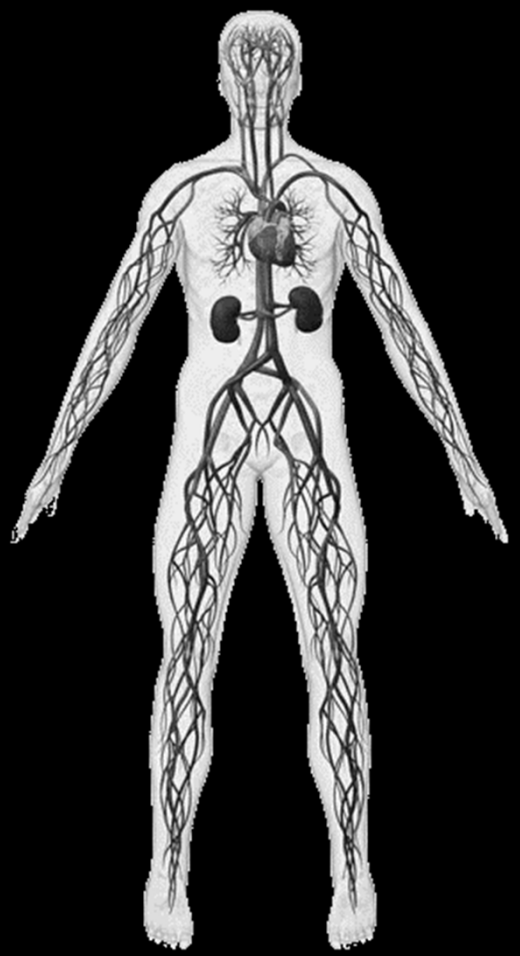
Interoception and Autism: What you need to know

Jo Minchin and Geoff Bird

Hi. How are you?



What is interoception?

- Interoception is described as an awareness of the physical condition of the body including hunger, itch, taste, cardiac and respiratory awareness (Craig, 2002).
- “Interoception encompasses both non-conscious and conscious levels of information processing, and the processing of painful and non-painful stimuli.” (Khalsa & Lapidus, 2016).

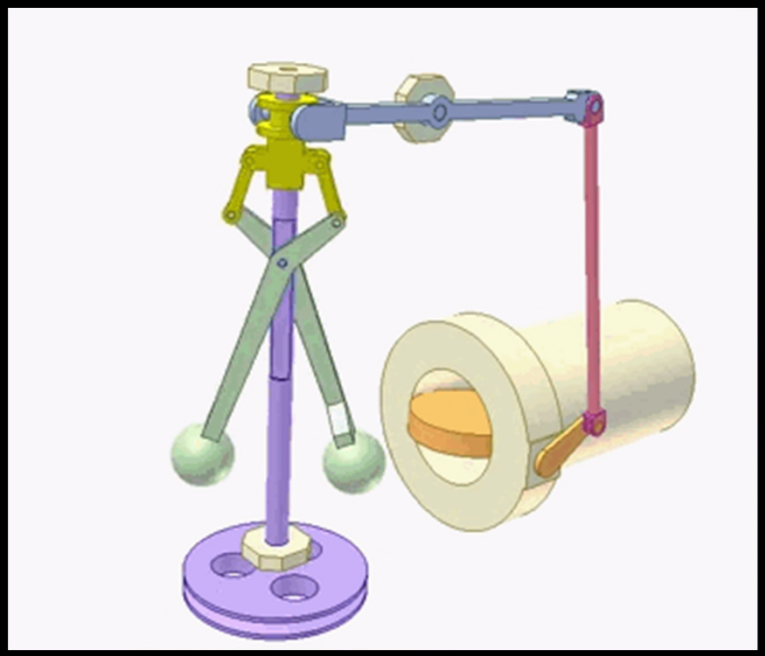
What is interoception?

- Numerous definitions.
- Contentious.

(Table from Khalsa & Lapidus, 2016)

Author(s)	Definition
Vaitl (5)	A general concept, which includes two different forms of perception: proprioception and viscероception
Cameron (6)	The afferent information that arises from anywhere and everywhere within the body – the skin and all that is underneath the skin, e.g., labyrinthine and proprioceptive functions – not just the visceral organs
Cameron (4)	Perception of the functions and physiological activities of the interior of the body
Craig (7)	The sense of the physiological condition of the body or a homeostatic afferent pathway that conveys signals from small diameter primary afferents that represent the physiological status of all tissues in the body
Khalsa et al. (8)	The perception of internal body states
Paulus et al. (9)	The central nervous system representation of visceral feelings
Couto et al. (10)	The processing of bodily signals from the viscera and somatic tissues
Critchley and Harrison (11)	Continuous dynamic feedback of afferent visceral signals that shape (the brain's) operational functioning
Paulus (12)	A process consisting of integrating the information coming from the inside of the body in(to) the central nervous system
Barrett and Simmons (13)	The perception and integration of autonomic, hormonal, visceral and immunological homeostatic signals that collectively describe the physiological state of the body

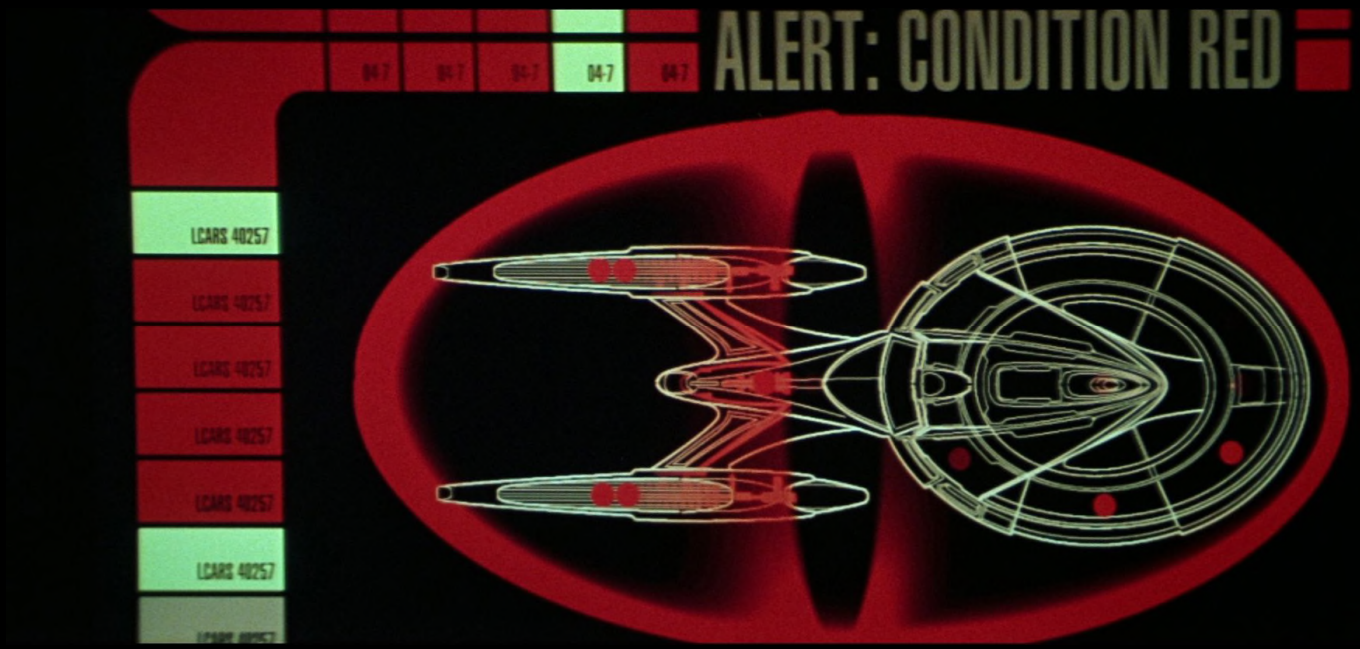
What is interoception?



- At the very least you can imagine Interoception to encompass awareness of any number of internal homeostatic feedback loops needed to keep your body well and functioning properly, like a governor regulates an engine.

(Gif from https://ultraimg.com/)

What if it isn’t accurate?



Anatomical definition of Interoception

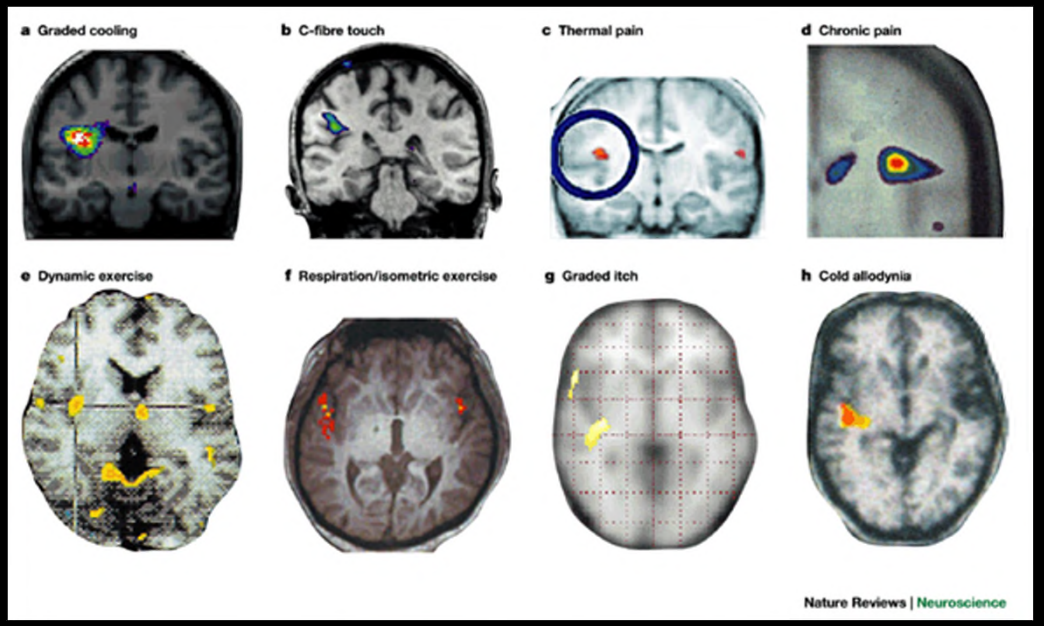
More recent definitions of interoception include:

“bodily information sent either via 1) small diameter (unmyelinated) C-fibres or (myelinated) Aδ-fibres, lamina I, the spinothalamic tract (Craig, 2002),

or 2) cranial nerves (vagus and glossopharyngeal) to the nucleus of the solitary tract - the ‘cranial homeostatic pathway.’” (Critchley & Harrison, 2013)

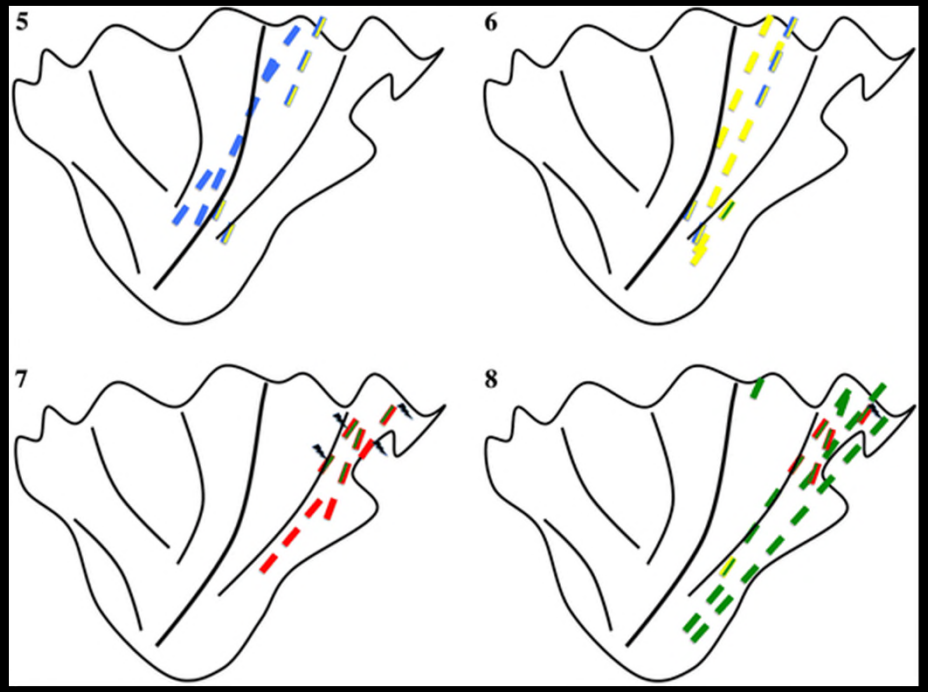
Neural basis of interoception: fMRI

Reliable association with anterior insula and anterior cingulate cortex.



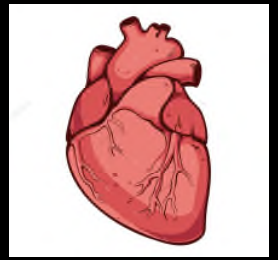
Neural basis of interoception: Single cell stimulation

- Gastric/gustation – including taste
- Viscerosensation– throwing up, something in the throat, stomach vibration
- Pain/warmth
- General somatosensory responses – vibration, pulling, numbness

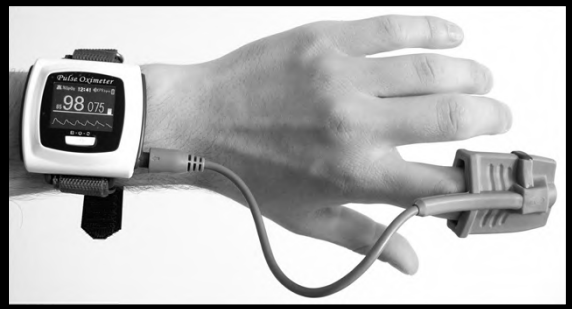


Ventral/dorsal Posterior

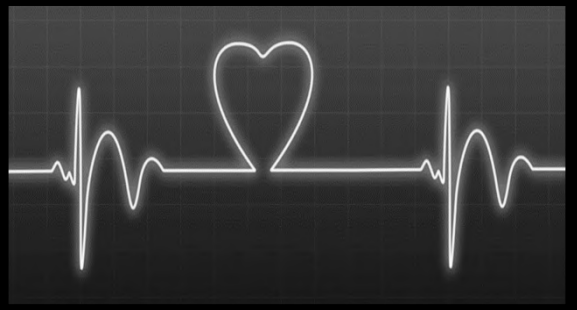
How is interoception measured?



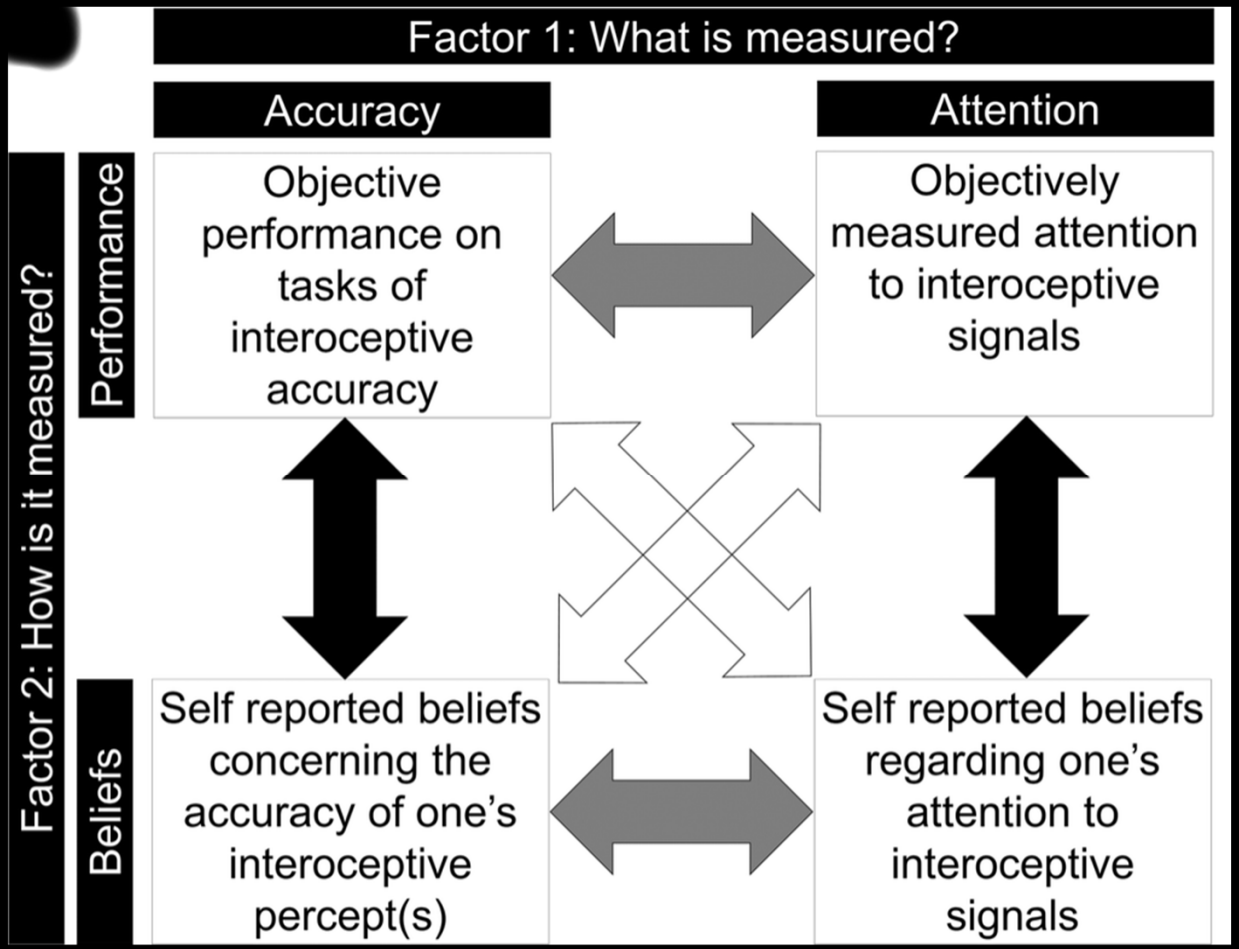
- Participants are asked to count their heartbeats over a series of intervals. The difference between the objective and subjective estimates is taken as a measure of interoception **(Schandry, 1981)**.



- Participants determine whether auditory or visual stimuli are in sync or out of sync with their heartbeat; accuracy is taken as measure of interoception (Katkin et al., 1983; Whitehead et al., 1977).

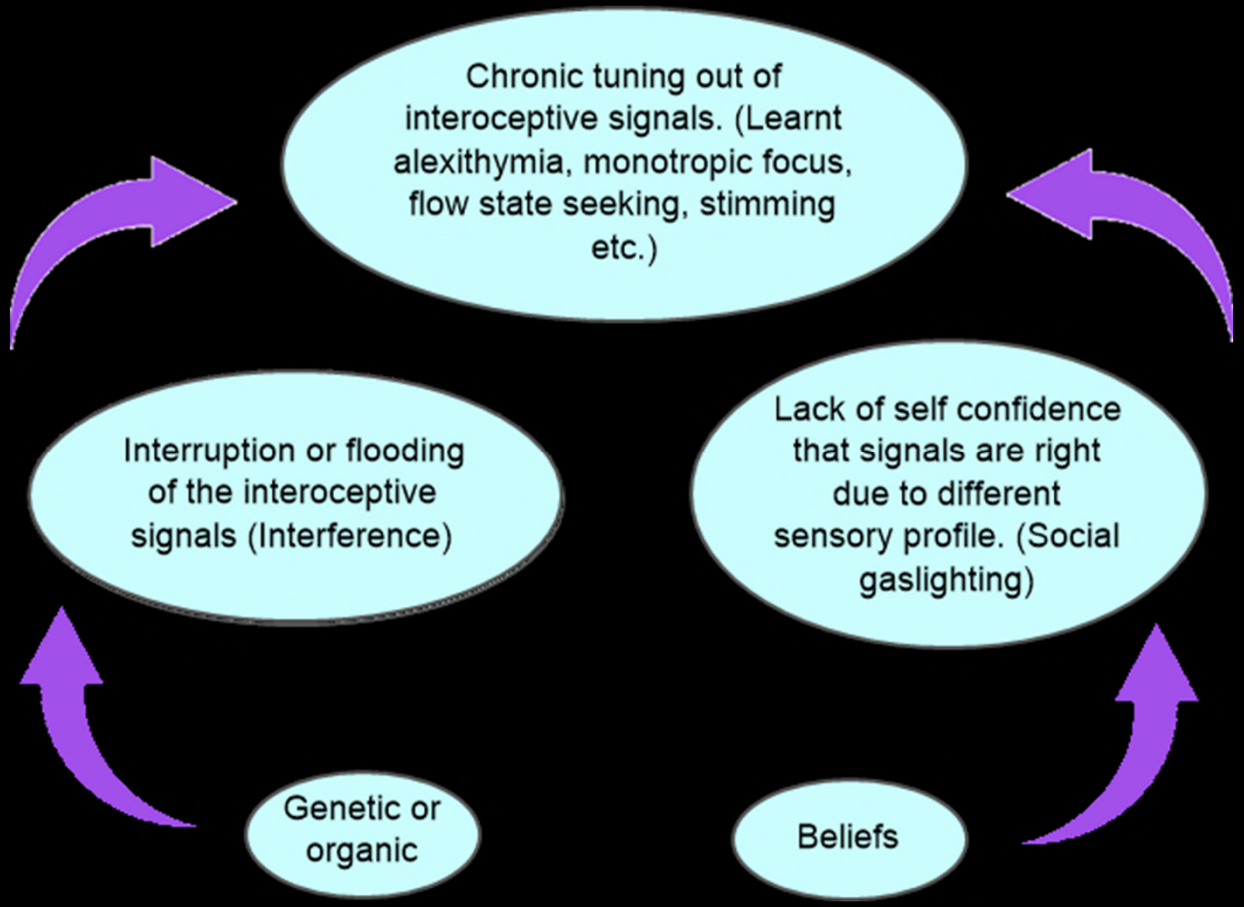


Four Aspects of interoception measurement



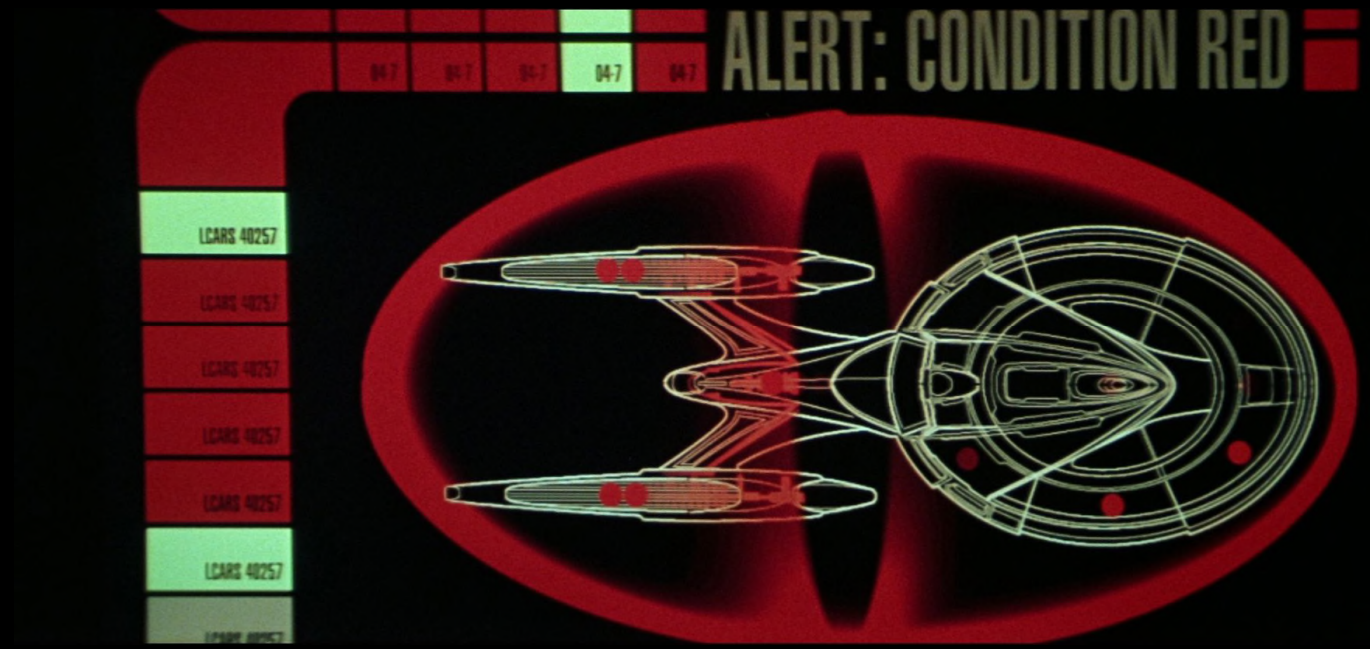
Murphy et al., (2019, Psychon. Bull & Rev), Murphy et al., (2018, JEP:G), Murphy et al., (2017, Dev Cogn Neuro).

What might be happening in autistic people?



Minchin, Hypotheses

In other words…



becomes

Interoception – Its Importance?

1. Learning and decision-making
2. Emotion processing
3. Social Cognition
4. Sensory sensitivity
5. Sleep

Does this sound familiar?

Learning and Decision-Making 1

- Operant conditioning (noisy or inconsistent learning signal - Bevins and Besheer, 2014).
- Representations of value (Damasio's somatic marker theory).
- Werner et al. (2009): scores on the heartbeat tracking task predicted performance on the Iowa Gambling Task, which relies on the ability to learn which of four options are advantageous, and which disadvantageous.
- Dunn, Evans, Makarova, White, & Clark, (2012): rejection rates in the ultimatum game were predicted by electrodermal responses in those with good interoceptive sensitivity, but not in those with poor interoceptive sensitivity.
- Sokol-Hessner et al (2014): Individual differences in physiological arousal correlate with individual differences in loss aversion (the overweighting of losses with respect to equal gains) during risky decision-making. Degree to which these physiological signals of arousal can be perceived (interoception) modulates the impact of arousal on loss aversion during risky decision-making.

Learning and Decision-Making 2

- Kandasamy, et al. (2016) People with greater sensitivity to interoceptive signals, as measured by, for example, tests of heart beat detection, perform better in laboratory studies of risky decision-making..
- Dunn et al. (2010): used Iowa Gambling Task to demonstrate that when arousal cues favoured adaptive choices, those with better interoception made better choices, yet when arousal cues favoured maladaptive choices, individuals with better interoception made worse choices than those with poor interoception.
- Katkin, Wiens and Ohman (2001): acquisition of fear conditioning with masked stimuli dependent upon successful interoception. When masked images were associated with the delivery of an electric shock, individuals with high interoceptive sensitivity were able to use the physiological arousal response associated with the stimulus to predict the likelihood of shock, whereas poor interoceptors were not.
- High interoceptive awareness associated with better recognition memory for affective stimuli (Pollatos and Schandry, 2008; Werner, Peres, Duschek & Schandry, 2010).

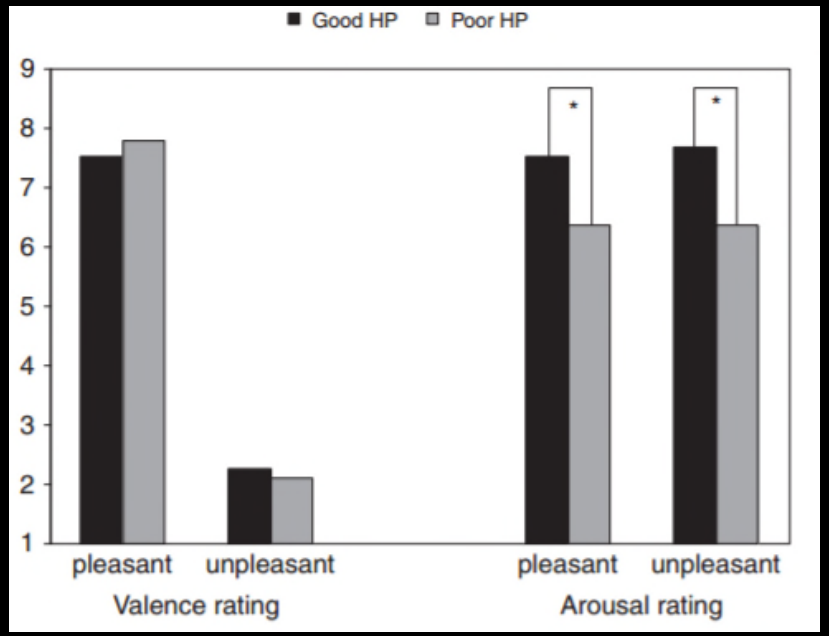
Interoception and Emotional Processing

The vast majority of current theories of emotion suggest that both interoceptive signals and cognitive evaluation of one's internal and external environment contribute towards emotional experience (e.g., Schachter and Singer, 1962; Gendron and Barrett, 2009; Garfinkel and Critchley, 2013; see Hobson et al., (in press) Emotion Review for an overview).

The relationship between interoception and the experience of emotions

Interoception has been positively linked to one's own experiences of emotion

- Emotional stability (Schandry, 1981)
- Emotion regulation (Fustos et al., 2013)
- Emotional intensity (the tendency to experience more extreme emotions with greater awareness and depth of experience e.g. (Herbert et al., 2010).



HP = Heartbeat Perception
(Herbert et al., 2010)

Interoception predicts sensitivity to the emotions of others

- Some evidence also that the a
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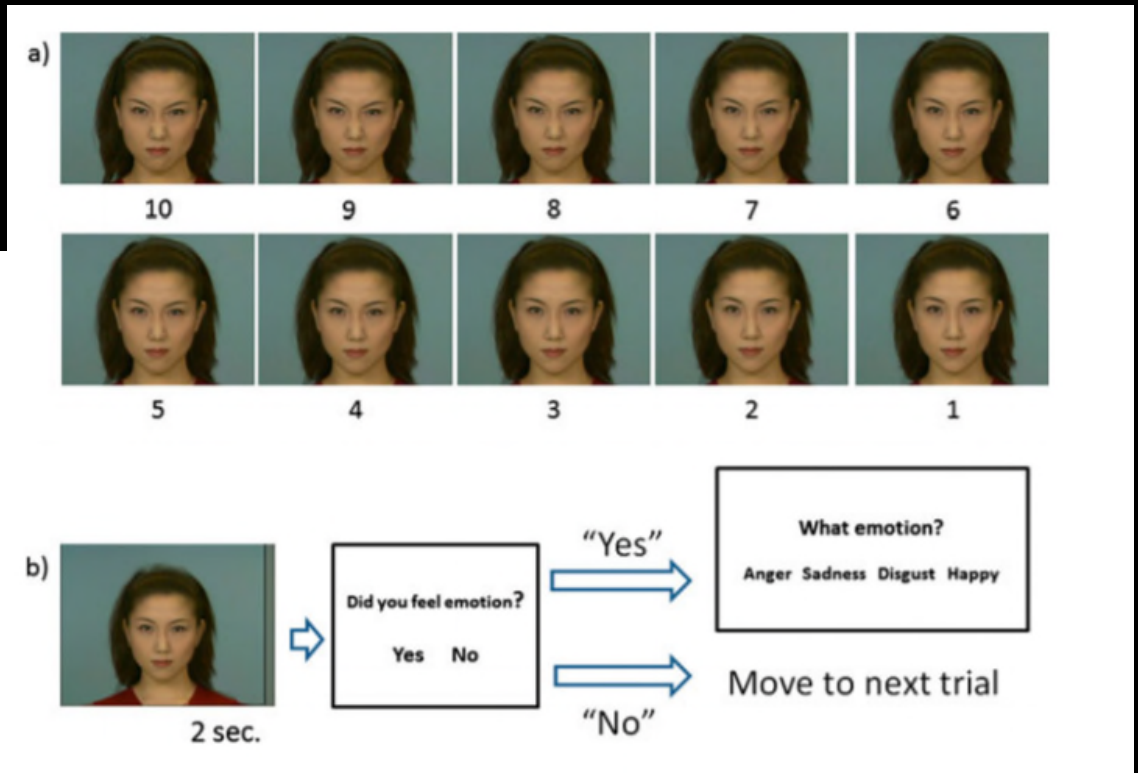
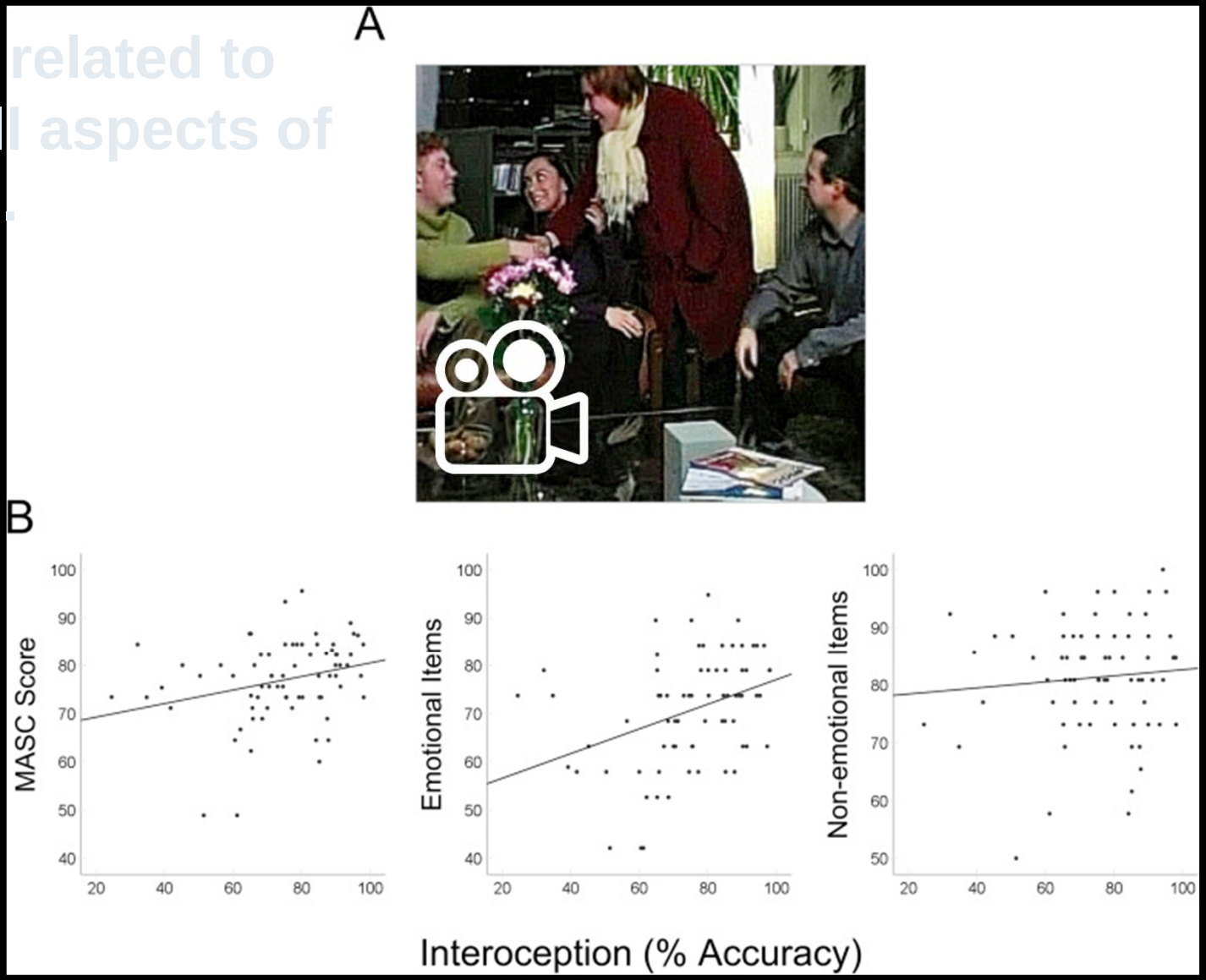


Teresawa (2014)

Interoception is related to some, but not all aspects of social cognition.



(Shah, Catmur, Bird, 2017)

A, Play Movie for the Assessment of Social Cognition (MASC)
B, Ask subjects how 'characters' were feeling or what they were thinking.

Interoception and sleep

- Poor sleep quality differentially impacts interoception across diagnoses.
- For all diagnoses, poor sleep quality was linked with poor interoceptive accuracy.
- For all diagnoses, poor sleep was linked with enhanced interoceptive sensibility.
- For depression and mixed diagnoses, poor sleep impaired metacognitive awareness.

Ewing, et al. (2017)

Is Autism an Interoceptive Condition?

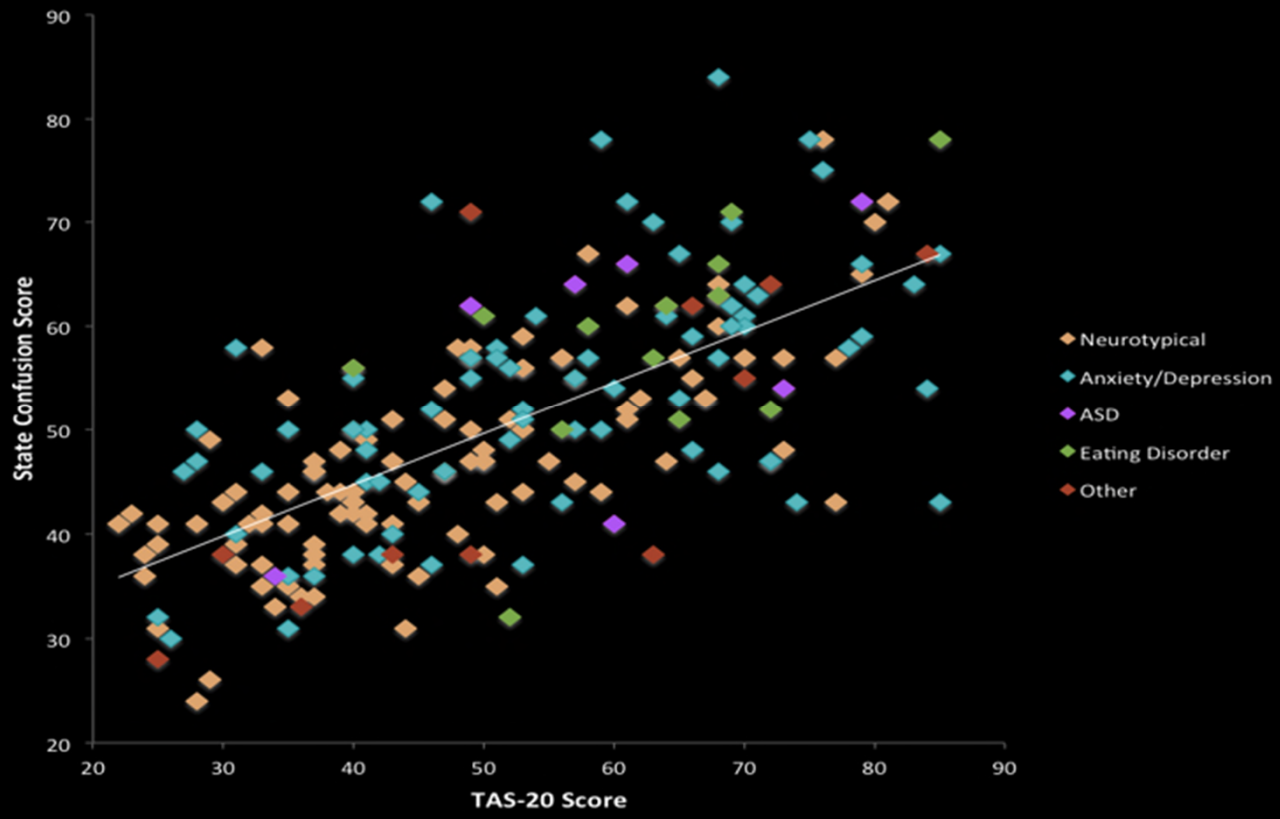
Evidence for trans-diagnostic atypical interoception

- Feeding and Eating Disorders
- Anxiety and panic disorders
- Alcohol and substance abuse
- Depression
- Somatoform disorders
- Obsessive Compulsive Disorder
- Schizophrenia
- Psychopathic traits
- Personality disorders
- PTSD

… etc.

“I frequently don’t know when I’m hungry.”

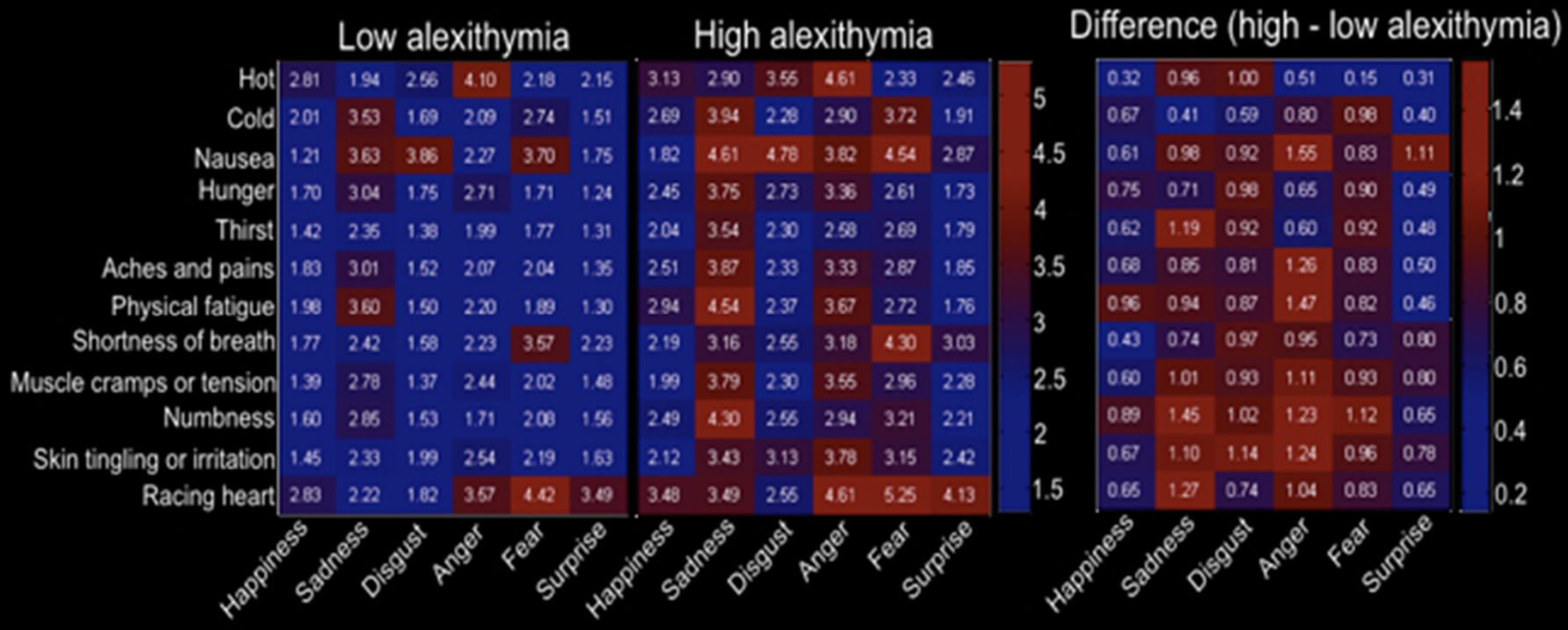
Experiment 1: Alexithymia and interoceptive confusion in 212 ‘typical’ individuals & various patient groups (r = .69).



“How similar are your personal experiences of (a state) and feeling (an emotion)?”

n = 240

r = .45



Brewer et al., in 2016, RSOS Longarzo et al., 2015

Alexithymia

1. Difficulty in identifying & describing feelings
2. Difficulty distinguishing feelings from arousal

“Don’t ask me how I am doing, I genuinely don’t know”

“I don’t know whether I am thirsty or angry”

“I’m often the last person in the room to know how I am feeling.”

How common is alexithymia?

- **5-8**% of general population alexithymic.
- **50**% of autistic individuals alexithymic

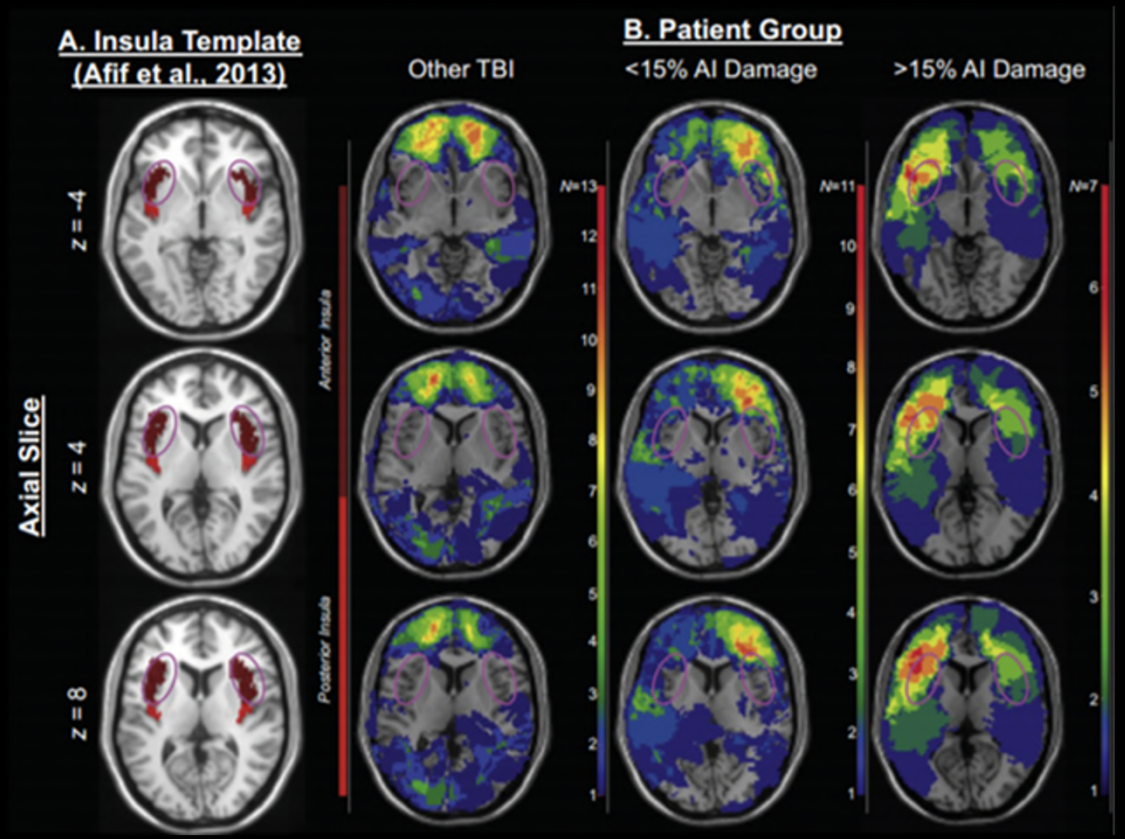
Consider

1. Are ‘emotional indicators associated with autism’ due to co-morbid alexithymia?

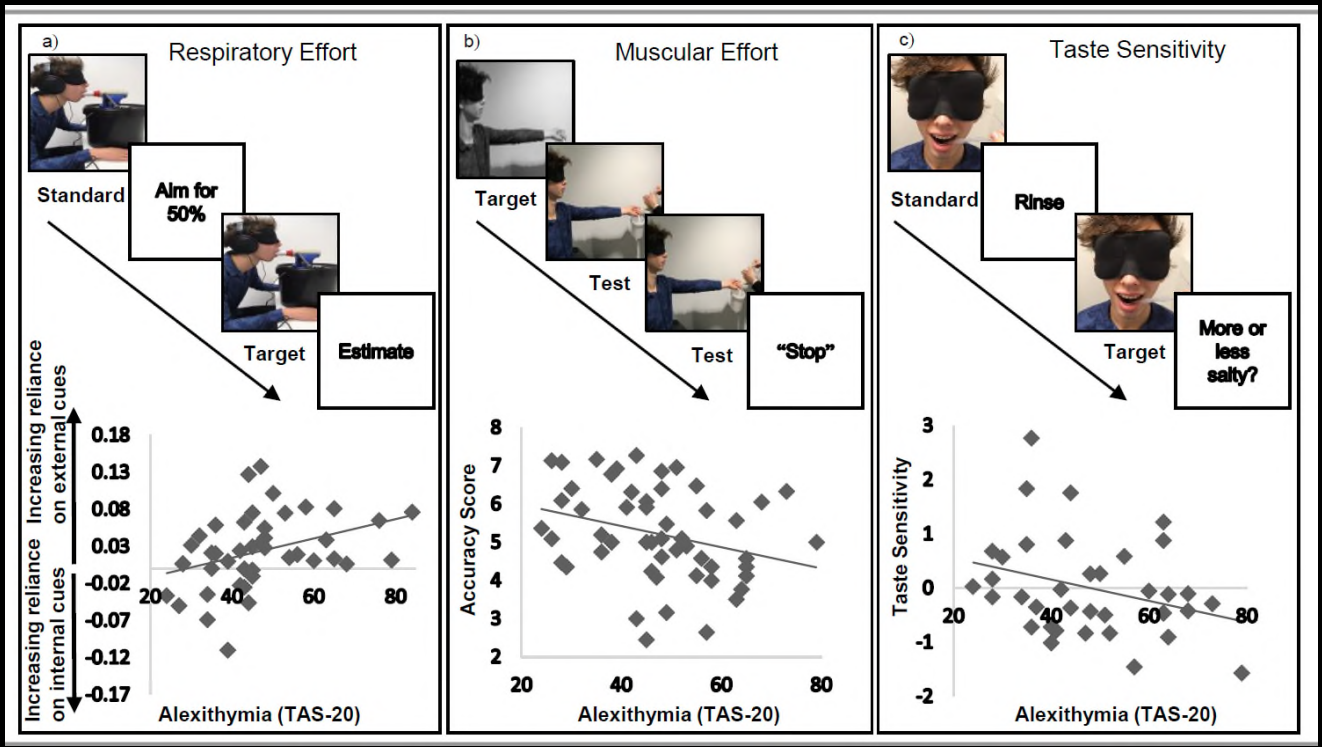
2. Can atypical interoception explain the heterogeneity within the autistic population?

Consistent evidence at the neural level

Increasing damage to the anterior insula is also associated with increasing levels of alexithymia
(Hogeveen et al., 2016)



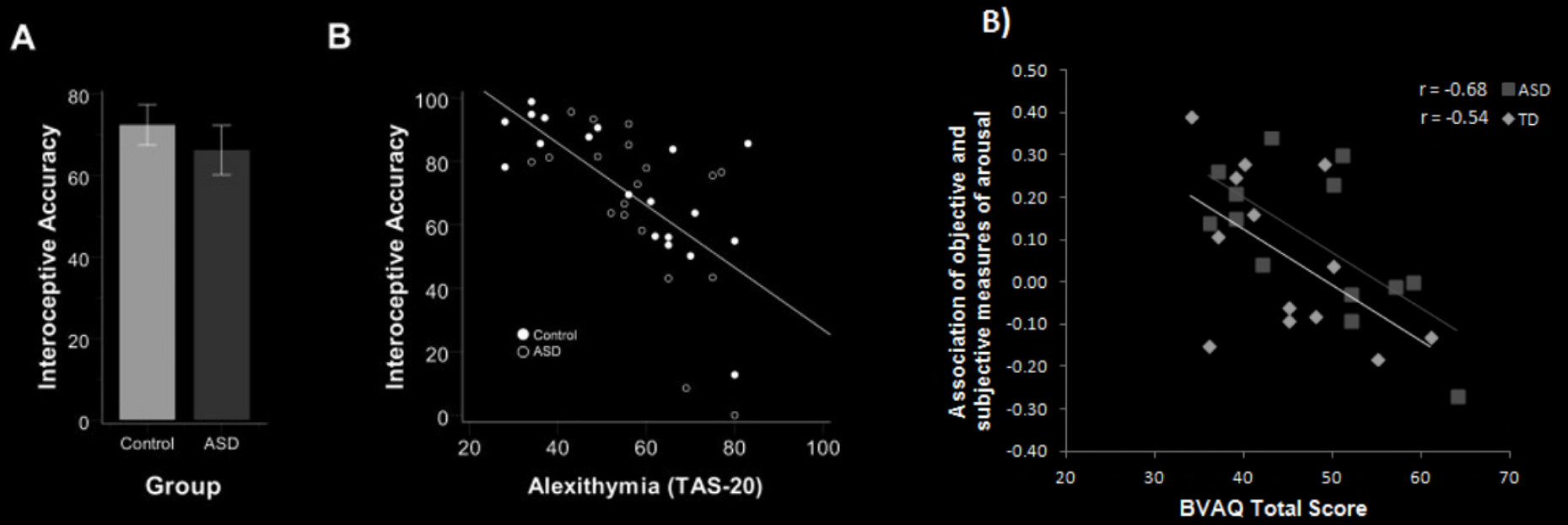
Alexithymia, not autistic traits, associated with poor interoception



Alexithymia is associated with poor perception of various visceral sensations (e.g., Brewer et al., 2016; Shah et al., 2016; Murphy et al., 2018, JEP:G)

Recent criticism: Zamariola et al., 2018, P&ID. See response Murphy et al., 2018, Biol Psychol

Alexithymia, not autism, predicts interoceptive accuracy



Herbert et al., 2012; Shah et al., 2016; Gaigg et al., 2018

J Autism Dev Disord (2016) 46:1354–1367
DOI 10.1007/s10803-015-2670-8

ORIGINAL PAPER

Alexithymia in Adolescents with Autism Spectrum Disorder: Its Relationship to Internalising Difficulties, Sensory Modulation and Social Cognition

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Published online: 11 December 2015

Abstract Alexithymia is a personality trait frequently found in adults with autism spectrum disorder (ASD), and has been linked to impairments in emotion recognition and empathy. The presentation of alexithymia within ASD at younger ages remains unexplored, and was examined in the present study. Alexithymia rates were significantly elevated in ASD (55 %; 31/56 scoring above cut-off) versus non-ASD adolescents (16 %; 5/32 scoring above cut-off). Within individuals with ASD, alexithymia was associated with increased self-reported anxiety, parent-reported emotional difficulties, self-reported sensory processing atypicalities, and poorer emotion recognition, but was not associated with theory of mind ability. Overall, our results suggest that alexithymia is highly prevalent, and has selective cognitive correlates in young people with ASD.

Keywords Alexithymia · Autism spectrum disorder · Emotion recognition · Theory of mind · Anxiety · Sensory processing

Introduction

Individuals with autism spectrum disorder (ASD) have difficulties in social communication and social relating, show restrictive and repetitive patterns of behaviour, and hyper- and hypo-sensitivity to sensory input (American Psychological Association 2013). They frequently

Sensory Symptoms

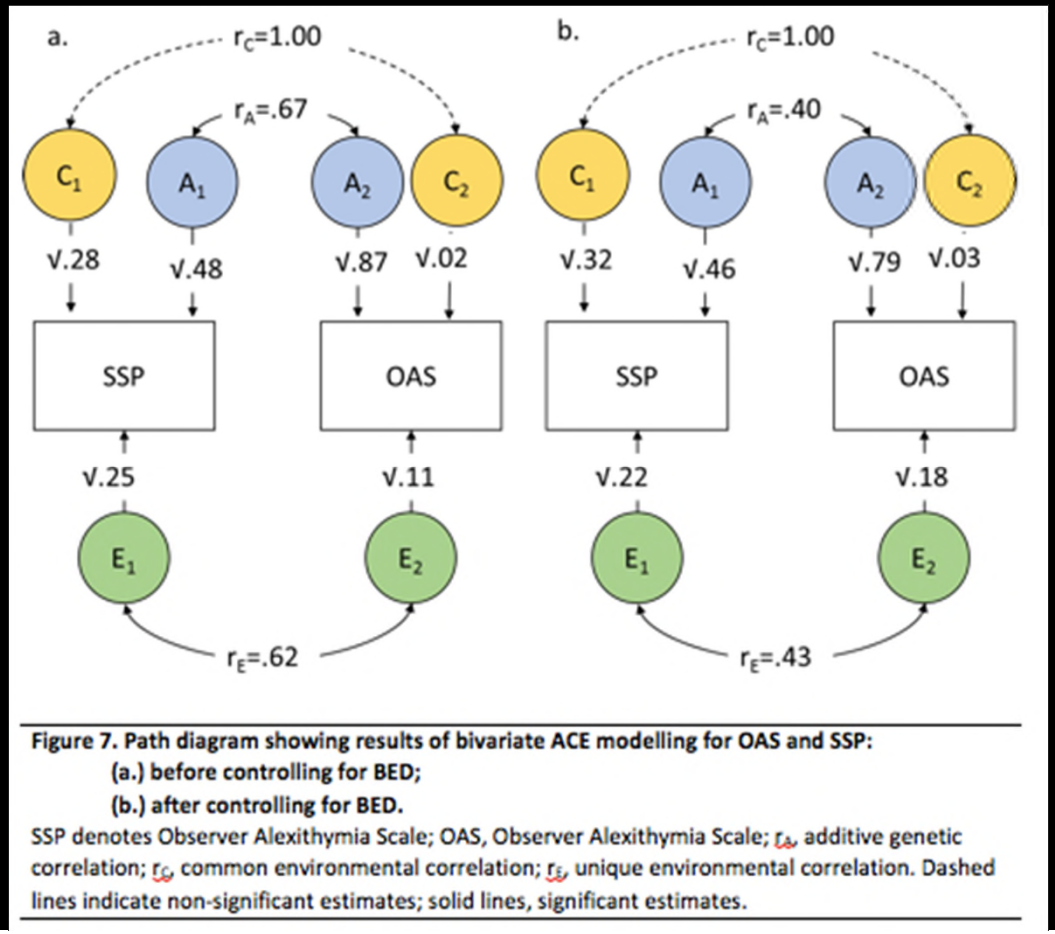


Figure 7. Path diagram showing results of bivariate ACE modelling for OAS and SSP:
(a.) before controlling for BED;
(b.) after controlling for BED.
SSP denotes Observer Alexithymia Scale; OAS, Observer Alexithymia Scale; r_A, additive genetic correlation; r_C, common environmental correlation; r_E, unique environmental correlation. Dashed lines indicate non-significant estimates; solid lines, significant estimates.

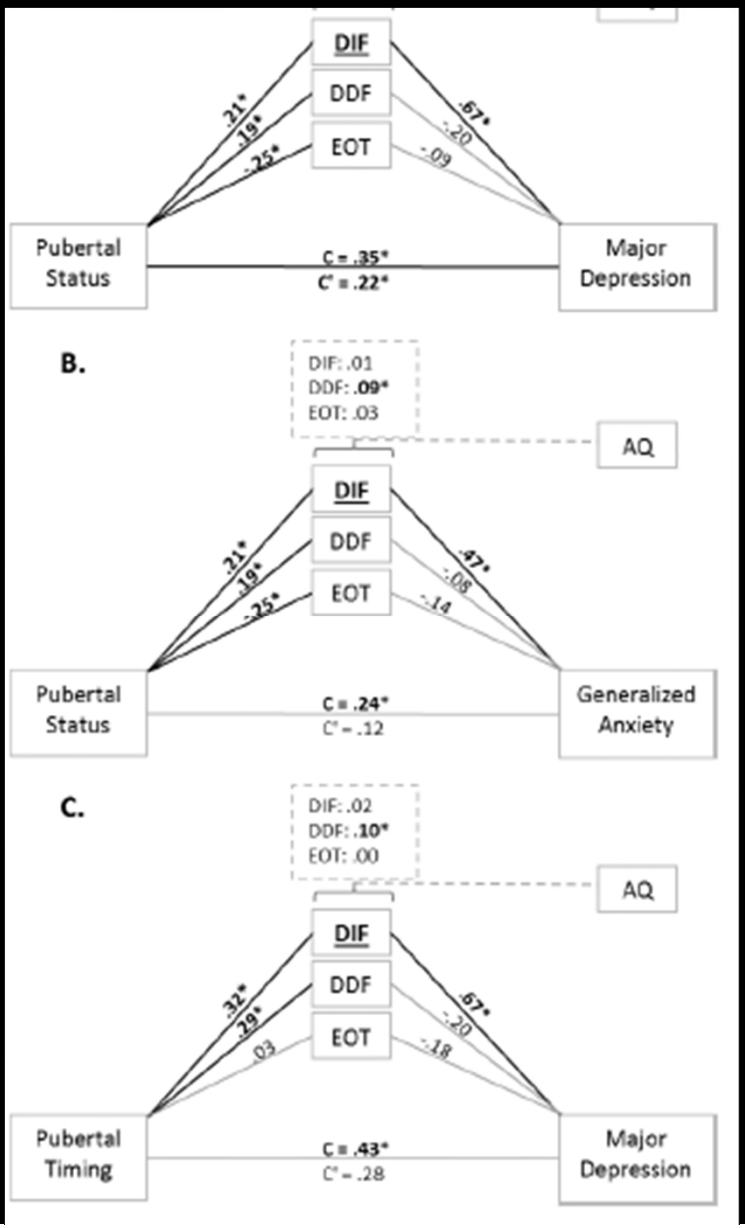
Development & Life Events

- Adolescence (& puberty) mark onset of a lot of psychiatric conditions.
- Relationship between depression and anxiety & puberty in females.

Alexithymia mediates fully, or partially, the relationship between puberty and depression and anxiety in females.

- Post-natal depression / psychosis?
- Menopause?

- Learned alexithymia in autism?



2019, PLoS One

What can we do about it?

Be lead by the individual!

Establish the factors involved
Consider a sensory assessment
Develop a profile
Counselling
Good Psychoeducation

What can we do about it?

Interoception:

Mindfulness

CBT

Medication

Biofeedback

Technology

Capnometry assisted respiratory training

Yoga

Meditation

Counselling

Good Psychoeducation

What can we do about it?

Alexithymia:

All of the same

But beware, there may be other factors involved.

Review

Biological Psychiatry: CNNI

Interoception and Mental Health: A Roadmap

Sahib S. Khalsa, Ralph Adolphs, Oliver G. Cameron, Hugo D. Critchley, Paul W. Davenport, Justin S. Feinstein, Jamie D. Feusner, Sarah N. Garfinkel, Richard D. Lane, Wolf E. Mehling, Alicia E. Meuret, Charles B. Nemeroff, Stephen Oppenheimer, Frederike H. Petzschner, Olga Pollatos, Jamie L. Rhudy, Lawrence P. Schramm, W. Kyle Simmons, Murray B. Stein, Klaas E. Stephan, Omer Van den Bergh, Ilse Van Diest, Andreas von Leupoldt, Martin P. Paulus, and the Interoception Summit 2016 participants

ABSTRACT

Interoception refers to the process by which the nervous system senses, interprets, and integrates signals originating from within the body, providing a moment-by-moment mapping of the body's internal landscape across conscious and unconscious levels. Interoceptive signaling has been considered a component process of reflexes, urges, feelings, drives, adaptive responses, and cognitive and emotional experiences, highlighting its contributions to the maintenance of homeostatic functioning, body regulation, and survival. Dysfunction of interoception is increasingly recognized as an important component of different mental health conditions, including anxiety disorders, mood disorders, eating disorders, addictive disorders, and somatic symptom disorders. However, a number of conceptual and methodological challenges have made it difficult for interoceptive constructs to be broadly applied in mental health research and treatment settings. In November 2016, the Laureate Institute for Brain Research organized the first Interoception Summit, a gathering of interoception experts from around the world, with the goal of accelerating progress in understanding the role of interoception in mental health. The discussions at the meeting were organized around four themes: interoceptive assessment, interoceptive integration, interoceptive psychopathology, and the generation of a roadmap that could serve as a guide for future endeavors. This review article presents an overview of the emerging consensus generated by the meeting.

Summary

1. Interoception is how you sense your health and feelings.
2. It is crucial for a number of cognitive processes, and has role in socio-emotional differences, sensory sensitivities and sleep issues.
3. Interoception is atypical in a greater number of the autistic population but maybe due to alexithymia.
4. There are things that can be done to improve interoception.