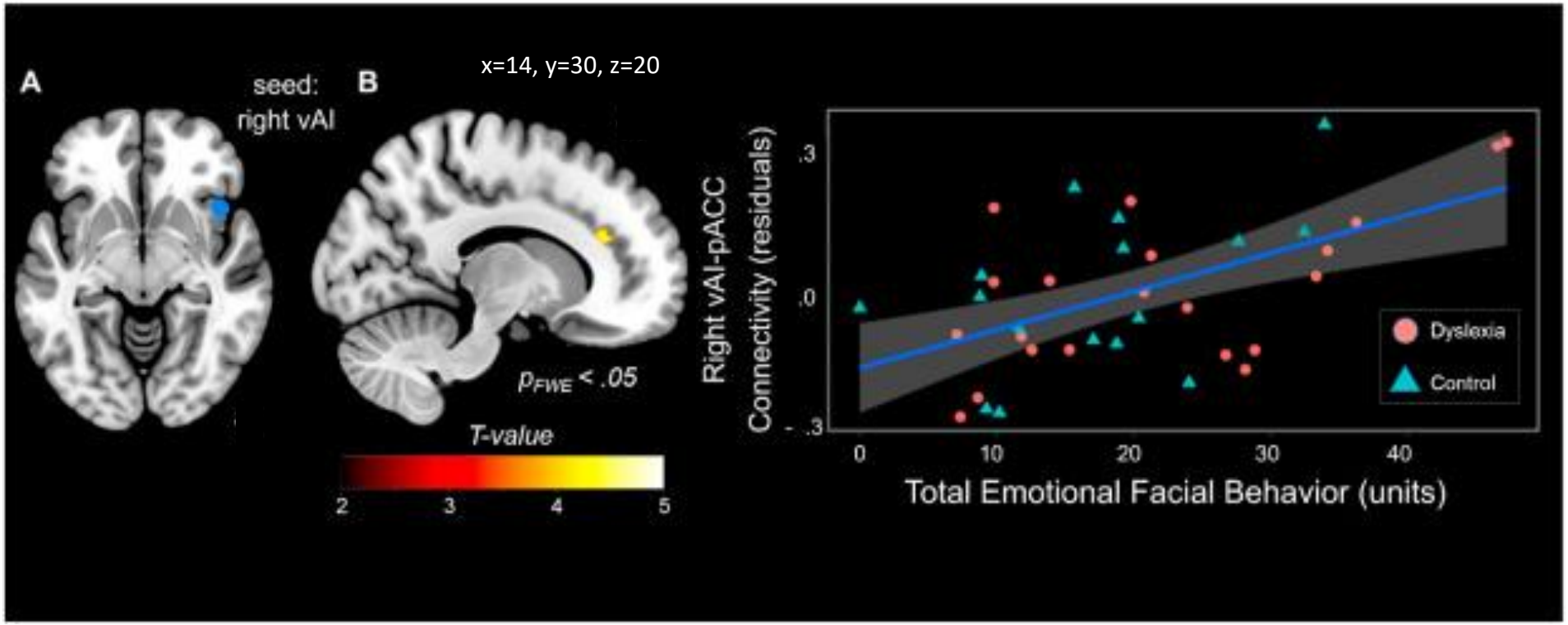


*p<.05

Controlling for age, sex, and film clip familiarity

Sturm…Palser et al., 2021, *Cortex*

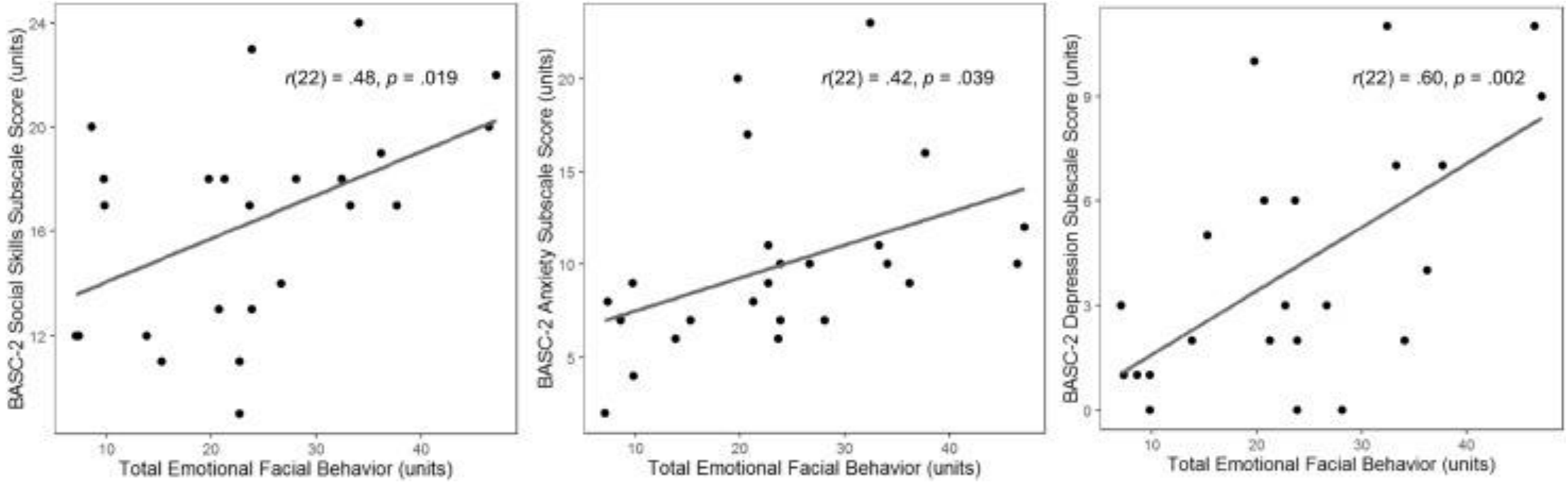
Heightened emotional responses associated with salience network connectivity



Controlling for age, sex, group, scanner type, and time interval between MRI and emotion assessment

Sturm…Palser et al., 2021, *Cortex*

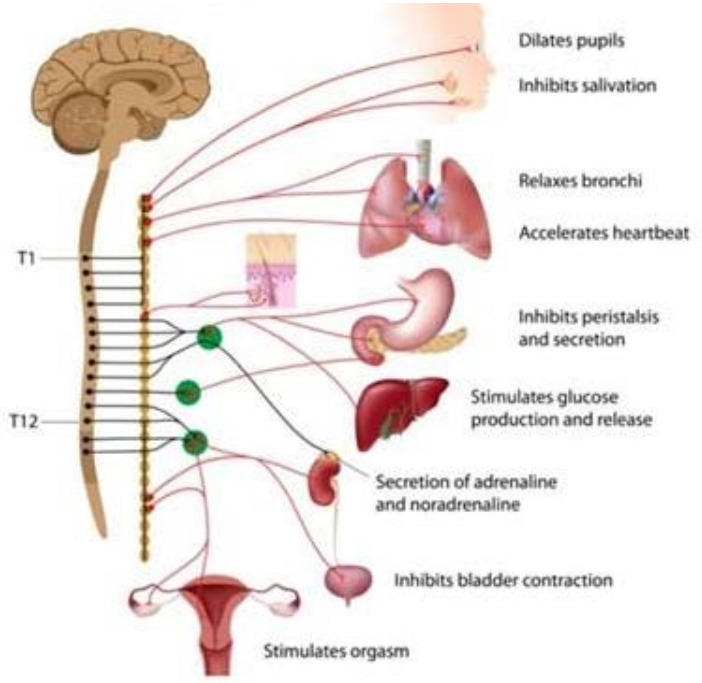
Heightened emotional responses represent area of strength as well as vulnerability



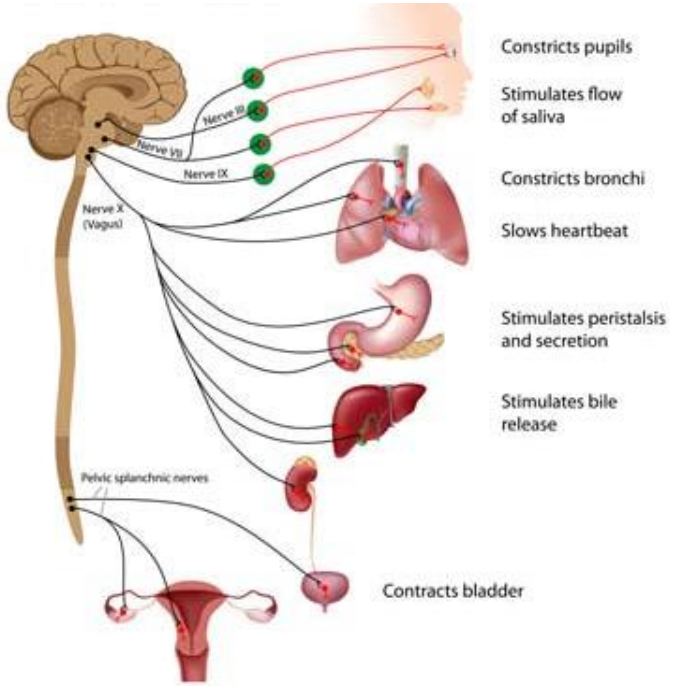
Sturm…Palser et al., 2021, *Cortex*

Autonomic nervous system is comprised of two branches

Sympathetic



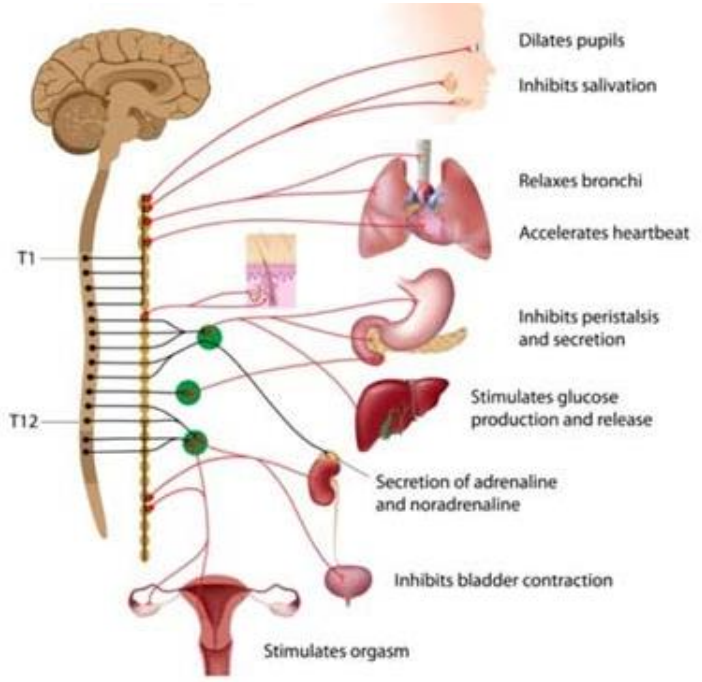
Parasympathetic

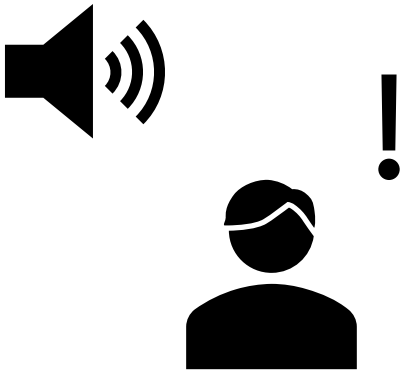


Images courtesy of simplifaster.com

Unanticipated startle response in dyslexia

Sympathetic

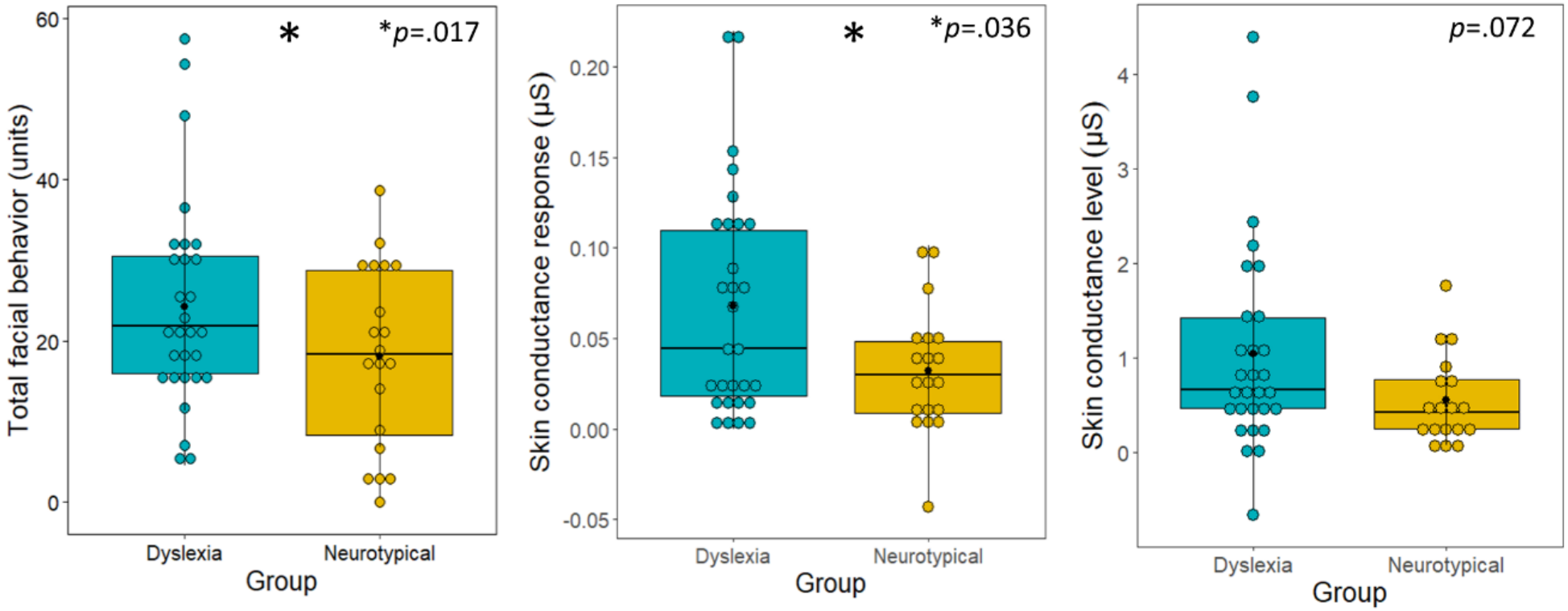




Unanticipated loud noise at rest
Recorded facial behavior and physiology throughout

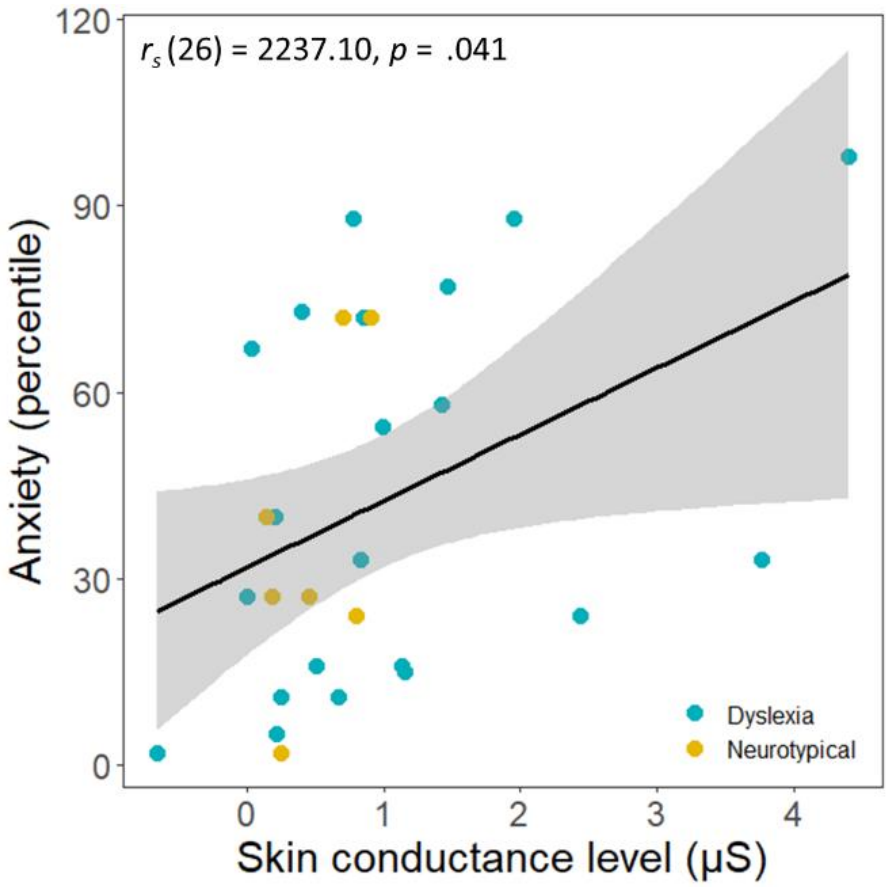
Palser et al., in prep

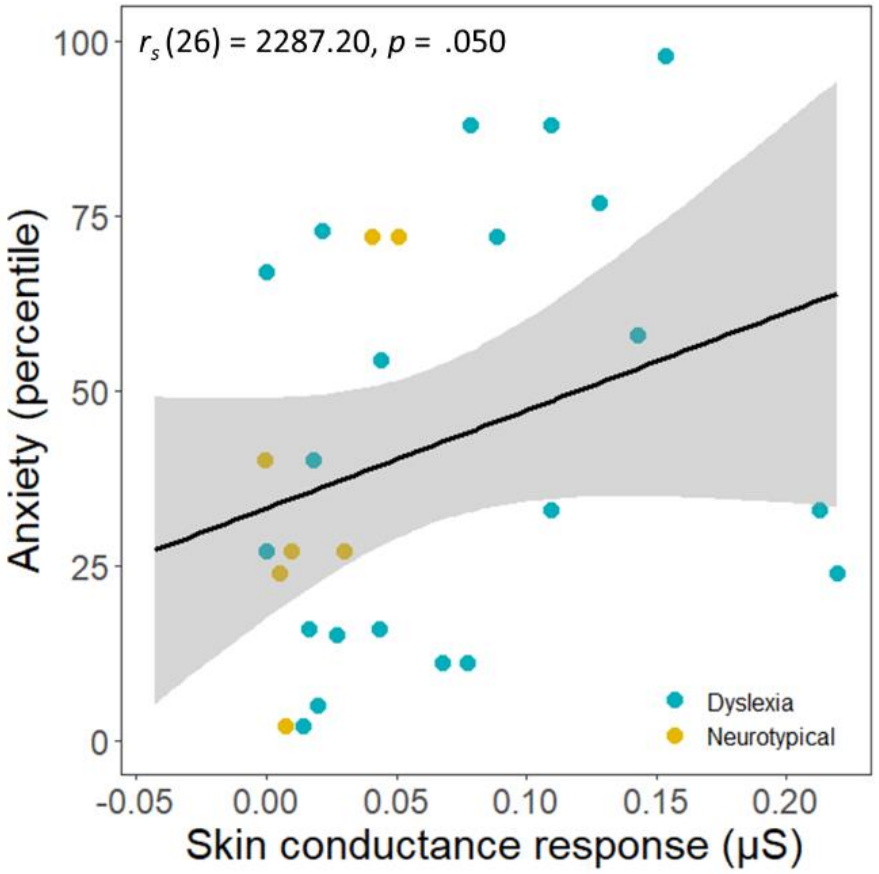
Elevated startle response in dyslexia



Palser et al., in prep

Electrodermal activity during startle predicts anxiety symptoms

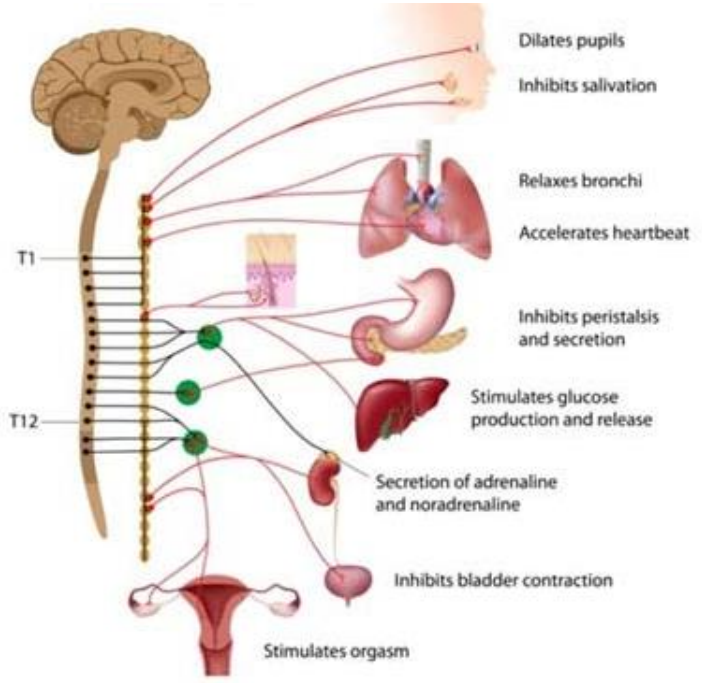




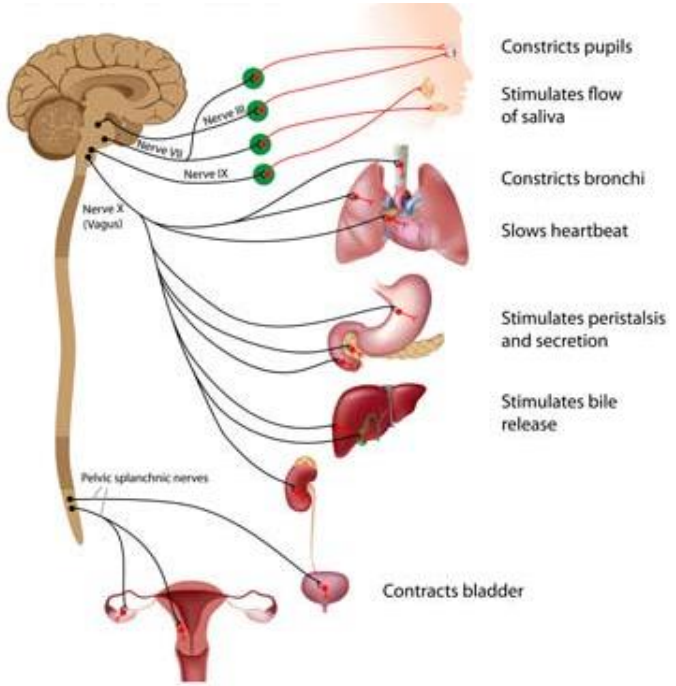
Palser et al., in prep

Autonomic nervous system is comprised of two branches

Sympathetic



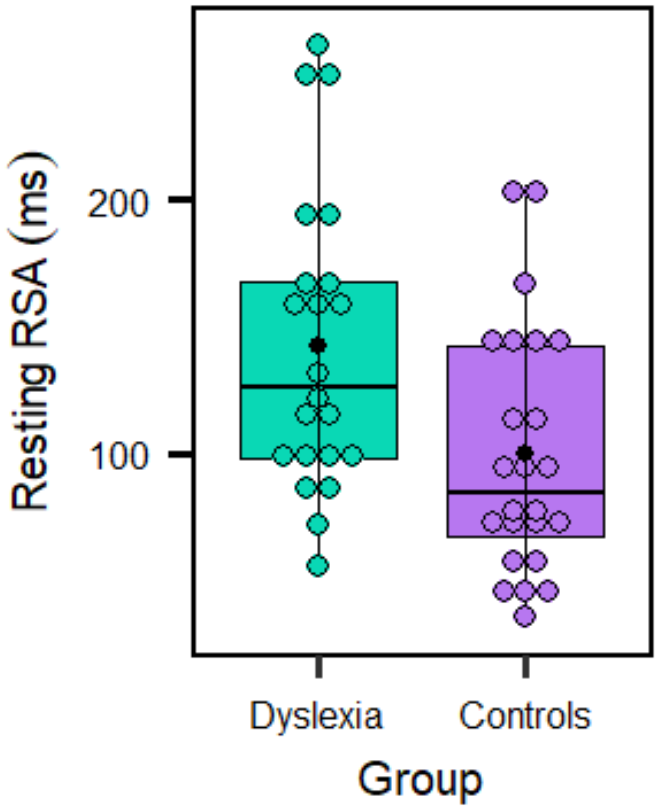
Parasympathetic



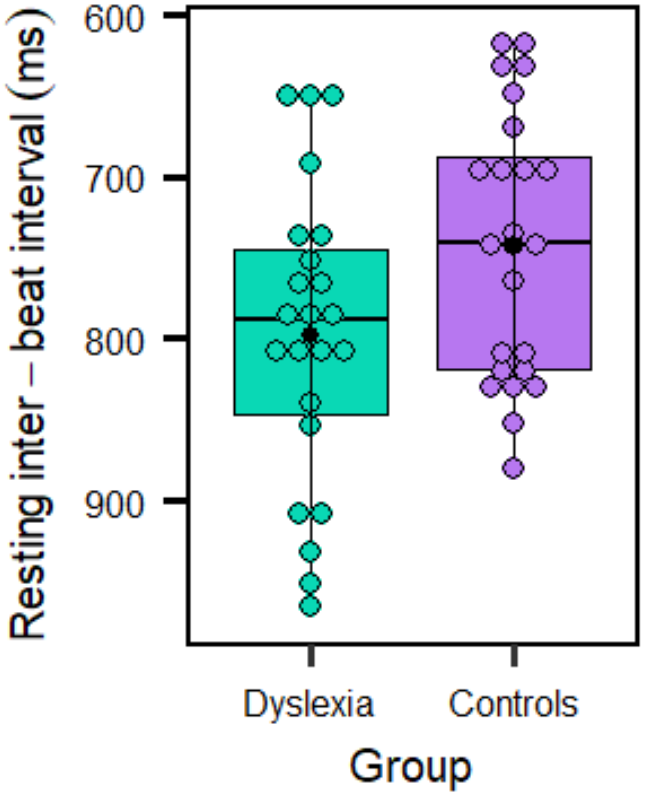
Images courtesy of simplifaster.com

Greater parasympathetic influence at rest in dyslexia

B = 0.39, *t* = 2.81, *p* = .007, *f2* = .78



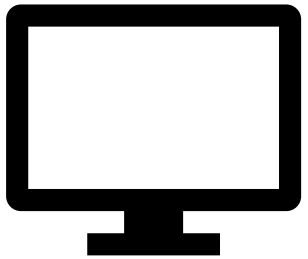
B = 57.83, *t* = 2.28, *p* = .028, *f2* = .64



Groups matched on age, sex, BMI, and intellectual ability

Palser et al., 2021, *Biological Psychology*

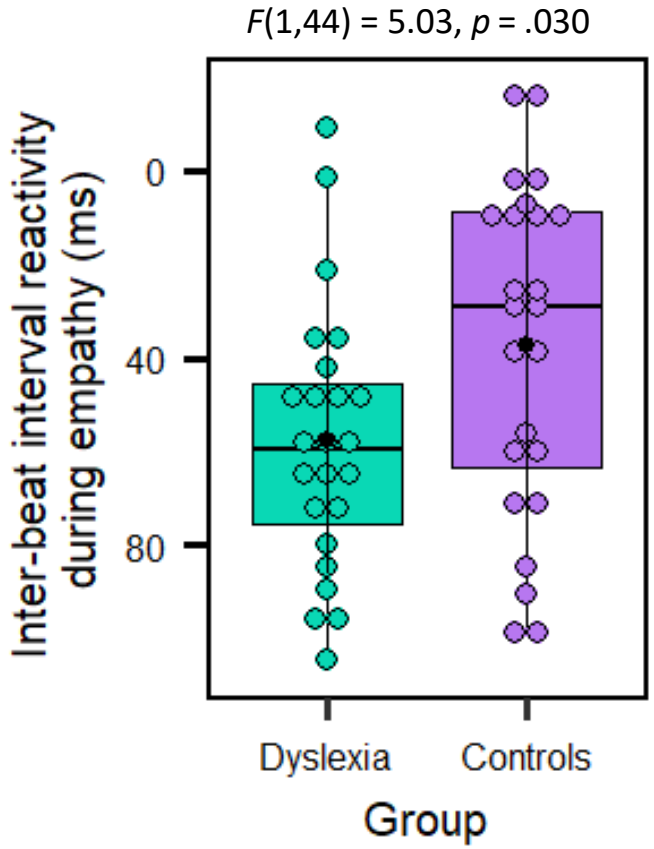
Parasympathetic activity and social attention in dyslexia

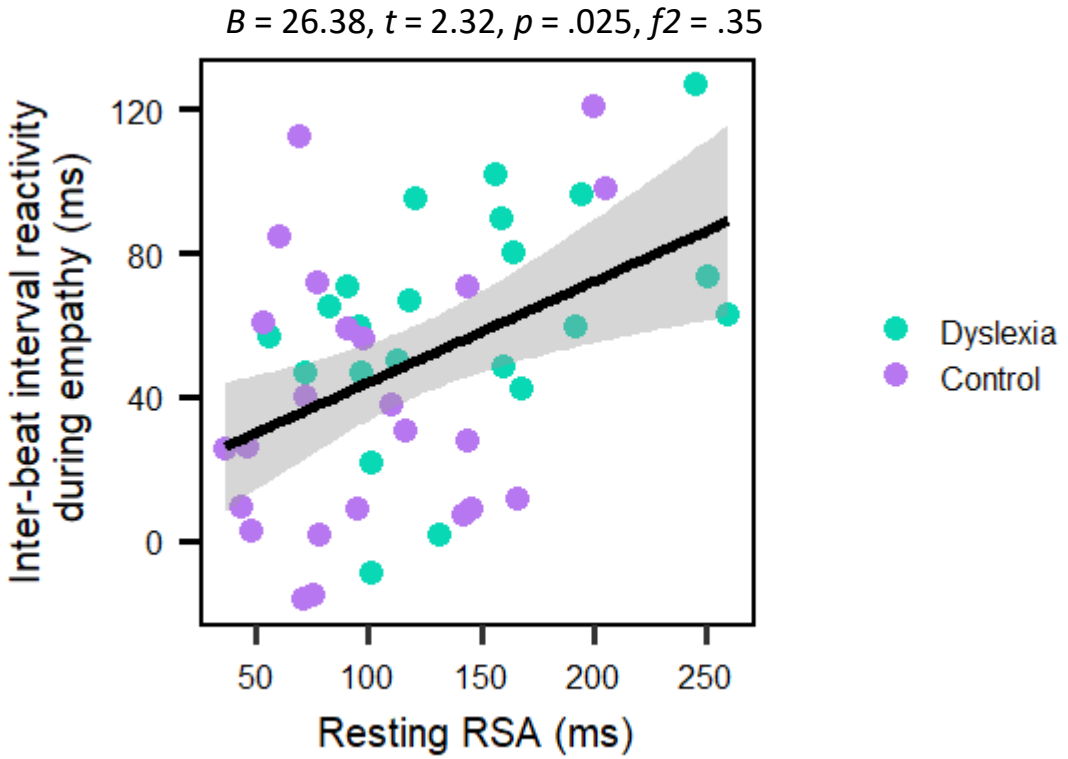


Participants viewed movie clips of others experiencing emotions
Recorded physiology and facial behavior throughout

Palser et al., 2021, *Biological Psychology*

Parasympathetic activity predicts greater social attention in dyslexia

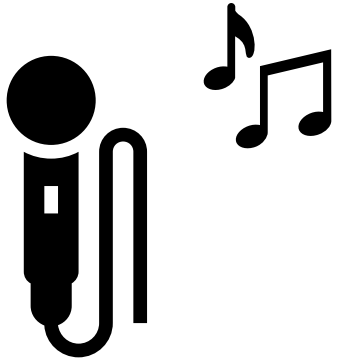


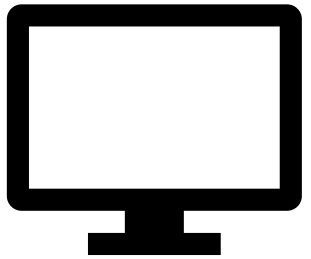


Palser et al., 2021, *Biological Psychology*

Parasympathetic activity and embarrassment proclivity

Karaoke task



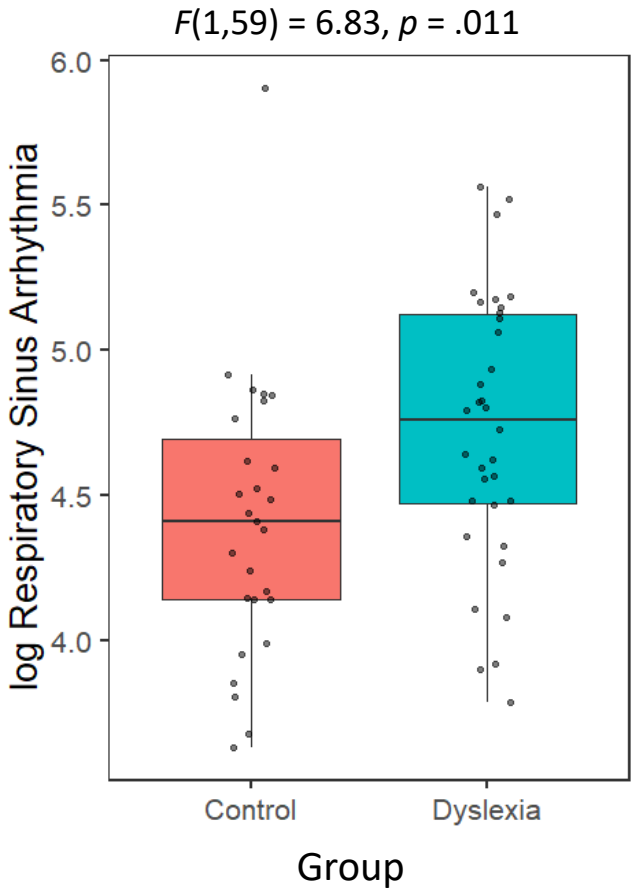


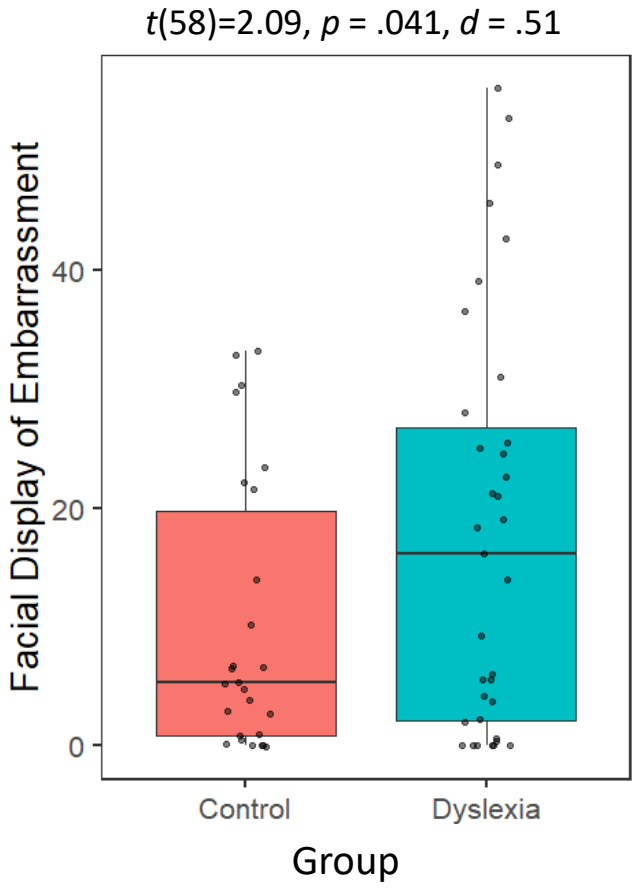
Participants sing '*Old McDonald had a farm…*'

Participants watch back the recording of them singing

Recorded physiology and facial behavior throughout

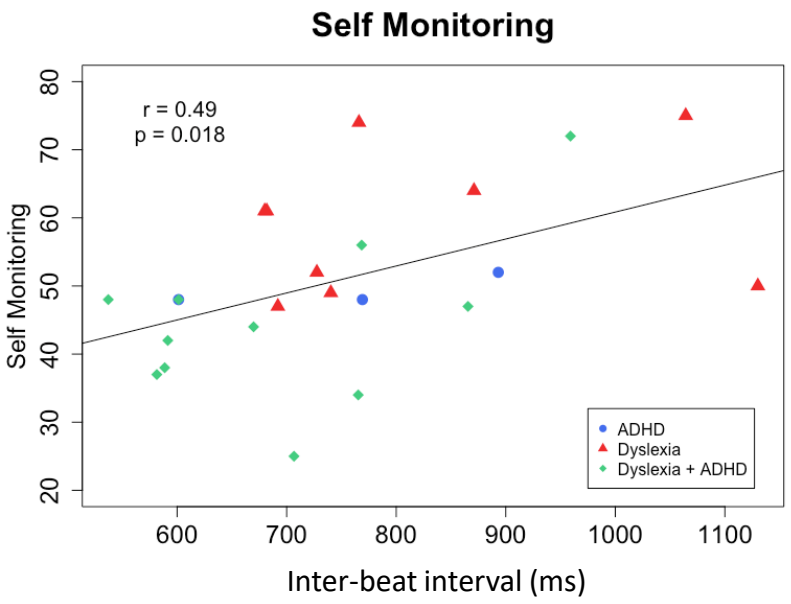
Greater parasympathetic activity linked to greater embarrassment proclivity

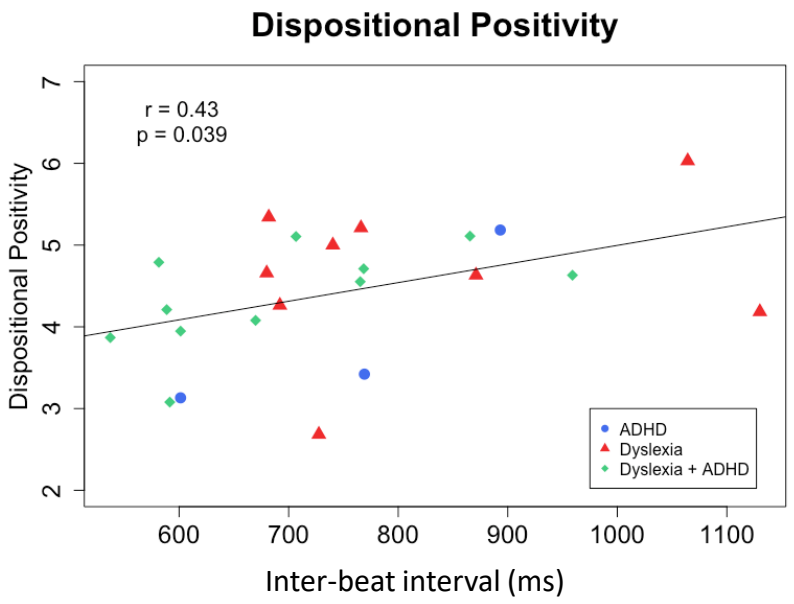


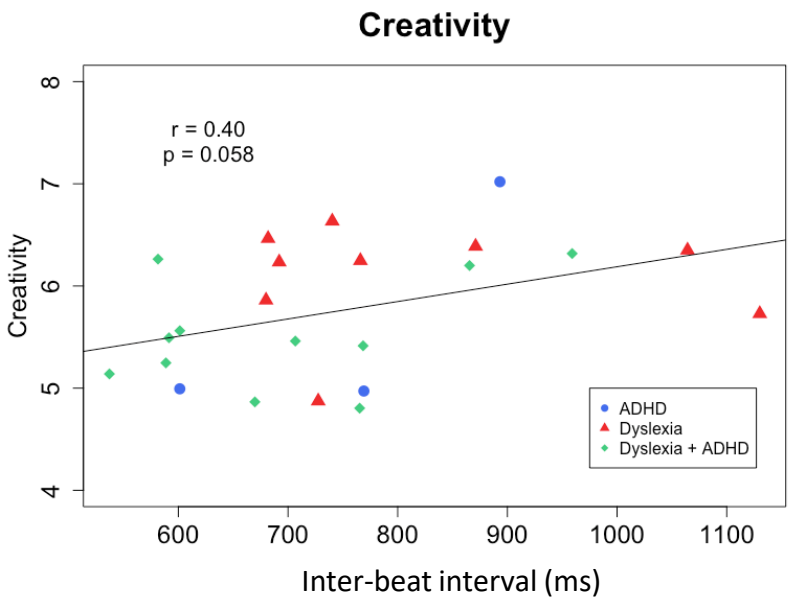


Groups matched on age and sex

Parasympathetic activity longitudinally linked to host of strengths



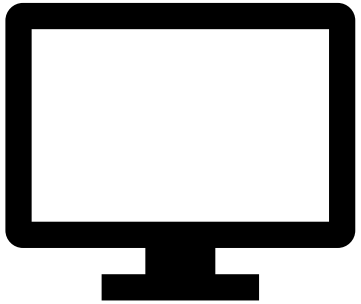




Slower resting heart rate at Time Point 1 predicts greater parent-reported self-monitoring, positivity, and creativity **2 years later**

Facial variability in dyslexia

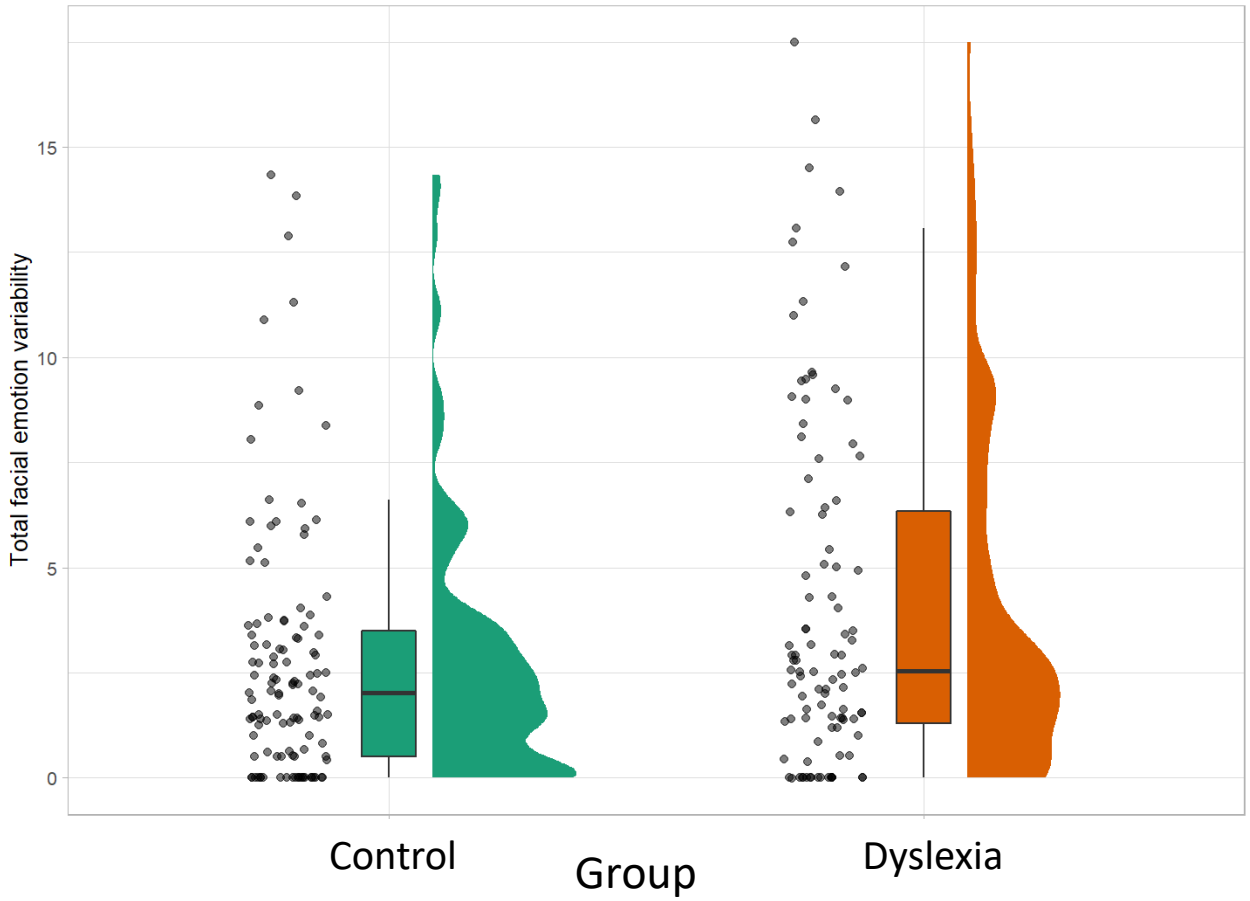
Emotional reactivity task
Participants viewed movie clips chosen to elicit discrete emotions



Conditions: awe, sadness, amusement, disgust, and nurturant love

Facial behavior recorded throughout
Variability quantified as second by second change

Greater facial variability in dyslexia



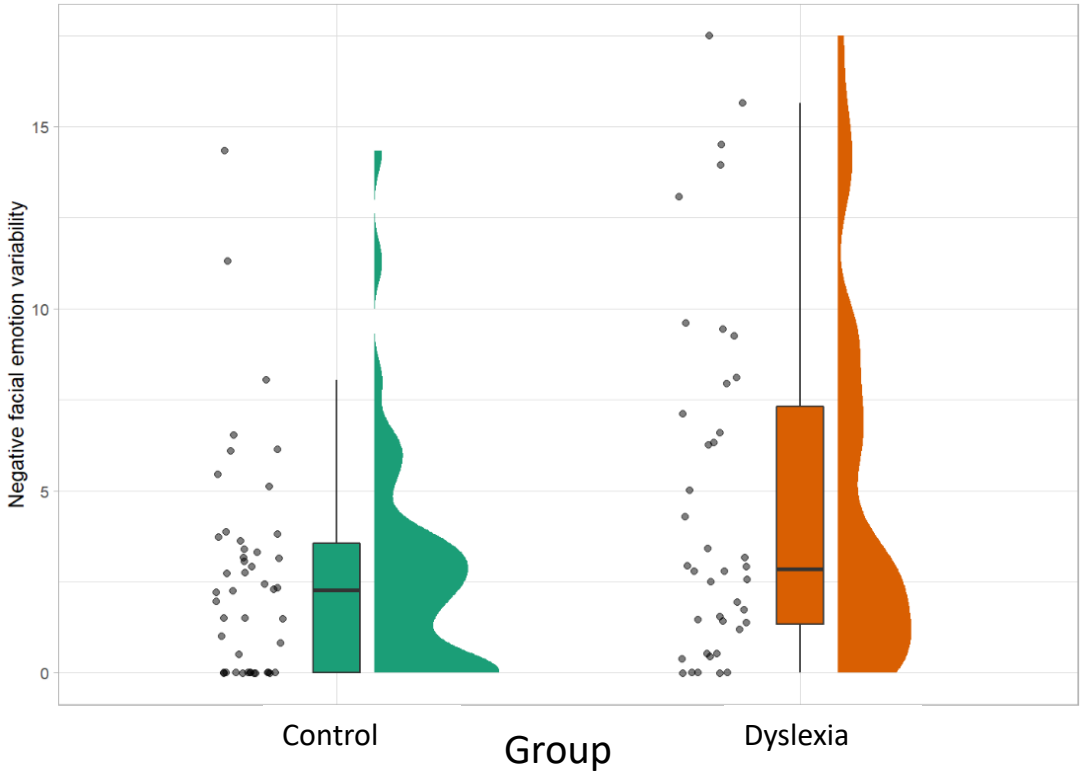
$F(1,8) = 2.37$, $p = .019$

Group
Control
Dyslexia

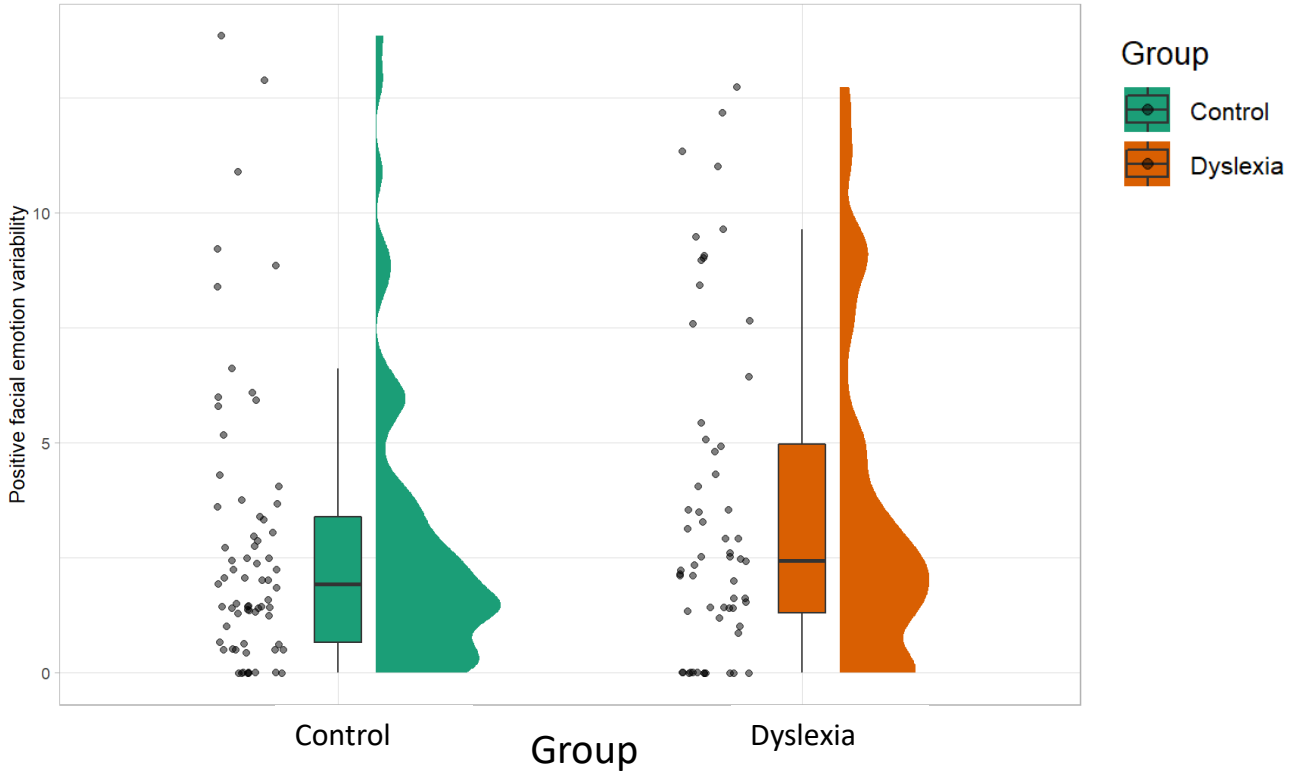
Mixed effects model indicated group by condition interaction, controlling for age and sex

Greater facial variability in dyslexia

B = 1.99, *t* = 2.30, *p* = .024



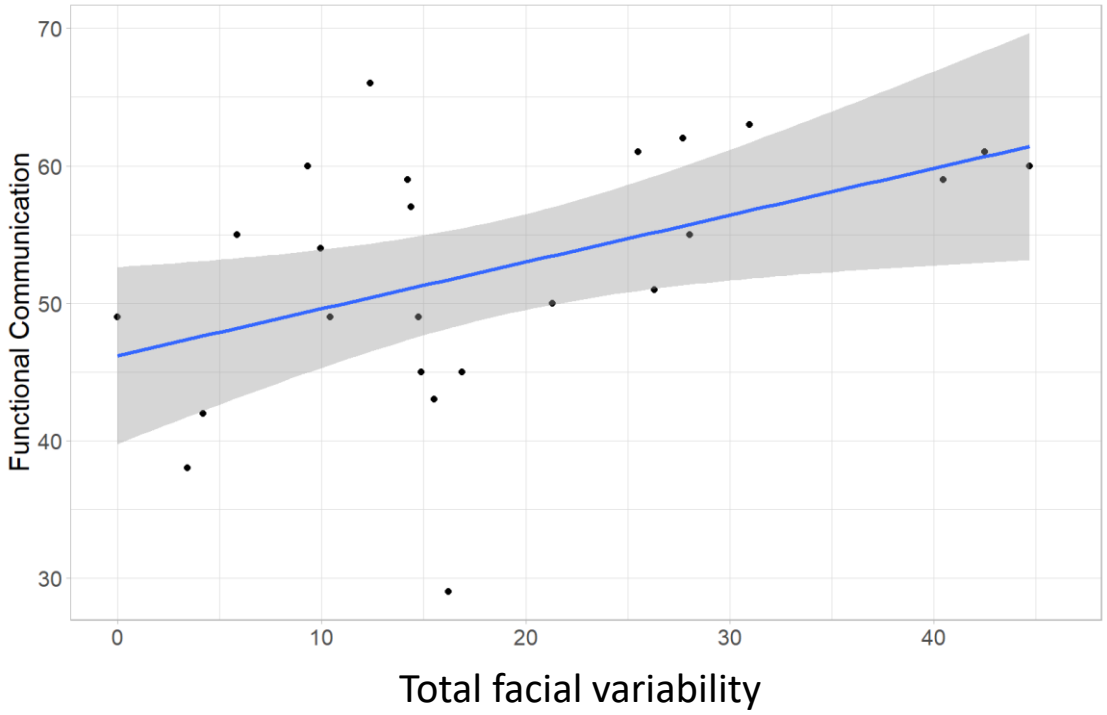
B = 0.76, *t* = 1.32, *p* = .189



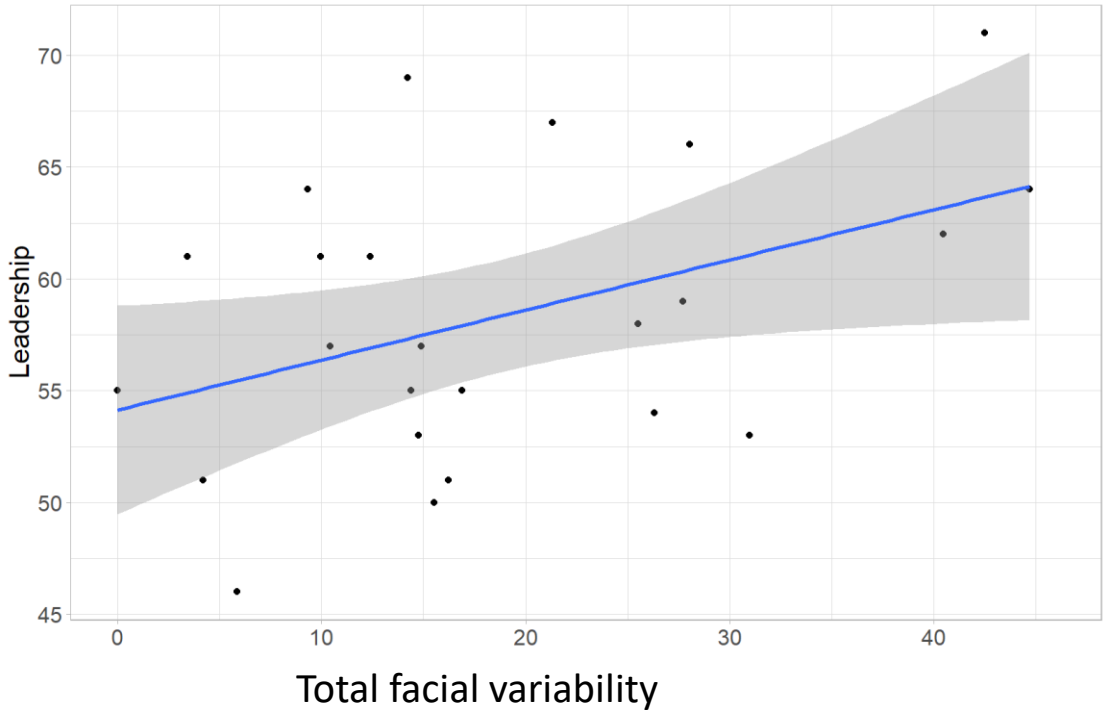
Greater variability during negative but not positive emotion conditions, controlling for age and sex

Facial variability as a social strength

B = 0.33, *t* = 2.21, *p* = .039*



B = 0.22, *t* = 1.98, *p* = .061



Frequent occurrence of externalizing behaviors in dyslexia and ADHD

Symptom overlap suggests involvement of a common brain system

Possible candidate is elevated approach motivation mediated by the left hemisphere

Palser et al., in prep

Applying a dimensional approach to emotion regulation

Subjective assessment of emotion regulation	Objective regulation	Regulation awareness
		

e.g.,

“How well do you think you regulate your emotions?”

Amount individual is able to suppresses facial behavior

Discrepancy between subjective assessment and behavior

Palser et al., in prep

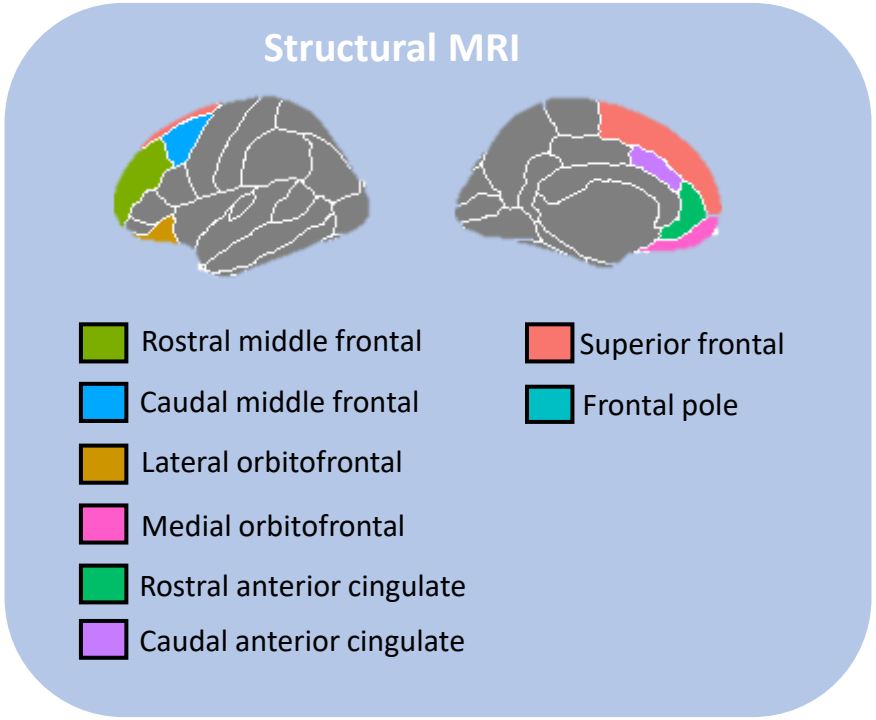
Prefrontal anatomy of emotion regulation dimensions in children

Emotion regulation task

Conditions: amusement, disgust

Facial behavior was recorded throughout

"In the next task you will watch movies. Hide your reaction so that no one would know how you feel when you watch the movie."



Grey matter volume quantified in 8 regions of interest associated with emotion regulation

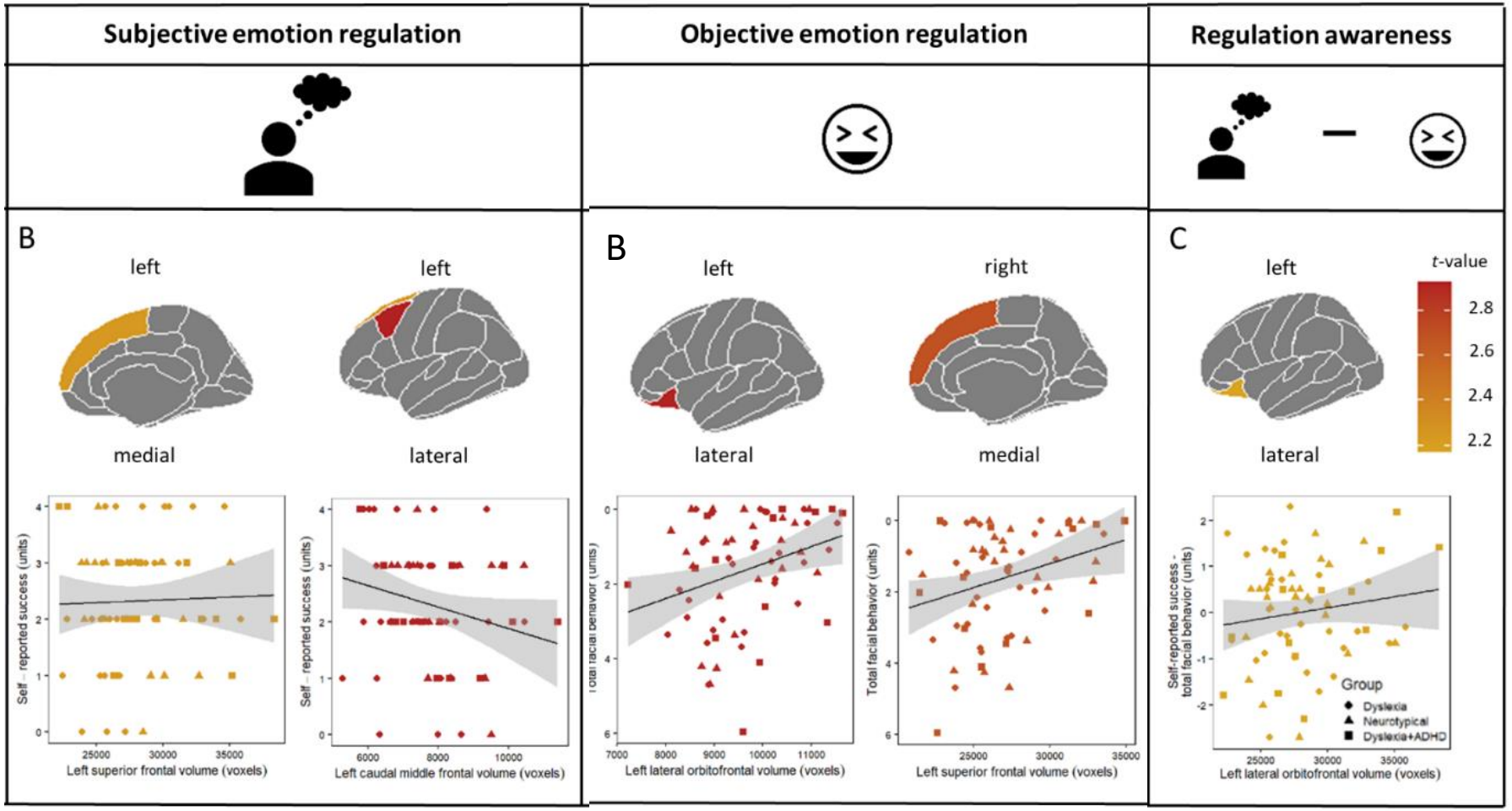
Palser et al., in prep

Prefrontal anatomy of emotion regulation dimensions in children

Subjective assessment of emotion regulation	Objective regulation	Regulation awareness
		
"How well did you hide your reaction?"	Total facial behavior	Error term between subjective and objective scores

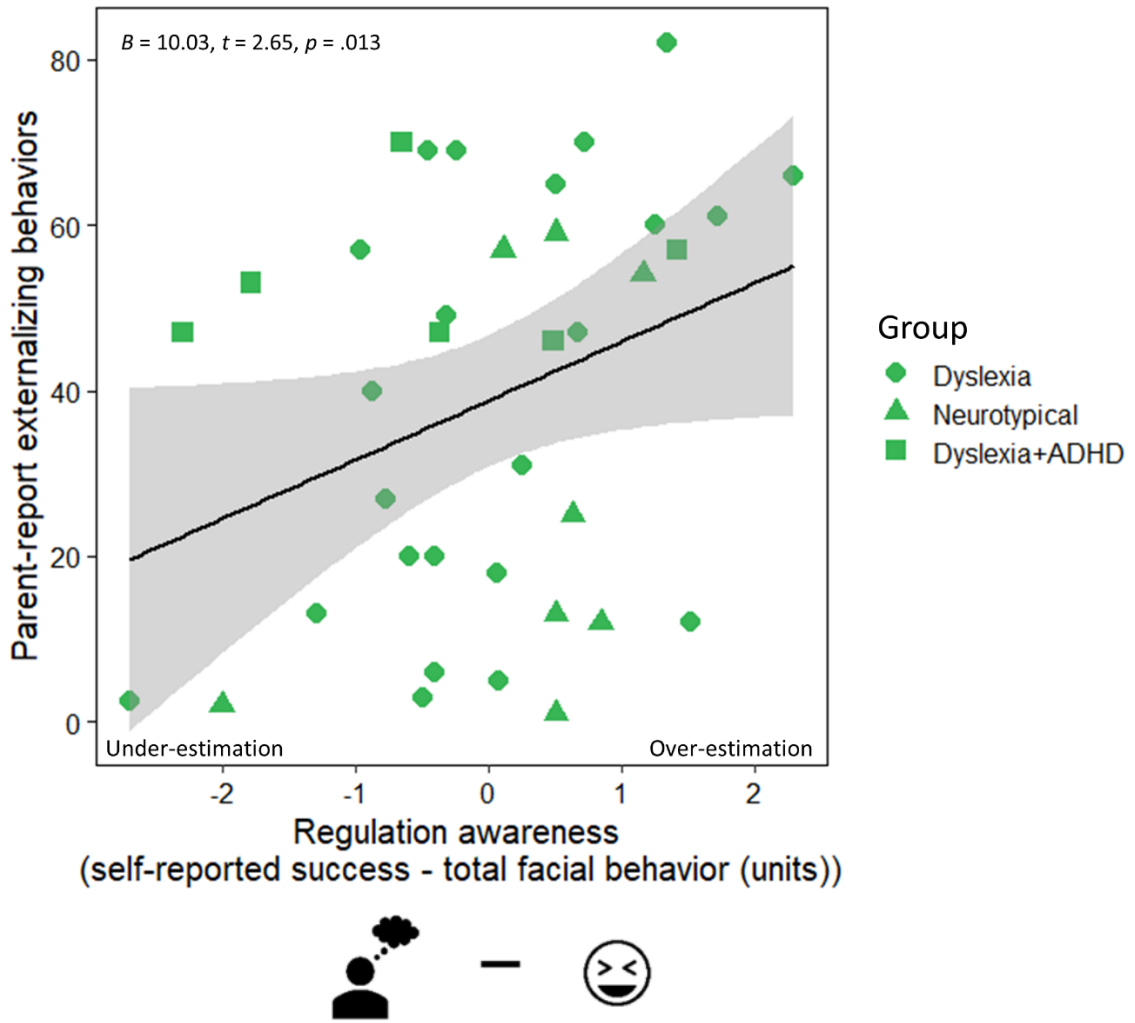
Palser et al., in prep

Left-lateralized localization of positive emotion regulation



Palser et al., in prep

Regulation awareness transdiagnostically predicts externalizing behaviors



Palser et al., in prep

Conclusions

- Alterations in communication along the body-brain axis are relevant to several neurodevelopmental disorders.
- Perturbations in interoception may underlie core and associated features of autism.
- An emerging framework of emotional differences in dyslexia offers a novel account of mental health challenges. Reframing within a strength-based approach could improve outcomes.

Acknowledgements

James Kilner, UCL
Katerina Fotopoulou, UCL
Liz Pellicano, UCL
Virginia Sturm, UCSF
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