AUTISM in CONTEXT

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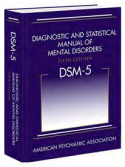
Are sensory issues in autism actually sensory?

The predictive mind, context and sensory issues in autism



DSM-5 criteria for autism spectrum disorders

An individual must meet criteria A, B, C and D:

A. Persistent deficits in social communication and social interaction across contexts, not accounted for by general developmental delays, and manifest by all 3 of the following:

1. Deficits in social-emotional reciprocity; ranging from abnormal social approach and failure of normal back and forth conversation through reduced sharing of interests, emotions, and affect and response to total lack of initiation of social interaction.
2. Deficits in nonverbal communicative behaviors used for social interaction; ranging from poorly integrated- verbal and nonverbal communication, through abnormalities in eye contact and body-language, or deficits in understanding and use of nonverbal communication, to total lack of facial expression or gestures.
3. Deficits in developing and maintaining relationships, appropriate to developmental level (beyond those with caregivers); ranging from difficulties adjusting behavior to suit different social contexts through difficulties in sharing imaginative play and in making friends to an apparent absence of interest in people

B. Restricted, repetitive patterns of behavior, interests, or activities as manifested by at least two of the following:

1. Stereotyped or repetitive speech, motor movements, or use of objects; (such as simple motor stereotypies, echolalia, repetitive use of objects, or idiosyncratic phrases).
2. Excessive adherence to routines, ritualized patterns of verbal or nonverbal behavior, or excessive resistance to change; (such as motoric rituals, insistence on same route or food, repetitive questioning or extreme distress at small changes).
3. Highly restricted, fixated interests that are abnormal in intensity or focus; (such as strong attachment to or preoccupation with unusual objects, excessively circumscribed or perseverative interests).
4. Hyper-or hypo-reactivity to sensory input or unusual interest in sensory aspects of environment; (such as apparent indifference to pain/heat/cold, adverse response to specific sounds or textures, excessive smelling or touching of objects, fascination with lights or spinning objects).

C. Symptoms must be present in early childhood (but may not become fully manifest until social demands exceed limited capacities)

D. Symptoms together limit and impair everyday functioning

J Autism Dev Disord (2009) 39:1–11
DOI 10.1007/s10803-008-0593-3

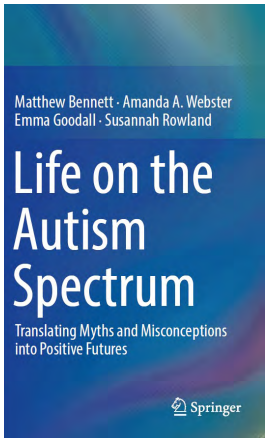
ORIGINAL PAPER

A Meta-Analysis of Sensory Modulation Symptoms in Individuals with Autism Spectrum Disorders

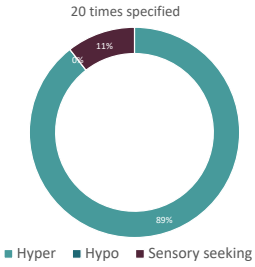
Ayelet Ben-Sasson · Liat Hen · Ronen Fluss · Sharon A. Cermak · Batya Engel-Yeger · Eynat Gal

autism

hyperreactivity | hyporeactivity | sensory seeking



Sensory issues



Hyporeactivity probably more autism specific

- Decreased responsivity to **pain** (Moore, 2014)
- Reduced detection of **temperature** (Duerden a.o., 2015)
- Reduced **odor** detection (Dudova a.o., 2011; Muratori a.o., 2017)
- Poorer identification of **flavours** (Bennetto a.o., 2007)

Important difference!

Hypersensitivity:

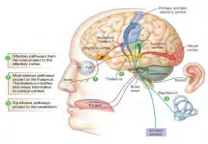
- Physiological response
- Sensory threshold

≠

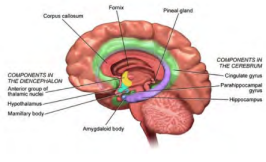
Hyperreactivity:

- Psycho-emotional / behavioural response

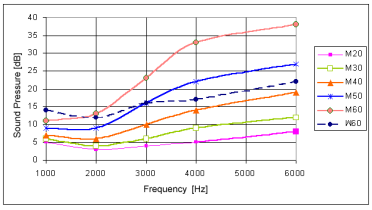
The Sensory System

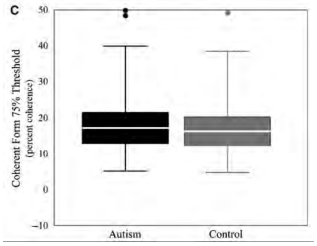


The Limbic System



No unambiguous, clear indications for difference in sensory thresholds in autism





Original Article

autism

Autism
1–14
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SAGE

Differentiating between sensory sensitivity and sensory reactivity in relation to restricted interests and repetitive behaviours

Samantha E Schulz and Ryan A Stevenson

Abstract

Recent studies have suggested that individuals who exhibit heightened sensitivity also exhibit higher rates and severity of restricted interests and repetitive behaviours. This line of research has been conducted almost exclusively through caregiver reports of sensitivity. Here, a more rigorous psychophysics paradigm was applied to assess sensory sensitivity and relate hypersensitivity to restricted interests and repetitive behaviours. In addition, commonly used questionnaire measures of sensory sensitivity were collected to determine if self-reported measures accurately reflect behavioural measures of sensory sensitivity. In all, 90 typically developing participants completed a visual detection task, a questionnaire measure of sensory processing and a measure of restricted interests and repetitive behaviours. Visual sensitivity, measured both behaviourally and with questionnaires, is positively related to restricted interests and repetitive behaviours. Surprisingly, visual sensitivity as measured behaviourally and through self-report are unrelated. Furthermore, a regression analysis suggests that while restricted interests and repetitive behaviours can be predicted based on both behavioural and self-reported sensitivity, these two predictors account for different portions of the variance in restricted interests and repetitive behaviours. Thus, while these results provide evidence supporting the contribution of sensory sensitivity to restricted interests and repetitive behaviours, these results also indicate that behavioural and questionnaire measures of sensory sensitivity are measuring two distinct constructs. We hypothesize that behavioural measures are measuring sensory *sensitivity*, while questionnaires measures are in fact measuring sensory *reactivity*.

https://doi.org/10.1007/s10803-019-03890-9

ORIGINAL PAPER

Check for updates

Stop Making Noise! Auditory Sensitivity in Adults with an Autism Spectrum Disorder Diagnosis: Physiological Habituation and Subjective Detection Thresholds

Marieke W. M. Kuiper[1,2] · Elisabeth W. M. Verhoeven[1] · Hilde M. Geurts[1,2]

Abstract

Auditory sensitivities are common among people with autism spectrum disorder diagnoses (ASD). As underlying factors are unknown, we examined whether ASD adults ($N_{ASD}=33$; $N_{Typically\ Developing}=31$; 25–45 years; IQ > 70): (1) habituated slower to auditory stimuli; (2) had lower auditory detection thresholds; and (3) whether these mechanisms related to self-reported auditory sensitivities. Two auditory stimuli (tone, siren) were repeated, whilst skin conductance responses were recorded to measure habituation. Detection thresholds were measured by stepwise reductions in tone volume. We found no evidence in favor of our hypotheses, but ASD adults did rate the auditory stimuli as more arousing. Based on explorative analyses, we argue that studying the strength of physiological responses to auditory stimuli is needed to understand auditory sensitivities.

Hammill Institute on Disabilities

Focus on Autism and Other Developmental Disabilities
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DOI: 10.1177/1088357610364530
http://focus.sagepub.com
SAGE

Understanding Sound Sensitivity in Individuals with Autism Spectrum Disorders

Lillian N. Stiegler[1] and Rebecca Davis[1]

Abstract

Literature on sound sensitivity in individuals with and without autism spectrum disorders (ASD) is reviewed in this article. Empirical evidence is examined, and physiologic and psychoemotional-behavioral perspectives are described. There is virtually no evidence of true physiological differences in auditory systems of individuals with ASD. It is evident, however, that many people with ASD (a) feel fearful and anxious about sound, and (b) may experience unpleasant physiological sensations because of autonomic and/or behavioral responses to nonpreferred sounds, but (c) can learn to react in less stigmatizing, more effectively self-regulating ways. Current assessment and intervention practices are discussed, and a case is presented. Heightened understanding of this issue among caregivers and interventionists may ultimately improve life participation for individuals with ASD.

Hammill Institute on Disabilities

Focus on Autism and Other Developmental Disabilities
28(3) 184–191
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DOI: 10.1177/1088357613475810
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SAGE

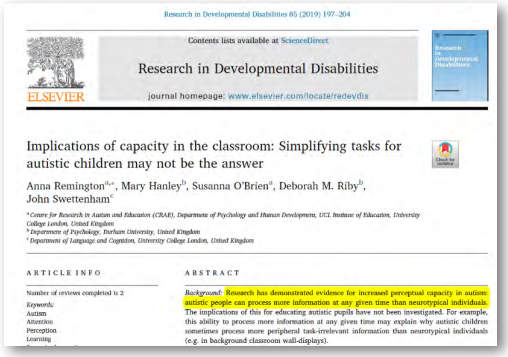
Auditory Hypersensitivity in Children With Autism Spectrum Disorders

ay R. Lucker, EdD[1]

Abstract

A review of records was completed to determine whether children with auditory hypersensitivities have difficulty tolerating loud sounds due to auditory-system factors or some other factors not directly involving the auditory system. Records of 150 children identified as not meeting autism spectrum disorders (ASD) criteria and another 50 meeting that criteria were reviewed. All participants had normal hearing. Tolerance was measured up to 110 dBHL. Findings revealed a smaller-than-expected percentage of children were unable to tolerate loud sounds. The conclusion drawn is that auditory hypersensitivity is not based in the auditory system, but rather is a conditioned response to sounds perceived as aversive or annoying. Treatments for auditory hypersensitivity should not be auditory based but should include desensitization training. Implications for practice are provided.

Probably even increased perceptual capacity



Research in Developmental Disabilities 85 (2019) 197–204

Contents lists available at ScienceDirect

Research in Developmental Disabilities

journal homepage: www.elsevier.com/locate/redevdis

ELSEVIER

Implications of capacity in the classroom: Simplifying tasks for autistic children may not be the answer

Anna Remington[a,*], Mary Hanley[a], Susanna O'Brien[a], Deborah M. Riby[b], John Swettenham[c]

[a] Centre for Research in Autism and Education (CRAE), Department of Psychology and Human Development, UCL Institute of Education, University College London, United Kingdom
[b] Department of Psychology, Durham University, United Kingdom
[c] Department of Language and Cognition, University College London, United Kingdom

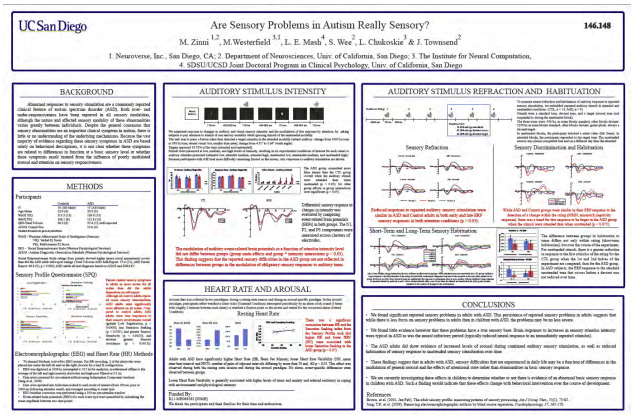
ARTICLE INFO

Number of reviews completed is 2

Keywords:
Autism
Attention
Perception
Learning

ABSTRACT

Background: Research has demonstrated evidence for increased perceptual capacity in autism: autistic people can process more information at any given time than neurotypical individuals. The implications of this for educating autistic pupils have not been investigated. For example, this ability to process more information at any given time may explain why autistic children sometimes process more peripheral task-irrelevant information than neurotypical individuals (e.g. in background classroom wall-displays).



Are sensory issues really sensory?

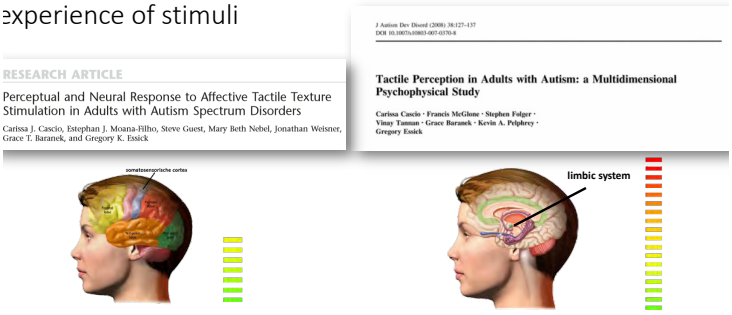
CONCLUSIONS

- We found significant reported sensory problems in adults with ASD. This persistence of reported sensory problems in adults suggests that while there is less focus on sensory problems in adults than in children with ASD, the problems may be no less severe.
- We found little evidence however that these problems have a true sensory base. Brain responses to increases in sensory stimulus intensity were typical in ASD as was the neural refractory period (typically reduced neural response to an immediately repeated stimulus).
- The ASD adults did show evidence of increased levels of arousal during continued auditory sensory stimulation, as well as reduced habituation of sensory response to unattended sensory stimulation over time.
- These findings suggest that in adults with ASD, sensory difficulties that are experienced in daily life may be a function of differences in the modulation of general arousal and the effects of attentional state rather than abnormalities in basic sensory response.
- We are currently investigating these effects in children to determine whether or not there is evidence of an abnormal basic sensory response in children with ASD. Such a finding would indicate that these effects change with behavioral intervention over the course of development.

References

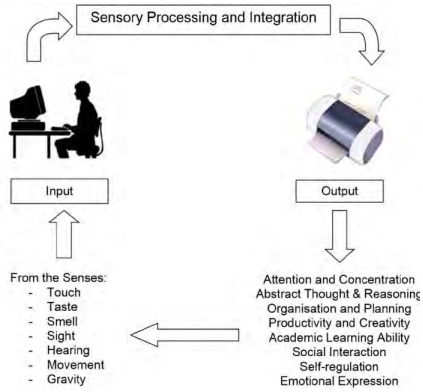
Brown, et al. (2001, Jan-Feb). The adult sensory profile: measuring patterns of sensory processing. *Am J Occup Ther.*, 55(1), 75-82.
Jung, T.P., et al. (2000). Removing electroencephalographic artifacts by blind source separation. *Psychophysiology, 37*, 163-178.

No stronger sensory response, but stronger experience of stimuli



Interventions should focus on the limbic system, rather than on the sensory system …

Our ideas about sensory issues are based on the old computer metaphor



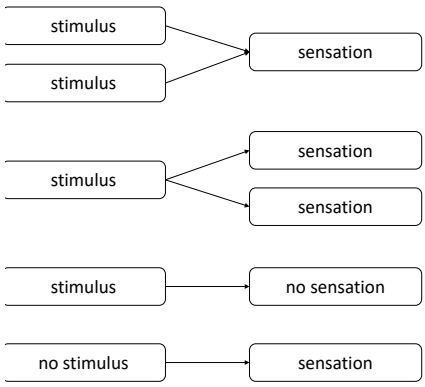
The brain does *not* process stimuli, only what is different from the stimuli it predicted…

Why so complicated?

Bayesian brain:

Working with probabilities is appropriate in situations that are uncertain

The input coming from the senses is unreliable!



EXAMPLE:

Color is in your brain: Tomato is not always red, yet you 'see' red

Color is in your brain: you can see the same color as two different colors

The dancing gorilla you don't see

Hallucinations, phantom pain, illusions e.g.**Rubber Hand** illusion

The brain does not receive sensory input, it predicts it and processes the prediction errors

Predictability plays a major role in sensory issues

REVIEW NEUROREPORT

Why can't you tickle yourself?

Sarah-Jayne Blakemore,[CA] Daniel Wolpert and Chris Frith

Wellcome Department of Cognitive Neurology, Institute of Neurology, University College London, 12 Queen Square, London WC1N 3BG, UK

[CA]Corresponding Author

Hyperresponsivity:
reduced habituation in autism because of **reduced predictivity** (Turi et al., 2015)

Children with autism spectrum disorder show reduced adaptation to number

Marco Turi[a,b], David C. Burr[b,c], Roberta Igliozzi[d], David Aagten-Murphy[a], Filippo Muratori[d,1], and Elizabeth Pellicano[a,b,1]

"A key determinant of habituation is stimulus predictability.
... **a lack of predictability** would compromise habituation and lead to hypersensitivity."
(Sinha et al., 2014)

Autism as a disorder of prediction

Pawan Sinha[a,1], Margaret M. Kjelgaard[a,b], Tapan K. Gandhi[a,c], Kleovoulos Tsourides[a], Annie L. Cardinaux[a], Dimitrios Pantazis[a], Sidney P. Diamond[d], and Richard M. Held[a,1]

[a]Department of Brain and Cognitive Sciences, Massachusetts Institute of Technology, Cambridge, MA 02139; [b]Department of Communication Sciences and Disorders, Massachusetts General Hospital Institute of Health Professions, Boston, MA 02129; and [c]Department of Biomedical Engineering, Defense Institute of Physiology and Allied Sciences, New Delhi, India DL 110054

Psychological Review
2014, Vol. 121, No. 4, 649–675

0033-295X/14/$12.00 http://dx.doi.org/10.1037/a0037665

Precise Minds in Uncertain Worlds: Predictive Coding in Autism

Sander Van de Cruys, Kris Evers, Ruth Van der Hallen, Lien Van Eylen, Bart Boets, Lee de-Wit, and Johan Wagemans
KU Leuven

e.g., under the form of enhanced discomfort to bright light; Kern et al., 2001). When the gain of the neural units representing the prediction errors is fixed at a high level, it is easy to see that hypersensitivity becomes very likely, especially for unexpected input, as is the case in ASD. Overweighting of irrelevant prediction errors causes sensory overload.

Seeing that unpredictability is at the core of the sensory overload, we can also attempt to explain its negative affective impact. Uncertainty has long been identified as a factor that intensifies stress and anxiety (Herry et al., 2007; Miller, 1981). In addition to leading to increased stress and anxiety, persistent significant prediction errors may actually by themselves generate negative affect (Huron, 2006; Van de Cruys & Wagemans, 2011). When prediction theories (Chevallier et al., 2012) that this is an important aggravating factor in the syndrome. Indeed, social interactions are not perceived to be that enjoyable or rewarding in individuals with ASD (Chevallier et al., 2012). Unsurprisingly, a lot of interventions focus on increasing the reward of social interactions. If social situations are avoided from early on in life, the number of social learning experiences decreases, and so, in a vicious circle, even more social impairments ensue.

Taken together, these factors arguably make individuals with ASD more vulnerable to mood and anxiety problems, which are indeed overrepresented in ASD (Kim, Szatmari, Bryson, Streiner, & Wilson, 2000). Hence, mood problems, anxiety, and anxious avoidance should in our view be considered as secondary symp-

RESEARCH ARTICLE

Tactile Hypersensitivity and GABA Concentration in the Sensorimotor Cortex of Adults with Autism

Laurie-Anne Sapey-Triomphe, Franck Lamberton, Sandrine Sonié, Jérémie Mattout, and Christina Schmitz

Sensory hypersensitivity is frequently encountered in autism spectrum disorder (ASD). Gamma-aminobutyric acid (GABA) has been hypothesized to play a role in tactile hypersensitivity. The aim of the present study was twofold. First, as a study showed that children with ASD have decreased GABA concentrations in the sensorimotor cortex, we aimed at determining whether the GABA reduction remained in adults with ASD. For this purpose, we used magnetic resonance spectroscopy to measure GABA concentration in the sensorimotor cortex of neurotypical adults (n = 19) and ASD adults (n = 18). Second, we aimed at characterizing correlations between GABA concentration and tactile hypersensitivity in ASD. GABA concentration in the sensorimotor cortex of adults with ASD was lower than in neurotypical adults (decrease by 17%). Interestingly, GABA concentrations were positively correlated with self-reported tactile hypersensitivity in adults with ASD (r = 0.50, P = 0.01), but not in neurotypical adults. In addition, GABA concentrations were negatively correlated with the intra-individual variation during threshold measurement, both in neurotypical adults (r = −0.47, P = 0.04) and in adults with ASD (r = −0.59, P = 0.01). In other words, in both groups, the higher the GABA level, the more precise the tactile sensation. These results highlight the key role of GABA in tactile sensitivity, and suggest that atypical GABA modulation contributes to tactile hypersensitivity in ASD. We discuss the hypothesis that hypersensitivity in ASD could be due to suboptimal predictions about sensations. ***Autism Research*** *2019.* © 2019 International Society for Autism Research, Wiley Periodicals, Inc.

Autism, CONTEXT and predictions

COGNITIVE NEUROSCIENCE
https://doi.org/10.1080/17588928.2019.1593126

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COMMENTARY

Check for updates

Sensory sensitivity in autism mostly depends on contextual predictions

Laurie-Anne Sapey-Triomphe, Thiago Leiros Costa and Johan Wagemans

Laboratory of Experimental Psychology, Department of Brain and Cognition, Leuven Brain Institute, KU Leuven, Leuven, Belgium

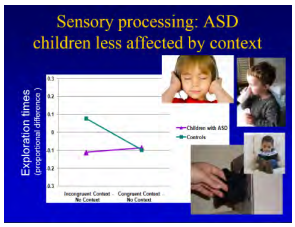
ABSTRACT
A signal detection theory was elaborated in order to account for three types of sensory sensitivity (subjective, behavioral and neural) in neurotypical individuals and in autism. Here, we argue that the predictive coding framework could better account for the atypical pattern of sensory sensitivity in autism. We review the idea that sensory sensitivity should be considered as mostly depending on contextual predictions and that these account for the heterogeneous pattern of neural responses.

ARTICLE HISTORY
Received 8 February 2019
Published online 21 March 2019

KEYWORDS
Autism spectrum disorder; predictive coding; sensory sensitivity; hypersensitivity; predictions; inflexibility

Sensory issues, **context** and predictions

- Steph Lietz & Francesca Happé



What defines your sensory reactivity?

SENSORY INPUT

(UN)CERTAINTY

PREDICTIONS
(prior beliefs)

We cannot avoid prediction errors

That's why the brain uses a **variable precision** of its own predictions

Sometimes, it must be precise
Sometimes, good enough is OK

Autism and the predictive brain

HIPPEA:
High, Inflexible Precision of Prediction Errors in Autism
(Van de Cruys e.a., 2013, 2014)

Precise Minds in Uncertain Worlds: Predictive Coding in Autism

Sander Van de Cruys, Kris Evers, Ruth Van der Hallen, Lien Van Eylen, Bart Boets, Lee de-Wit, and Johan Wagemans
KU Leuven

Autism and the predictive mind: context!

- In autism, there seems to be a problem with predictions, the precision of input and priors, and the handling of prediction errors.
- There's a deficit in the flexible adjustment of predictions and their precision in function of context

Hypothesis Palmer, Lawson, Hohwy (2017)

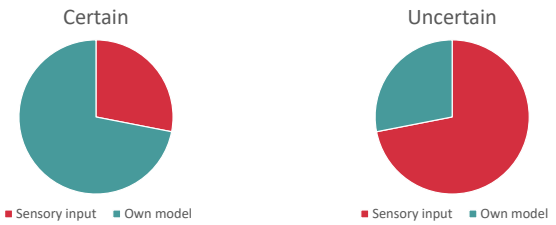
Psychological Bulletin

Bayesian Approaches to Autism: Towards Volatility, Action, and Behavior

Colin J. Palmer, Rebecca P. Lawson, and Jakob Hohwy
Online First Publication, March 23, 2017. http://dx.doi.org/10.1037/bul0000097

The autistic brain *treats* sensory information as being more informative (relative to prior information) when estimating the state of the environment.

The relative weight you give to the sensory input and predictions depends on the context



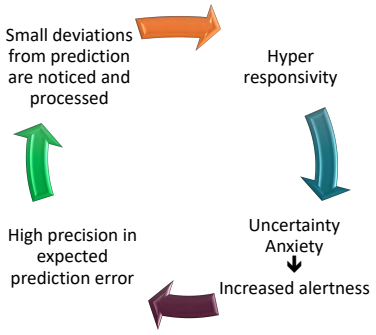
How much weight you give to a prediction error depends on the certainty about your model of the world and the predictions based o that model (Lawson, Mathys & Rees, 2017)

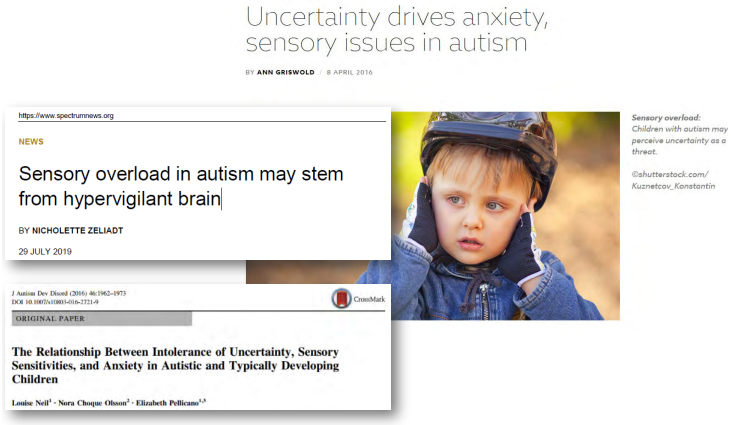
Precision determines the filter in our brain

sensory input

prediction (prior beliefs)

Sensory or anxiety and uncertainty?





Strategies for sensory issues: traditional way

But from **Hyperacusis – Tinnitus** we learned:

- Do not eliminate sounds, but make sounds predictable and controllable :
- Working on '**feedforward**' (*prediction*) instead of 'feedback' (*stimulus*)

We need to 'feed' the brain so it can update its models and reduce the prediction errors

(prediction errors = stress / unpleasant)

Predictability, not repetition leads to habituation

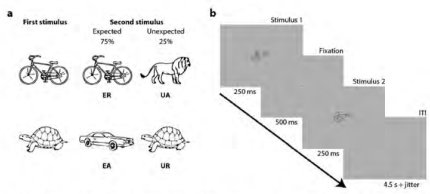


Fig. 1 – Perceptual expectations paradigm. (a) Examples of fixed stimulus pairings. During a practice task, participants implicitly learned that some stimuli are most likely to repeat, whereas others are most likely to alternate, thus creating expected repetitions (ER) and expected alternations (EA), as well as unexpected repetitions (UR) and unexpected alternations (UA). (b) Stimulus display, here showing an expected repetition (ER) trial. In the behavioural discrimination task, participants responded to the category of the second stimulus (vehicle or animal) during the inter-trial interval (ITI). During the fMRI task, participants responded to occasional targets (17.4% of trials) in which the stimulus was shown at 60% of its normal size.

Again…context

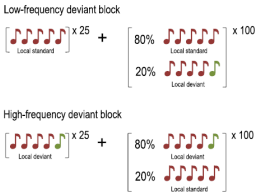

Archival Report

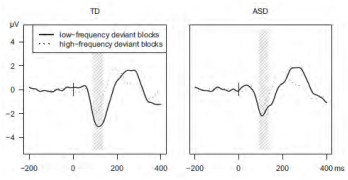
Biological Psychiatry: CNNI

Sensory Prediction Errors Are Less Modulated by Global Context in Autism Spectrum Disorder

Judith Goris, Senne Braem, Annabel D. Nijhof, Davide Rigoni, Eliane Deschrijver, Sander Van de Cruys, Jan R. Wiersema, and Marcel Brass

Mismatch negativity P3b





Strategies for sensory issues?

Tackle the prediction errors!

Changing prediction → Giving control → Changing stimulus → Stress coping

- Predictability in (changes) in sensory environment
- Contextual clarifying of stimuli:
  PUSH THE CONTEXT BUTTON
- Changing the brains model of the world

Strategies for sensory issues?

Tackle the prediction errors!

Changing prediction → Giving control → Changing stimulus → Stress coping

- Knowing how to 'control' the stimulus
- Generating a competitive stimulus (*again: predictability!*)

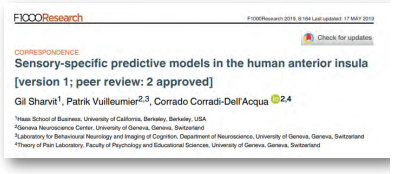
Reduce stress by optimistic predictions

The insular cortex does not only respond to pain but to a wide range of aversive events.

"This will be bad" leads to the same predictive information as "this will hurt"

This will be bad → stress ↗ → sensory overload

This will be good → stress ↘ → no sensory overload


F1000Research

Check for updates

CORRESPONDENCE

Sensory-specific predictive models in the human anterior insula

[version 1; peer review: 2 approved]

Gil Sharvit[1], Patrik Vuilleumier[2,3], Corrado Corradi-Dell'Acqua[2,4]

The importance of control

Perception, 2015, volume 44, pages 569–586

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The sensory experiences of adults with autism spectrum disorder: A qualitative analysis

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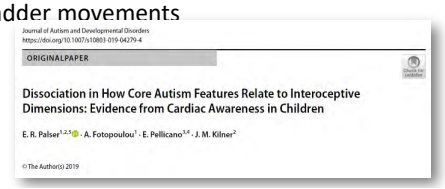
Abstract. It has been well established that individuals with autism spectrum disorder report unusual experiences with sensory stimuli compared with typically developing individuals. However, there is a paucity of research exploring the nature of such experiences. A focus group was conducted with six adults with a diagnosis of autism or Asperger syndrome. Data were coded and analysed using an inductive, qualitative thematic analysis. Four main themes encompassing both positive and negative sensory experiences emerged from these data: (a) the importance of particular aspects of stimuli in their perception, (b) the importance of having control over stimuli, (c) how emotions/mental states could impact/be impacted by sensory stimuli, and (d) physical responses to stimuli. These data are discussed alongside extant literature. Limitations, possible implications, and potential directions of future research are also discussed.

Keywords: autism spectrum disorders, sensory, qualitative, focus group

And what about **hypo**reactivity?

- **Interoception** is affected in autism
- Lower cardiac awareness (Palser e.a., 2019)
- Lack of awareness of hunger, thirst, pain and the need to make bowel or bladder movements



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ORIGINALPAPER

Dissociation in How Core Autism Features Relate to Interoceptive Dimensions: Evidence from Cardiac Awareness in Children

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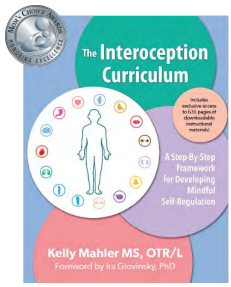
Hyporeactivity in interoception

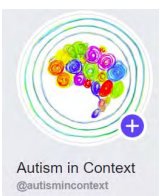
- The outside world is so stressful that the hypervigilant brain does not have time and energy to process the predictions and prediction errors regarding the inner world
- Overestimation of own interoceptive abilities (too certain about one's own interoceptive sensibility)
- Link with anxiety!
  - Anxiety (but also depression) linked to alexithymia
- Autistic brains have not learned to read their own body
- Recognizing inner body signals requires contextual sensitivity



Conclusion

- Take the stress / discomfort caused by sensory environment seriously
- Address the stress and the arousal rather than the stimuli
- Address the prediction-errors: reduce uncertainty, not stimuli
  - Make the sensory environment more predictable
  - Clarify the sensory environment
  - Give information about sensory environment
- Empowering approach: not avoiding, but coping
  - No "one size fits all" interventions
  - Give (feeling of) control over the sensory environment
  - Teach how to survive sensory stress

Thank you very much for your attention!



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