Eating-Related Behaviors and Their Correlates in Autism

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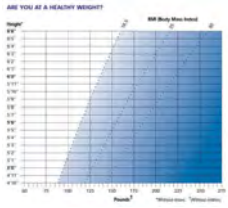
Overview

- Why study eating in Autism Spectrum Disorder (ASD)?
- Food neophobia and 'picky' eating in ASD
- Eating in the absence of hunger (EAH) in ASD
- "Selective overeating" in ASD
- Neural correlates of these eating-related behaviors in ASD?

Why study eating in ASD?

Suboptimal Health Outcomes in ASD

- Increased obesity risk in ASD in children, adolescents, and adults based on a meta-analysis (including 1,045,485 individuals with ASD and 48,891,482 controls) (Zhang et al., 2017)



- Elevated risk for ↑cholesterol, hypertension, and diabetes in adults with ASD compared to general population (Croen, 2015; Hand et al. 2020)

Nutritional Intake

- A meta-analysis suggests that macronutrient intake, particularly calcium and protein, is diminished in ASD (Sharp et al., 2013)

Focus on Exercise

- Although exercise is obviously important for optimal health, models of weight loss in the general population show that diet exerts a stronger influence than exercise
- Thus far, exercise (and its effects on weight/BMI) in ASD and other DDs has been the primary focus of research

Appetitive Traits Are Likely Contributing Factors

Food Repertoire

Food Neophobia

Drive to Eat

Eating in the Absence of Hunger

Food Neophobia and 'Picky' Eating in ASD

Selective Eating in ASD

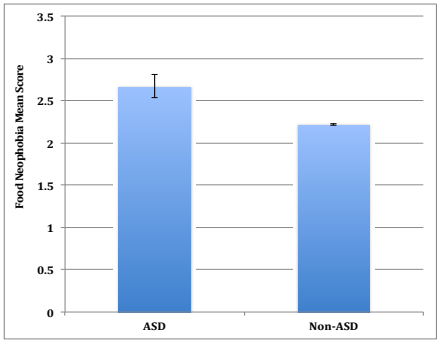
- Selective or 'picky' eating habits are common in ASD
- 60-75% of children with ASD exhibit some degree of selective eating (Kerwin et al., 2005; Schreck & Williams, 2006)
- Many selective eating symptoms never fully resolve in adolescents and adults with ASD (Fodstad & Matson, 2008)
- Here I will focus on one component of selective eating: food neophobia

Food Neophobia

Food Neophobia

- Fear of trying *new* foods (FN) is a common and seemingly adaptive feature of early eating
- Once food is in mouth, neophobia is 'overcome' and rejection would be considered 'picky' eating
- Typically dissipates and wanes across child development
- When persistent, FN can be stressful and interfere with everyday functioning

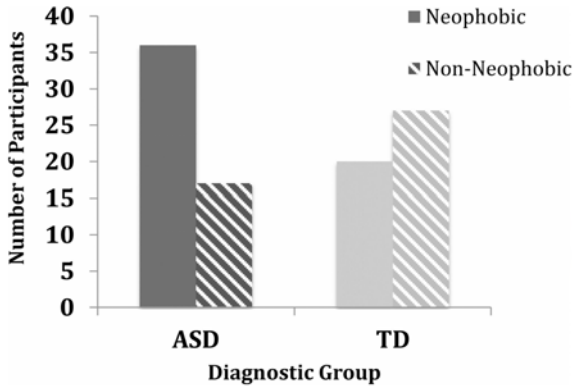
Food Neophobia in ASD During Childhood



- In a population-based cohort of 8-10 year olds from the UK, children with ASD (n=37) were rated as more food neophobic than non-ASD children (n=4,564) based on the 4-item Child Food Neophobia Scale (Pliner & Hobden, 1992)
- ~1/2 of children with ASD were rated as food neophobic as compared to ~1/4 of non-ASD children

Wallace, Llewellyn, Fildes, & Ronald (2018) *Am J Clin Nutr*

Food Neophobia in Adolescents and Adults with ASD



- ASD vs. TD adolescents and adults (12-28 years old) self-rated FN based on an item from the Adolescent/Adult Sensory Profile
- >FN rates in ASD compared to TD group (χ^2=6.51, p<.001)

Kuschner, Eisenburg, Orionzi, Simmons, Kenworthy, Martin, & Wallace (2015)

Why Drives Selective Eating (in ASD)?

- Numerous possibilities, though on the behavioral and cognitive level (as opposed to the biological level, for example), two prime candidates:
  - Sensory processing differences
  - Behavioral and cognitive inflexibility

Food Neophobia

Possible Underpinnings of Food Selectivity

- Across 4 samples food selectivity/"picky" eating was predicted by ***both*** behavioral inflexibility and oral texture sensory sensitivities
  - 190 children with ASD
  - 263 typically developing children
  - 179 children with anxiety disorders/OCD
  - 510 neurotypical undergraduates
- Because individuals with ASD have divergent sensory experiences (e.g., increased sensory sensitivities) and more challenges with behavioral flexibility, they are particularly susceptible to developing food selectivity.

Zickgraf, Richard, Zucker, & Wallace (2020) *J Clin Child Adol Psychology*

Clinical Significance of Selective Eating in ASD

- 'Avoidant Restrictive Food Intake Disorder' (ARFID)
  - The clinical (i.e., extreme) form of picky eating/food selectivity leading to limited food repertoire, nutrition, and growth
- ARFID is relatively common in ASD yet research is very limited (see Bourne et al., 2022)

Summary

- FN more common in ASD than in same-age TD peers across childhood, adolescence, and young adulthood – evidence suggests life course persistence despite interventions
- Behavioral inflexibility and sensory sensitivities are likely key contributors to food selectivity and thus represent potential intervention targets
- FN raises risk for nutritional deficiencies and ARFID
  - Our data suggest that a large minority (~35-40%) of young adults, particularly women, with ASD (n=250) screen positive for ARFID (Wallace, unpublished data)

Eating in the Absence of Hunger in ASD

Eating in the Absence of Hunger in ASD

- Eating in the absence of hunger (EAH) has rarely been examined in ASD
- Three small studies across two samples completed so far, with all three suggestive of increased overeating in ASD (Kobayashi et al., 1998; Hess et al., 2010; Tureck et al., 2014)

Eating in the Absence of Hunger in ASD Study 1

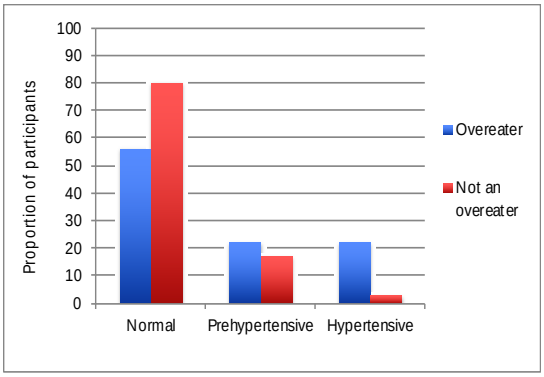
	ASD [n=99]	TD [n=59]
Age	15.11 (1.95)	15.55 (1.85)
Full Scale IQ	107.94 (17.31)	114.66 (11.72)
Gender Ratio (Male:Female)	75:24	49:10

- In this study of adolescents, eating in the absence of hunger was assessed using an item from the Child Behavior Checklist
- Associations examined between EAH and:
  - physical indices (i.e., both BMI, calculated with a calibrated scale and stadiometer, and blood pressure) and
  - real-world executive function (using the Shift and Inhibit scales from the BRIEF)

Wallace et al. (unpublished data)

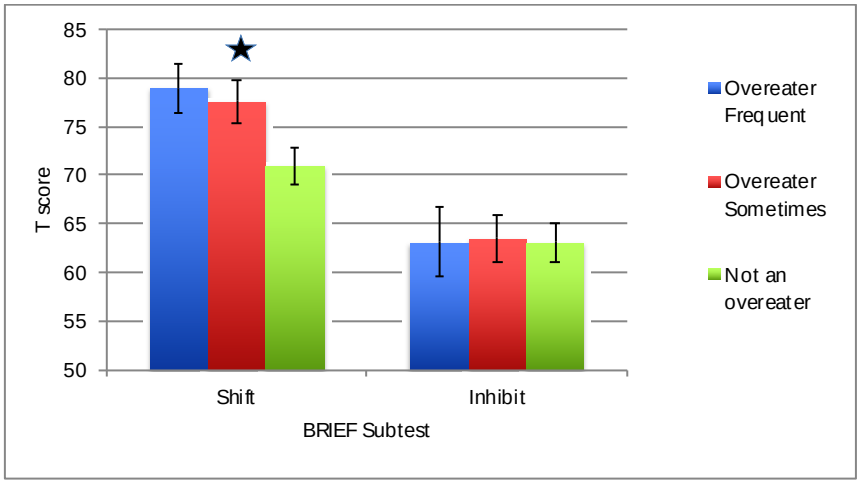
Eating in the Absence of Hunger in ASD Study 1

- Parents of children with ASD were more likely to rate their children as overeaters than parents of TD children
- Overeaters with ASD were more likely to meet CDC criteria for obesity than non-overeaters with ASD
- Overeaters with ASD were more likely to be hypertensive than non-overeaters with ASD



Wallace et al. (unpublished data)

Study 1: Cognitive/Behavioral Correlates of EAH in ASD



- Overeaters with ASD are rated as being more inflexible than non-overeaters with ASD while no differences emerge in ratings of inhibitory control

Wallace et al. (unpublished data)

Eating in the Absence of Hunger in ASD Study 2

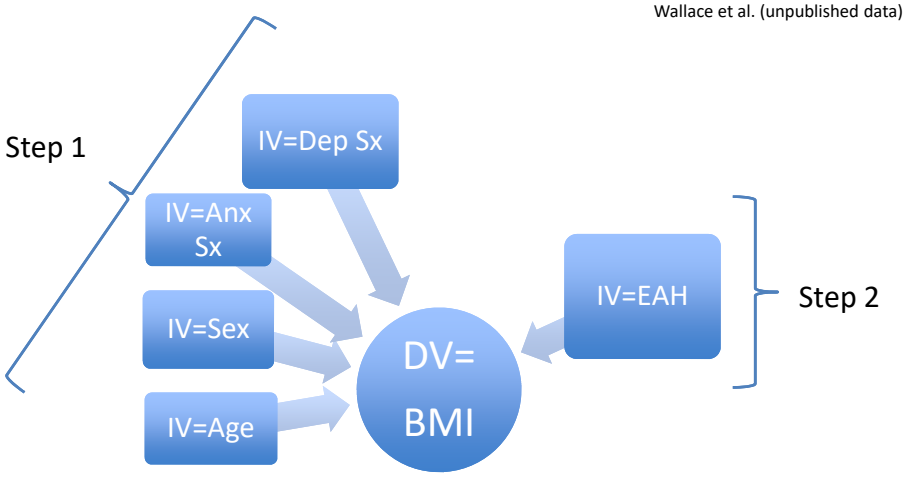
	ASD [n=190]	TD [n=119]
Age	8.69 (3.12)	9.29 (3.76)
Gender Ratio (Male:Female)	137:53	54:65

- In a subsequent study of children and adolescents, EAH was assessed using the Yale Food Addiction Scale for Children
- Associations examined between EAH and:
  - BMI, based on parent report of height and weight and
  - Behavioral flexibility (using the Routines and Rituals subscale from the Flexibility Scale-Revised)
- Just as in Study 1, parents rated ↑ EAH in children with ASD compared to TD children (p<.001)

Wallace et al. (unpublished data)

Is there a relationship between EAH and BMI in children with ASD?

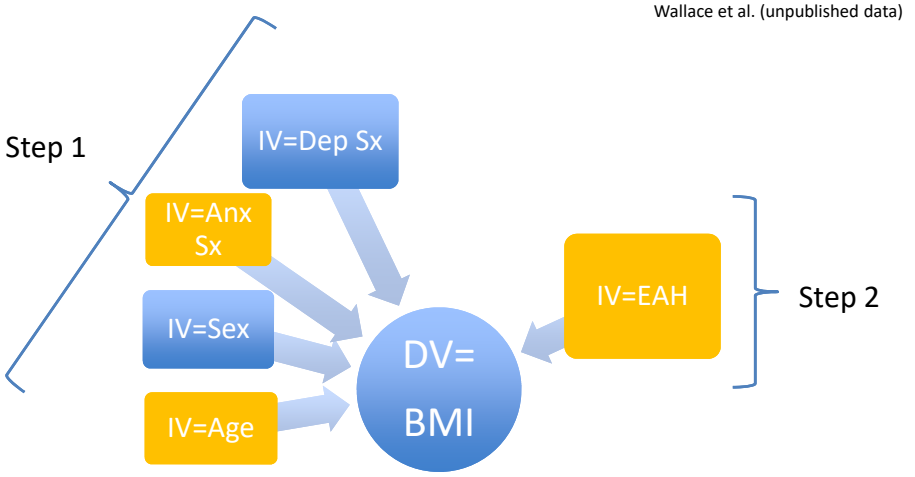
Wallace et al. (unpublished data)



Stepwise regression

Is there a relationship between EAH and BMI in children with ASD?

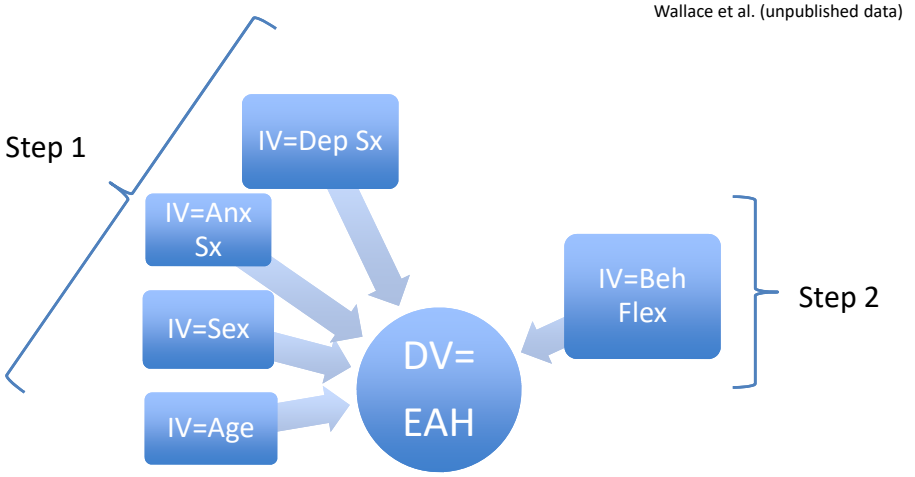
Wallace et al. (unpublished data)



Stepwise regression

Is there a relationship between Behavioral Flexibility and EAH in children with ASD?

Wallace et al. (unpublished data)



Stepwise regression

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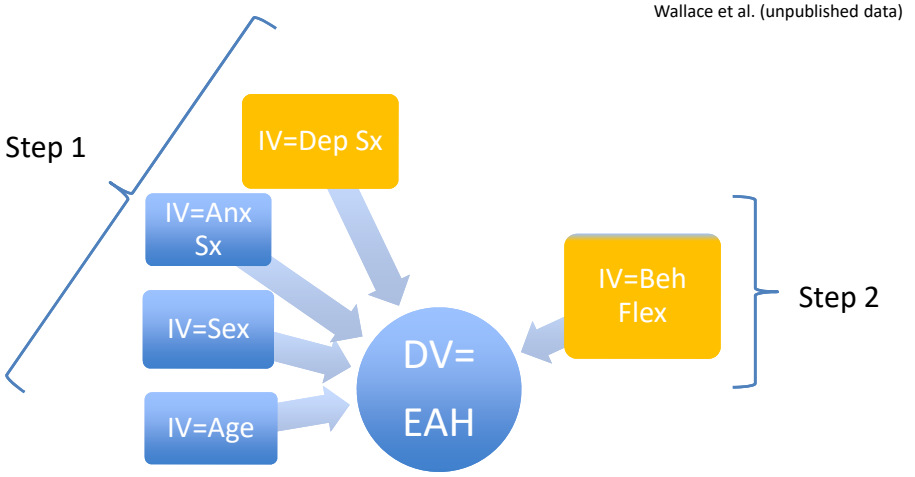


Stepwise regression

Summary

- Across both studies:
  - EAH is more prevalent in ASD than TD controls
  - EAH is positively associated with BMI
  - EAH is associated with behavioral inflexibility
- Much more work is needed including establishing longitudinal (closer to causal) relationships
- Does EAH (particularly stress-induced) serve a self-stimming function?
  - We find increased emotional overeating in ASD, particularly among girls (Wallace et al., 2021), and anecdotal reports are highly suggestive…

A Newly Described Eating Subtype in ASD? "Selective Overeating"

"Selective Overeating" in Children with Autism

	ASD [n=185]	**TD** [n=111]
Age	8.65 (3.04)	9.18 (3.64)
Sex Assigned at Birth Ratio (Male:Female)	134:51	51:60

- Presence of "Selective Overeating" was examined based on parent ratings of autistic vs. TD children
- EAH was assessed using the Yale Food Addiction Scale for Children
- Selective Eating and Dietary Variety were assessed using the Eating Habits Survey

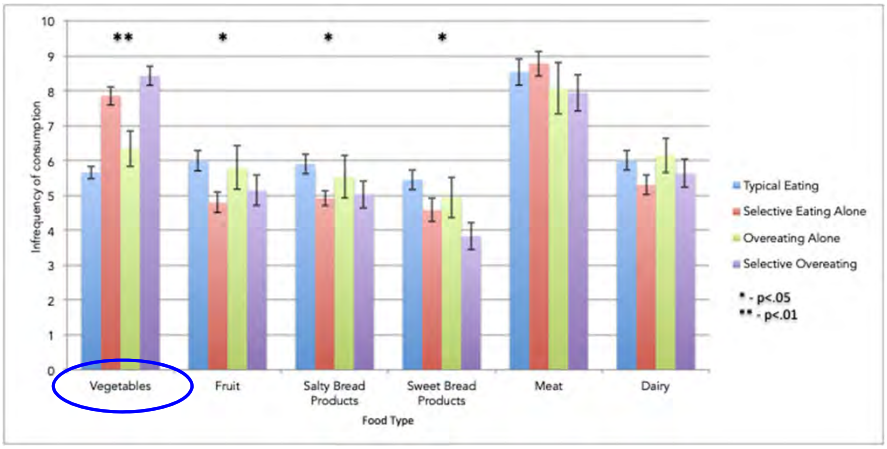
Nadeau…Wallace (2022) *JADD*

Selective Overeating in Children with ASD

- Autistic and TD children classified into 4 subgroups:
  - "typical" eating (neither selective nor EAH)
  - selective only
  - EAH only
  - "selective overeating" (both selective and EAH)
- Autistic and TD children differed in proportions of eating subtypes (χ^2=33.85, p<.001).
  - ↑Selective eating only (36.8% ASD; 21.6% TD) and ↑selective overeating (18.9% ASD; 3.6% TD) in autistic vs. TD kids
- Among autistic children, those with EAH also had a significantly ↑ rate of selective eating than children who did not exhibit EAH (χ^2=5.70, p=.02).

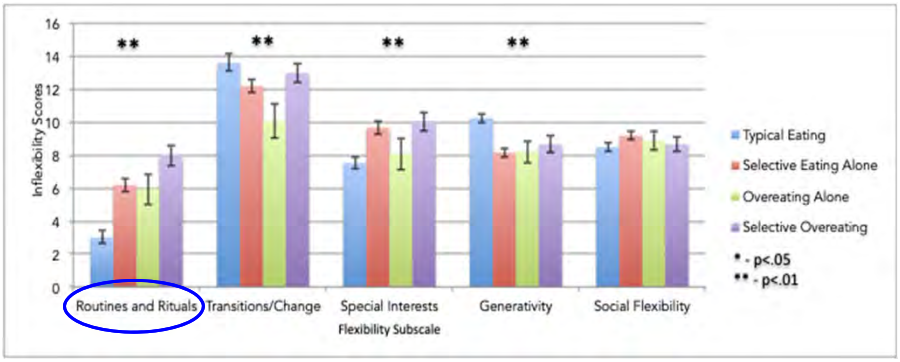
Nadeau…Wallace (2022) *JADD*

Infrequency of food type consumption by eating subtype in children with ASD



Nadeau…Wallace (2022) *JADD*

Inflexibility ratings by eating subtype in children with ASD



Nadeau…Wallace (2021) *JADD*

Neural Correlates of Eating-Related Behaviors in ASD

Sensory-Perception in ASD

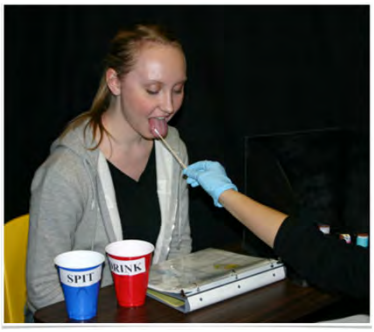
- ASD characterized by sensory-perceptual differences across modalities (e.g., vision, audition) and in valence (e.g., hypersensitive or hyposensitive)
- One prime candidate related to eating is taste perception/processing

Taste Perception in ASD

- Taste perception in 21 children with ASD vs. 27 TD children (M age ~14 years)
  - No group differences in detection thresholds
  - Children with ASD were less accurate in identifying citric acid and quinine than TD children

Taste Detection - Electrogustometry Detection Thresholds

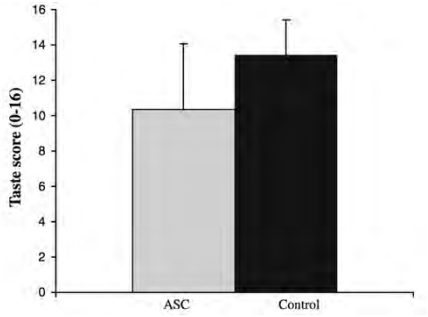
Taste Identification - Regional Chemosensory Exam



Bennetto et al. (2007) *Biological Psychiatry*

Taste Identification in ASD

- Taste Identification
  - Less accurate taste identification (particularly bitter and sour flavors) has been shown subsequently among adults with ASD as well



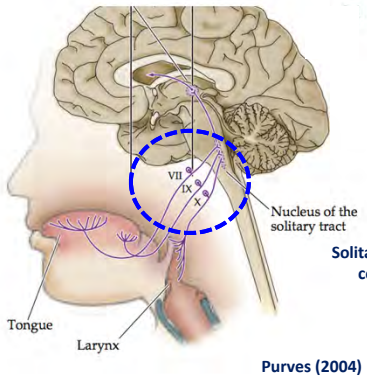
Tavassoli & Baron-Cohen (2012)

Taste Perception in ASD

- Intact taste detection, but impaired taste identification in ASD suggests that:
  - Low-level processing is intact (i.e., taste signals are being received)
  - Top-down processing and integration of taste information is atypical (i.e., cortical issue)
  - Yet, there have been no studies to examine the neural correlates of taste perception in ASD

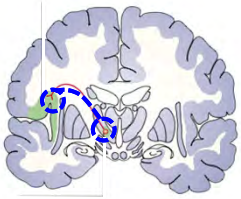
Cortical Taste Pathway

Chandrashekar et al. 2006

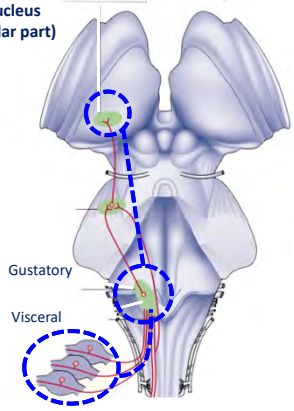


Purves (2004)

Insula and frontal operculum



Ventroposterior medial nucleus (parvocellular part)

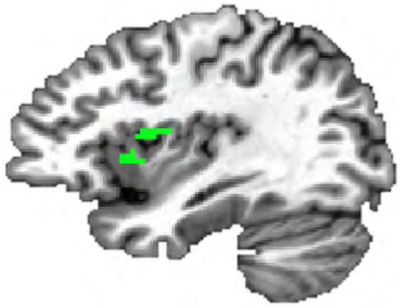


Solitary nuclear complex

Craig (2002) *Nat. Rev. Neuro.*

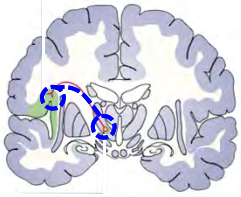
Cortical Taste Pathway

Chandrashekar et al. 2006



Sweet Tastant > Neutral Tastant
Simmons et al. (2013)

Insula and frontal operculum



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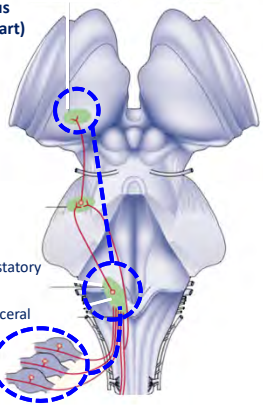


Solitary nuclear complex

Craig (2002) *Nat. Rev. Neuro.*

Thus, we can address the following questions using functional Magnetic Resonance Imaging (fMRI):

- **Do individuals with ASD exhibit an atypical neural response to tastants in gustatory cortex?**
- **Is the response to tastants related to individual differences in self-reported taste reactivity in ASD?**

Food Study Design

- 21 males with ASD; Age: mean(SD): 21(3) yrs
- 21 TD males; Age: mean(SD): 22(3) yrs

Assessments

- Adolescent/Adult Sensory Profile (AASP) – Taste Reactivity (e.g., "I don't like strong tasting mints or candies")
- Automated Self-Administered 24hr Dietary Assessment (ASA24)

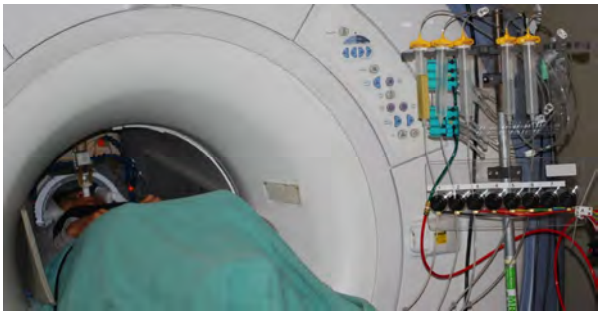
Behavioral Assessments

ASA24

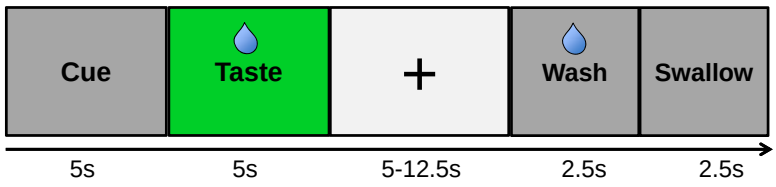
fMRI task

Gustatory Mapping Task

Gustatory Mapping (GM) task



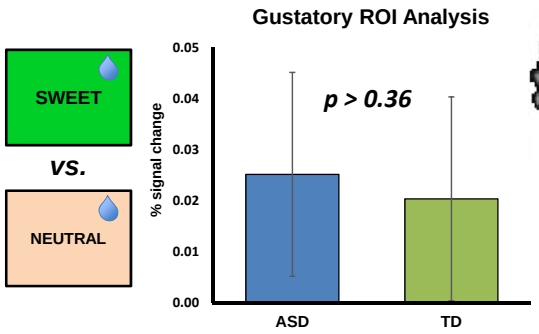
'Sweet' or 'Neutral'

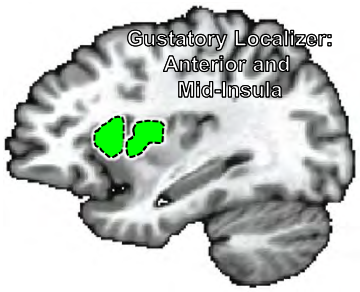


Do individuals with ASD exhibit an atypical neural response to tastants in gustatory cortex?

Within localizer ROIs, we compared Sweet vs. Neutral tastant response between ASD and TD groups

NO



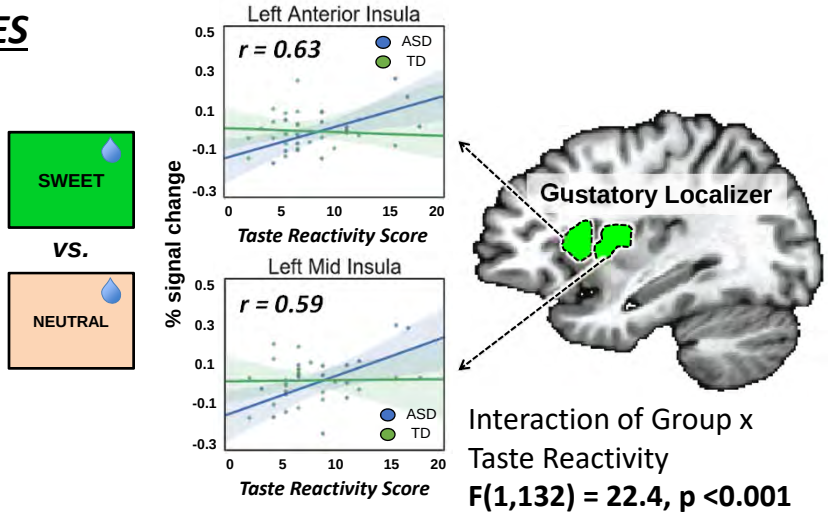


Avery et al. (2018) *NeuroImage Clinical*

Avery et al. (2018) *NeuroImage Clinical*

Is response to tastants related to individual differences in self-rated taste reactivity in ASD?

YES

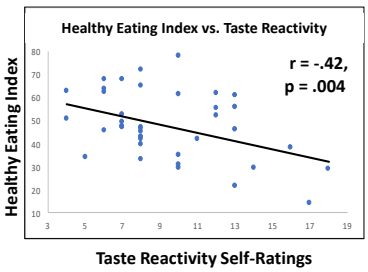


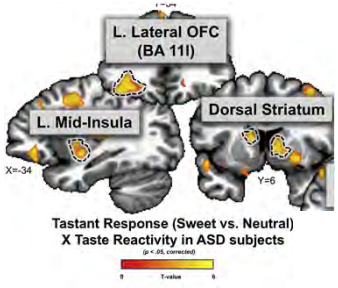
Interaction of Group x Taste Reactivity

F(1,132) = 22.4, p <0.001

Summary

- Although no evidence of overall atypical gustatory cortical function in ASD, activity in gustatory cortex is modulated by individual differences in self-rated taste reactivity
- This suggests atypical brain function for individuals with both ASD and food selectivity that could impact BMI via dietary variety
- More studies of cognitive and neural underpinnings of eating-related behaviors to inform intervention and etiology





Overall Summary

- Although we've known about eating-related differences in ASD since its first description in the 1940s our knowledge base is surprisingly small:
  - More work is needed including establishing longitudinal (closer to causal) relationships between eating-related behaviors and both what precedes/predicts them (e.g., sensory, cognitive, neural factors) as well as what follows them (e.g., physical health outcomes)
  - More intervention work is needed both for food avoidance and food seeking behaviors to improve physical health and overall quality of life in ASD

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