AUTISM in CONTEXT

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Are sensory issues in autism actually sensory?

The predictive mind and sensory issues in autism

Experience: sensory discomfort

↳ Valid

Explanation: possible causes

Intervention: possible solutions

↳ ????

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

ORIGINAL PAPER

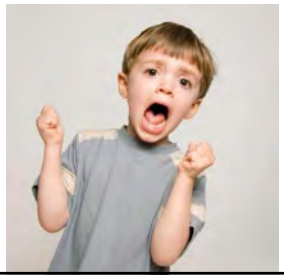
A Meta-Analysis of Sensory Modulation Symptoms in Individuals with Autism Spectrum Disorders

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

autism

SOR (over) | SUR (under) | SSB (seeking)





Experience: sensory overload & discomfort

Explanation: hypersensitive to stimuli

It is sensory!

Intervention: *reduce or eliminate stimuli*

How to cope with sensory overload

If you know that your senses get overwhelmed and trigger sensory overload, you can cope with the condition by recognizing your triggers. It might take some time, but work to understand what your sensory overload experiences have in common.

Some people are more triggered by noises, while others are triggered by pulsing lights and large crowds.

You can try to avoid triggers of sensory overload once you know what causes it for you. You may also want to do the same activities and attend the same events that you would if you didn't have this condition.

You can be proactive about sensory overload by thinking creatively about how to reduce sensory input when you're in triggering situations.

Asking for the lights or music to be turned down and closing doors to limit noise pollution when you enter a social gathering are preemptive steps you can take before se in. Other tips include the following:

Reduce

or

Avoid

Sensory input

Sensory overload

What is it?

Autistic people can be sensitive to lights, sounds, smells and sights. This can lead to an overload – and a meltdown.

What can I do?

Make some space. Lots of little things can add up to an overload of sensory information. Which means little things from you can cut this down- try to avoid talking over each other, turn down your music, or even just offer to dim glaring lights.

Important difference!

Hypersensitivity:
(Überempfindlichkeit – Hypersensitivität)

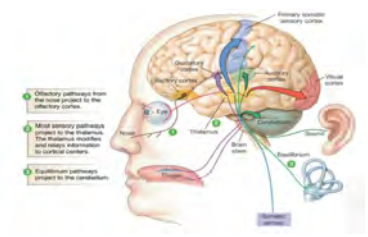
- Physiological response
- Sensory threshold

≠

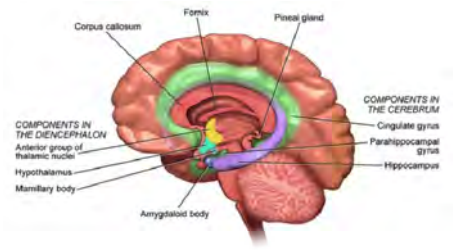
Hyperreactivity:
(Hyperreaktivität)

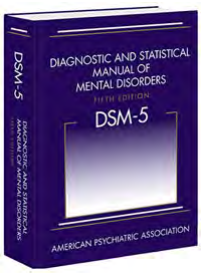
- Psycho-emotional / behavioural response

The Sensory System



The Limbic System





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

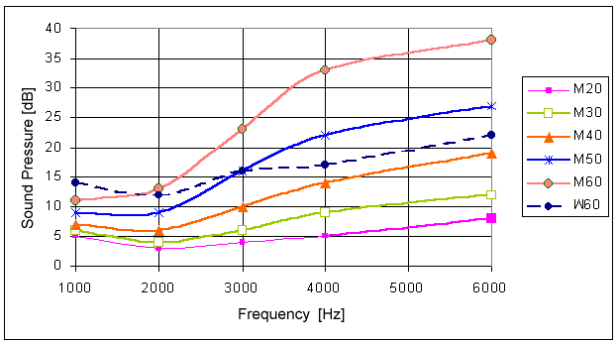
B. Restricted, repetitive patterns of behavior, interests, or activities as manifested by at least two of the following:

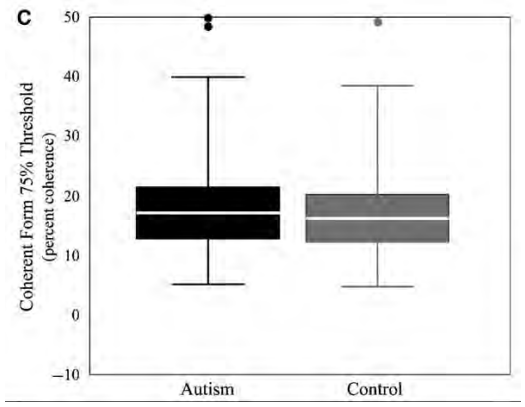
1. Stereotyped or repetitive speech, motor movements, or use of objects; (such as simple motor stereotypies, echolalia, repetitive use of objects, or idiosyncratic phrases).
2. Excessive adherence to routines, ritualized patterns of verbal or nonverbal behavior, or excessive resistance to change; (such 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

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





Hammill Institute on Disabilities

Focus on Autism and Other Developmental Disabilities
25(2) 67–75

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.

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
28(3) 184–191

DOI: 10.1177/1088357613475810
focus.sagepub.com
SAGE

Auditory Hypersensitivity in Children With Autism Spectrum Disorders

Jay R. Lucker, EdD[1]

Abstract

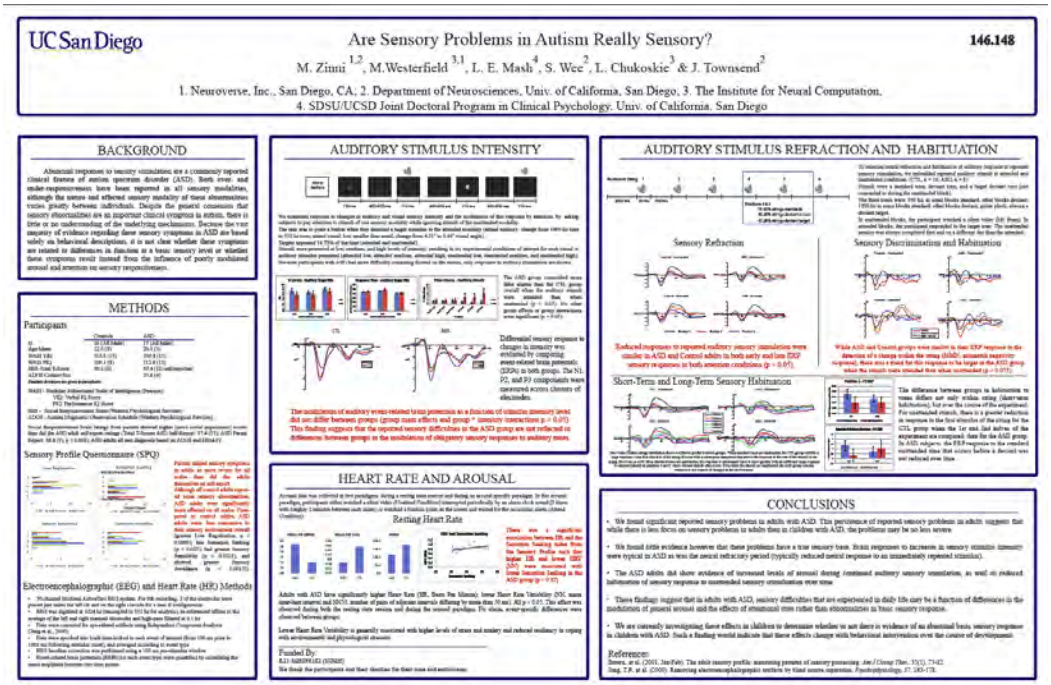
A review of records was completed to determine whether children with auditory hypersensitivities have difficulty tolerating loud sounds due to auditory-system factors or some other factors not directly involving the auditory system. Records of 150 children identified as not meeting autism spectrum disorders (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.

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

Kuiper, M. W., Verhoeven, E. W., & Geurts, H. M. (2019). Stop making noise! Auditory sensitivity in adults with an autism spectrum disorder diagnosis: physiological habituation and subjective detection thresholds. *Journal of Autism and Developmental Disorders*, *49*(5), 2116-2128.

Stiegler, L. N., & Davis, R. (2010). Understanding sound sensitivity in individuals with autism spectrum disorders. *Focus on Autism and Other Developmental Disabilities*, *25*(2), 67-75.

Lucker, J. R. (2013). Auditory hypersensitivity in children with autism spectrum disorders. *Focus on Autism and Other Developmental Disabilities*, *28*(3), 184-191.



UC San Diego

Are Sensory Problems in Autism Really Sensory? 146.148

M. Zinni [1,2], M.Westerfield [3,1], L. E. Mash [4], S. Wee [2], L. Chukoskie [3] & J. Townsend [2]

1. Neuroverse, Inc., San Diego, CA; 2. Department of Neurosciences, Univ. of California, San Diego, 3. The Institute for Neural Computation, 4. SDSU/UCSD Joint Doctoral Program in Clinical Psychology, Univ. of California, San Diego

BACKGROUND

METHODS

Participants

Sensory Profile Questionnaire (SPQ)

Electroencephalographic (EEG) and Heart Rate (HR) Methods

AUDITORY STIMULUS INTENSITY

AUDITORY STIMULUS REFRACTION AND HABITUATION

Sensory Refraction

Sensory Discrimination and Habituation

Short-Term and Long-Term Sensory Habituation

HEART RATE AND AROUSAL

Resting Heart Rate

Funded By:

CONCLUSIONS

References:

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

J Autism Dev Disord (2008) 38:127–137
DOI 10.1007/s10803-007-0370-8

RESEARCH ARTICLE

Perceptual and Neural Response to Affective Tactile Texture Stimulation in Adults with Autism Spectrum Disorders

Carissa J. Cascio, Estephan J. Moana-Filho, Steve Guest, Mary Beth Nebel, Jonathan Weisner, Grace T. Baranek, and Gregory K. Essick

Tactile Perception in Adults with Autism: a Multidimensional Psychophysical Study

Carissa Cascio · Francis McGlone · Stephen Folger · Vinay Tannan · Grace Baranek · Kevin A. Pelphrey · Gregory Essick

RESEARCH ARTICLE

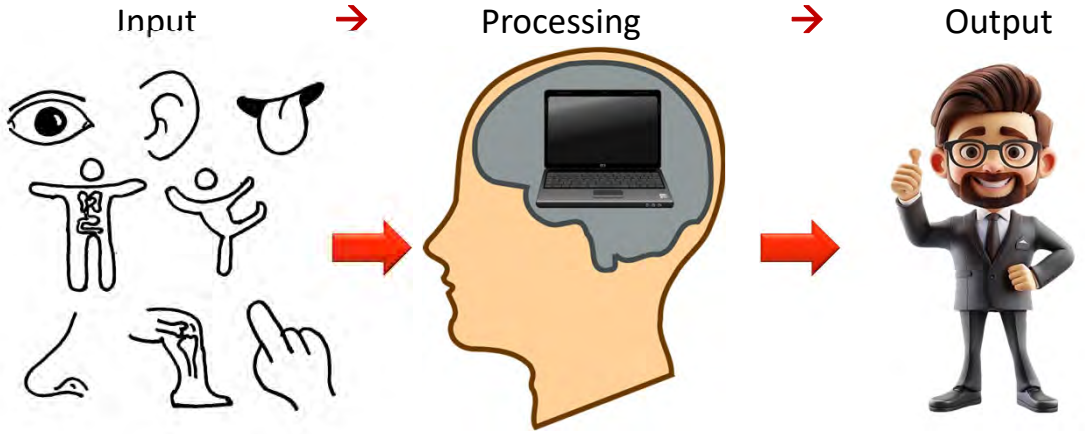
Tactile Hypersensitivity and GABA Concentration in the Sensorimotor Cortex of Adults with Autism

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

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

Standard idea about the brain

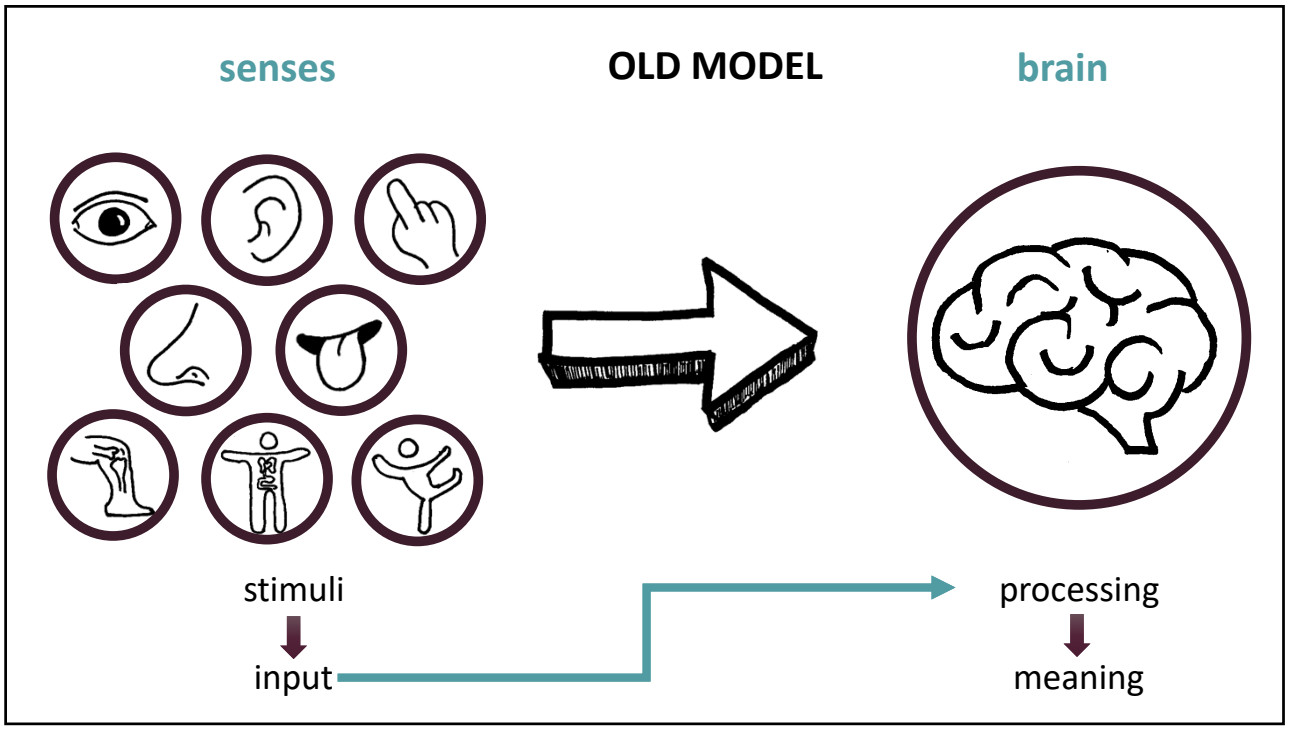
Computational analogy

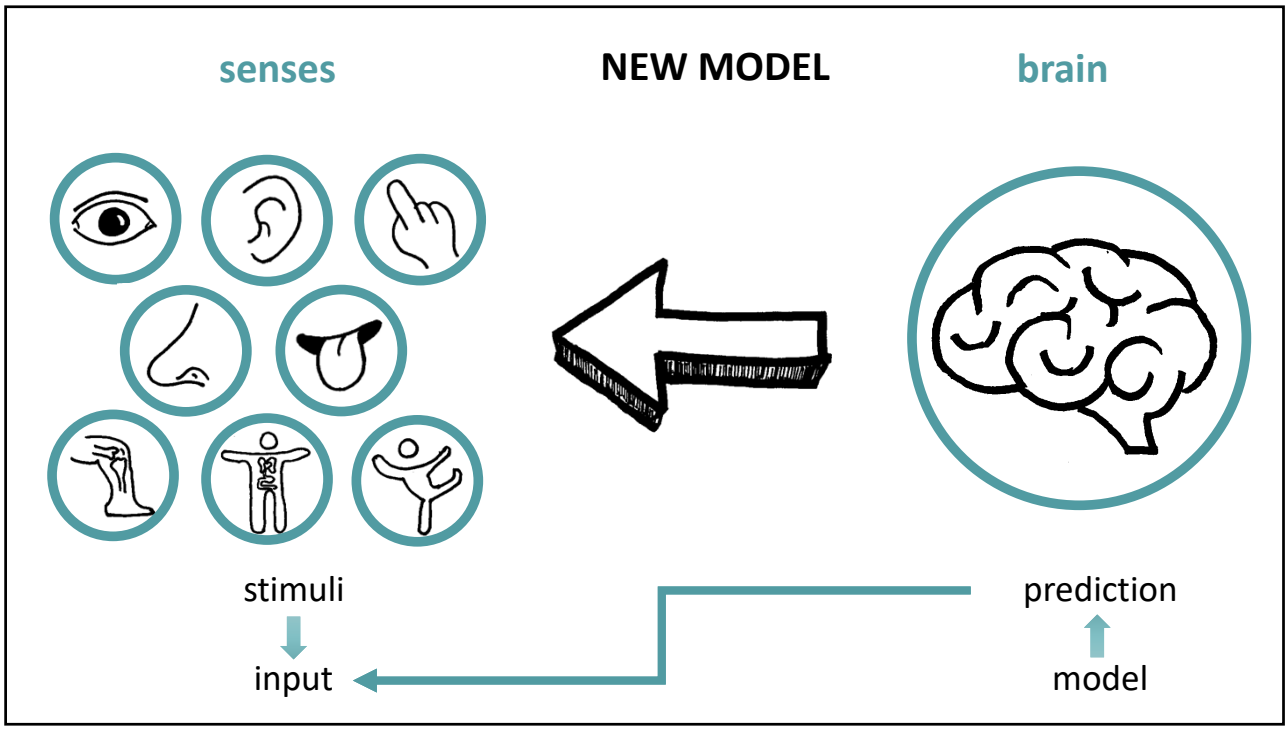


Perception	→	Cognition	→	Action
Stimulus (Reiz)	→	Verarbeiting	→	Response (Reaktion)

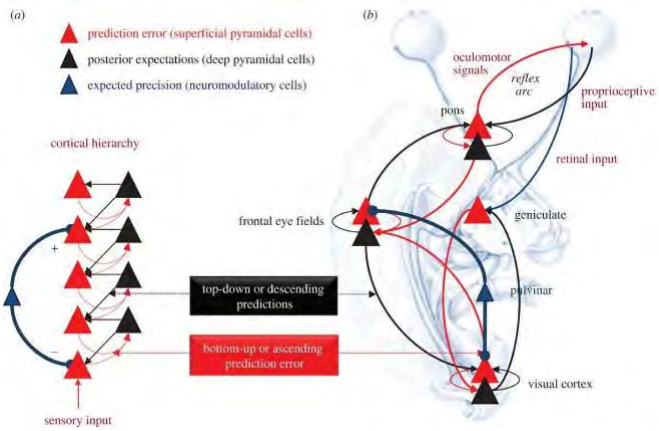
What's wrong with the stimulus-response model of the brain

- Sense making is not just integrating all the details of the sensory input
- So, the brain does not wait until it gets input, the brain anticipates (predicts) the input by making smart guesses
- And it can make smart guesses because it uses context,
- This is known as: **the predictive mind**





The brain does not process stimuli, only what is different from the stimuli it predicted: prediction errors.



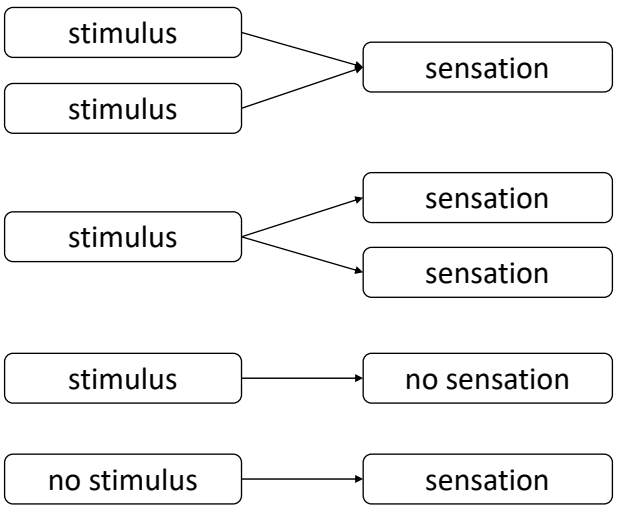
From *The Lancet*

Prediction errors

- The brain has only one goal:
  helping us to survive by minimizing prediction errors
- The brain doesn't like prediction errors (they cause stress)
- The brain knows it cannot avoid all prediction errors.
  Therefore, it uses **a variable precision** in handling prediction errors

Depending on the **context** the brain will treat a prediction error as noise (irrelevant) or signal (relevant)

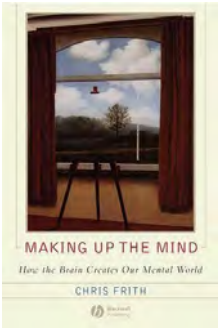
Sensory input is highly unreliable



Perception is controlled hallucinating.

We don't see the world, but our model of the world.

Our perception of the world is an **illusion** that (in most cases, fortunately) coincides with reality.



Chris Frith

Sensory input is not the most important

In terms of neural connections, only 10% of the information our visual brain uses comes from the eyes.

The rest comes from other parts of the brain: **90%.**

Autism, the predictive mind and context

- In autism the flexible adjustment in function of context of predictions and the weight given to prediction error seems to be affected
- **HIPPEA**:
  High, Inflexible Precision of Prediction Errors in Autism
  (Van de Cruys a.o., 2013, 2014)

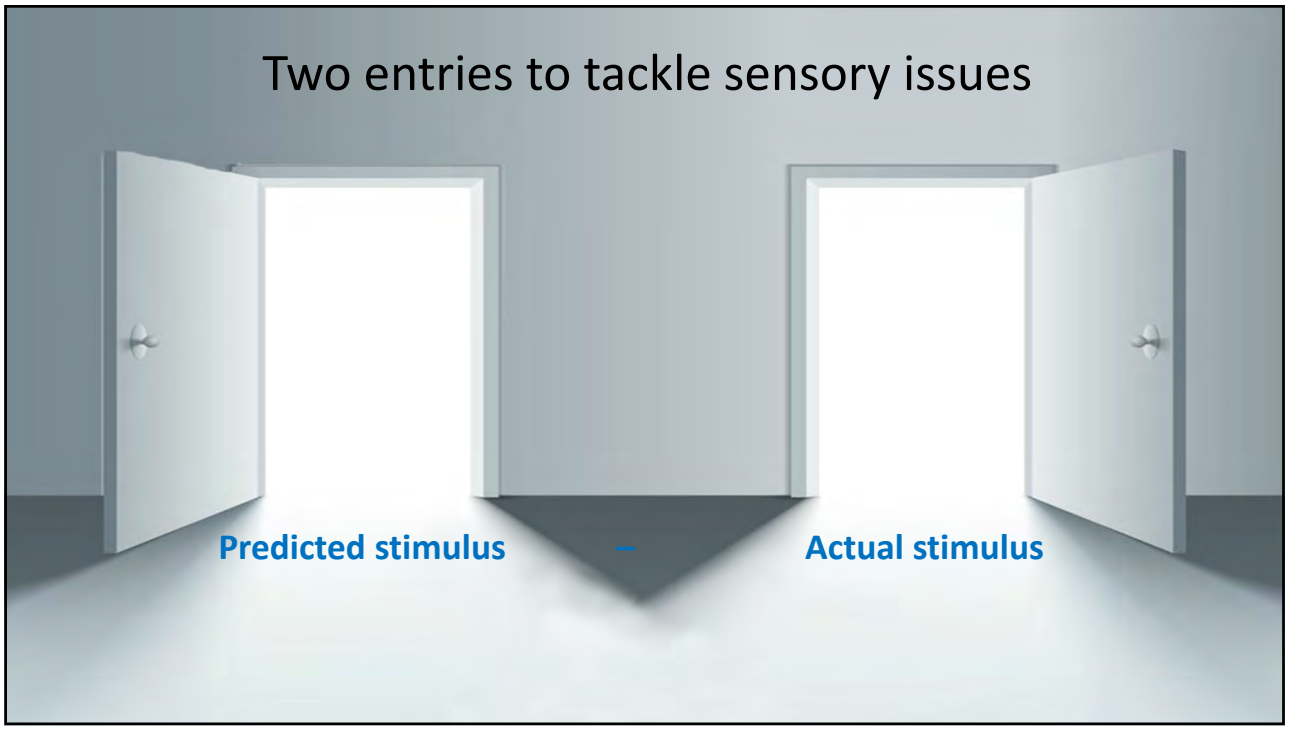
Psychological Review
2014, Vol. 121, No. 4, 649–675

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

Two entries to tackle sensory issues



Psychological Review
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Precise Minds in Uncertain Worlds: Predictive Coding in Autism

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(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-

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

CrossMark

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,f], and Elizabeth Pellicano[c,g,f]

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

CrossMark

Autism as a disorder of prediction

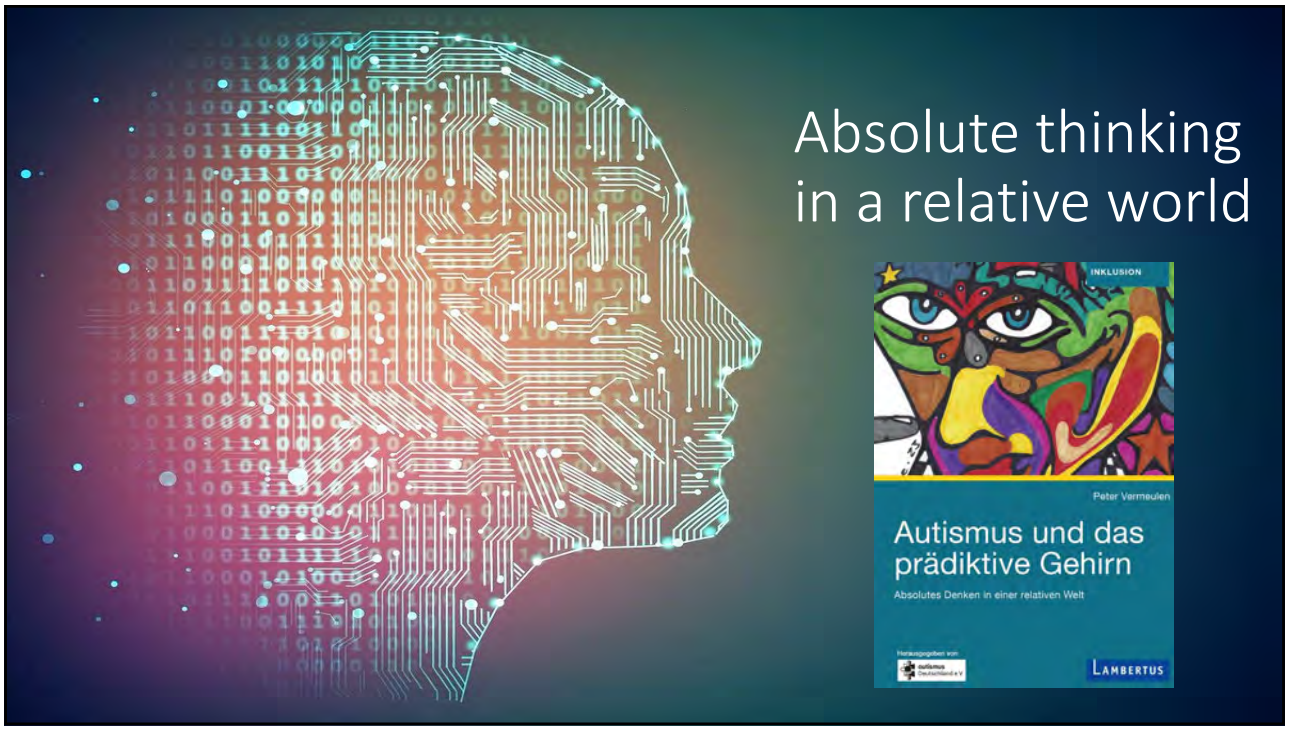
Pawan Sinha[a,1], Margaret M. Kjelgaard[a,b], Tapan K. Gandhi[a,c], Kleovoulos Tsourides[a], Annie L. Cardinaux[a], Dimitrios Pantazis[a], Sidney P. Diamond[a], and Richard M. Held[a,1]

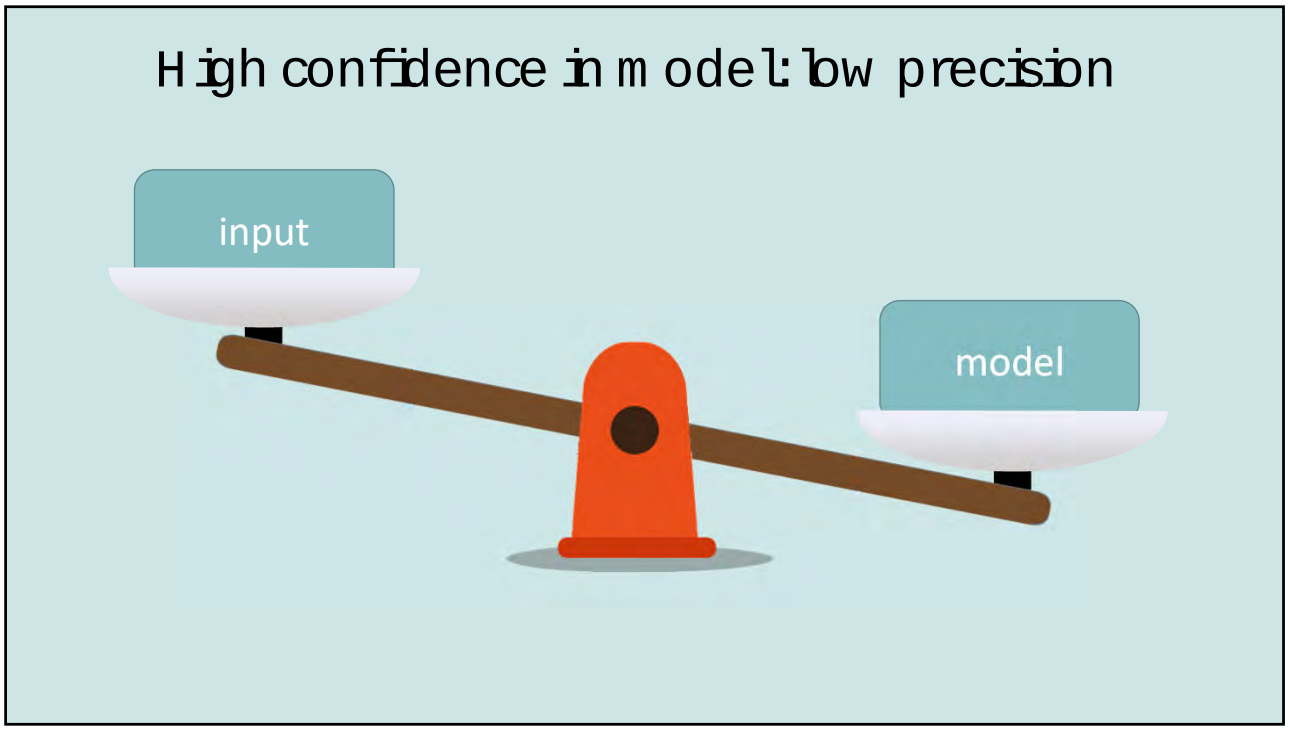
[a]Department of Brain and Cognitive Sciences, Massachusetts Institute of Technology, Cambridge, MA 02139; [b]Department of Communication Sciences and Disorders, Massachusetts General Hospital Institute of Health Professions, Boston, MA 02129; and [c]Department of Biomedical Engineering, Defense Institute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

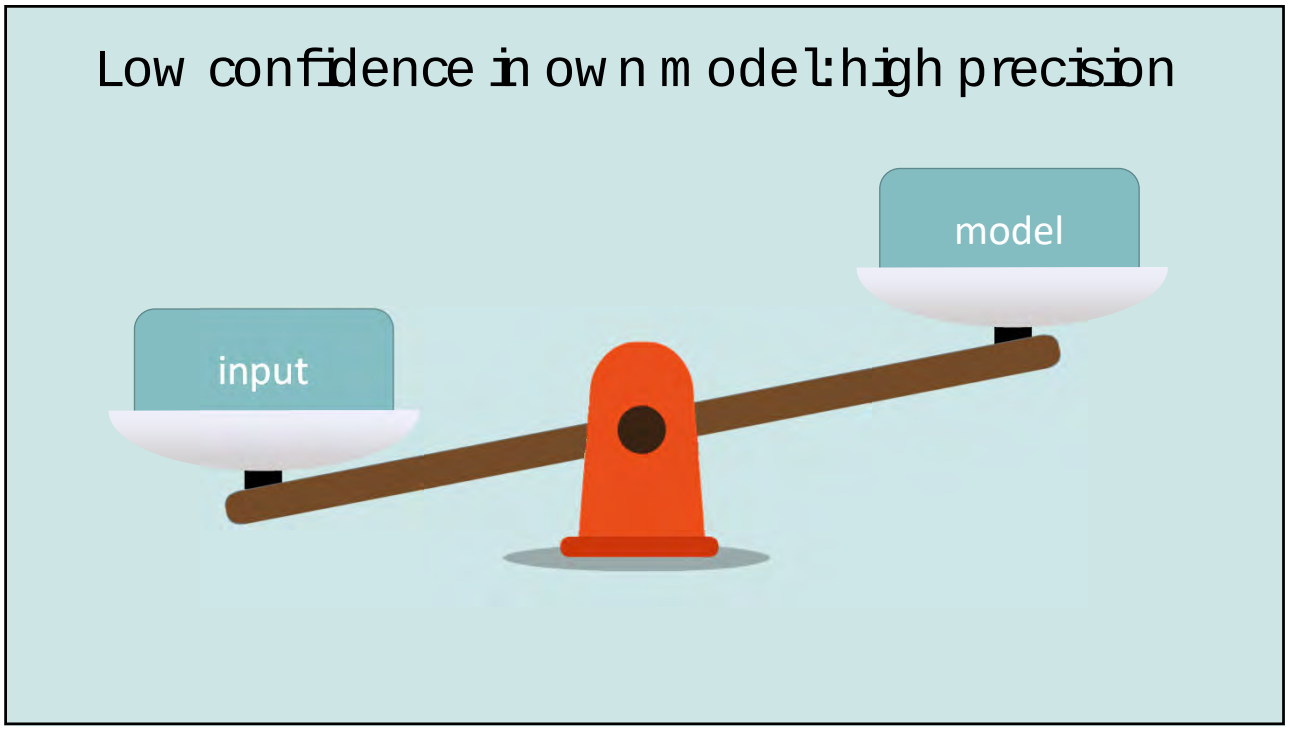
. I'm sensitive to sounds. Loud sounds. Sudden sounds. Worse yet, loud and sudden sounds I don't expect. Worst of all, loud and sudden sounds I *do* expect but cannot control — a common problem in people with autism. Balloons terrified me as a child, because I didn't know when they were going to pop.

Today I know that if I had been able to pop balloons myself, poking a small balloon with a pen and producing a soft sound, then working my way up to bigger and bigger balloons and louder and louder pops, I might have been able to tolerate balloons. I've heard a lot of people with autism say that if they can initiate the sound, they're more likely to be able to tolerate it. The same is true if they know the sound is coming; fireworks set off at random by kids down the block are shocking, but fireworks set off at the city park as part of a holiday program are acceptable.

Temple Grandin




High confidence in model: low precision
input
model


Low confidence in own model: high precision
model
input

Uncertainty drives anxiety, sensory issues in autism

BY **ANN GRISWOLD** / 8 APRIL 2016

https://www.spectrumnews.org

NEWS

Sensory overload in autism may stem from hypervigilant brain

BY **NICHOLETTE ZELIADT**

29 JULY 2019

Sensory overload: Children with autism may perceive uncertainty as a threat.

©shutterstock.com/ Kuznetcov_Konstantin

J Autism Dev Disord (2016) 46:1962–1973
DOI 10.1007/s10803-016-2721-9

CrossMark

ORIGINAL PAPER

The Relationship Between Intolerance of Uncertainty, Sensory Sensitivities, and Anxiety in Autistic and Typically Developing Children

Louise Neil[1] · Nora Choque Olsson[2] · Elizabeth Pellicano[1,3]

Uncertainty and sensory issues

brain sciences
MDPI

Article

Autistic Sensory Traits and Psychological Distress: Mediating Role of Worry and Intolerance of Uncertainty

Patricia Recio [1,2], Pilar Pozo [1,2], Cristina García-López [2,3,4] and Encarnación Sarriá [1,2,*]

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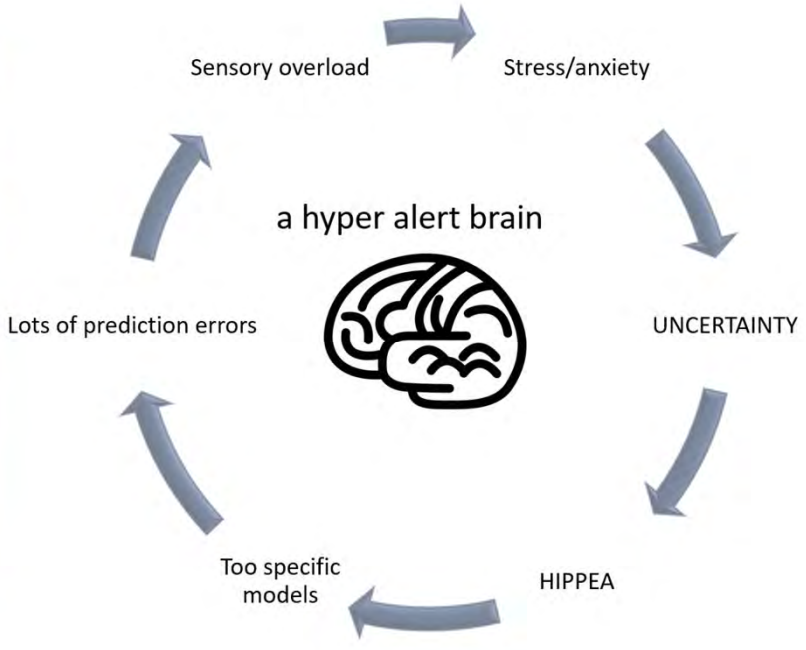
3 Learning Disabilities Unit (UTAE), Neuropediatrics Department, Hospital Sant Joan de Déu, 08950 Barcelona, Spain
4 Psychology Department, Faculty of Health Sciences, University Abat Oliba CEU, 08022 Barcelona, Spain
* Correspondence: esarria@psi.uned.es



Is it really the sound that is the problem?

Original Article

autism

Autism
1–11
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DOI: 10.1177/1362361320926061
journals.sagepub.com/home/aut
SAGE

Atypical visual-auditory predictive coding in autism spectrum disorder: Electrophysiological evidence from stimulus omissions

Thijs van Laarhoven[1], Jeroen J Stekelenburg[1], Mart LJM Eussen[2] and Jean Vroomen[1]

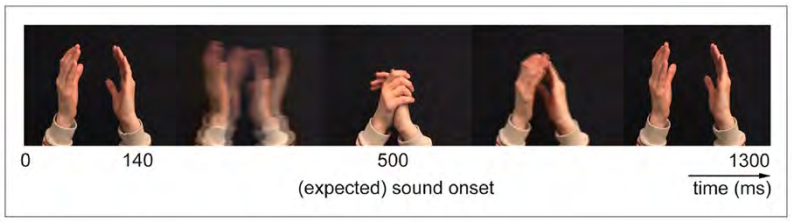

Figure 1. Time-course of the video used in the visual-auditory (VA) and visual (V) condition.

Increased brain activity at…silence!

Reducing – eliminating stimuli

Short term: OK
Long term: not OK!

- Sensory deprivation as torture (Guantanamo bay)
- Noise cancelling headphones make the brain more sensitive to sound and can even cause tinnitus (listening loss)

Hyperacusis - Tinnitus

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)

PAIN

Pain 74 (1998) 327–331

The role of prior pain experience and expectancy in psychologically and physically induced pain

Timothy L. Bayer[b], John H. Coverdale[a,b,*], Elizabeth Chiang[b], Mark Bangs[b]

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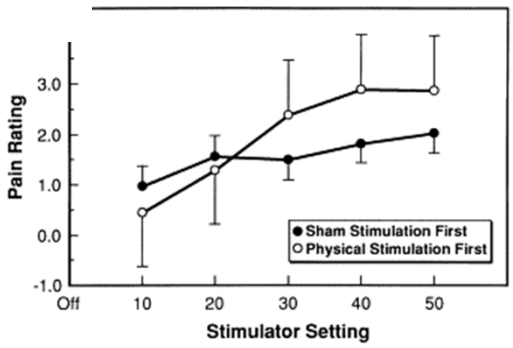
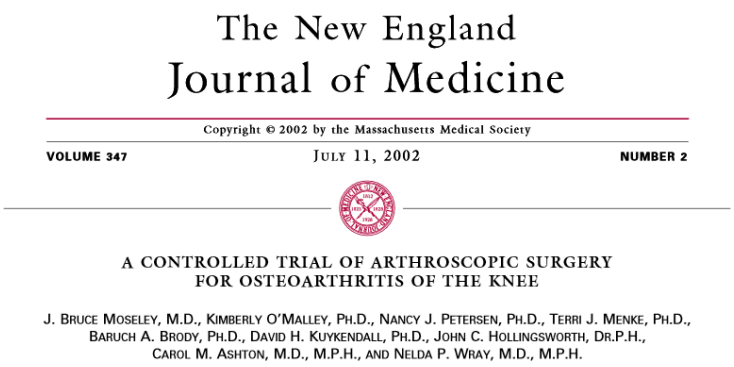
[b]Department of Psychiatry and Behavioral Science, Baylor College of Medicine, Houston, Texas, USA

Received 2 April 1997; received in revised form 27 October 1997; accepted 29 October 1997

If you can induce pain through information, you can also remove/reduce pain through information



Pain treatment 2.0



The New England Journal of Medicine

VOLUME 347 JULY 11, 2002 NUMBER 2

A CONTROLLED TRIAL OF ARTHROSCOPIC SURGERY FOR OSTEOARTHRITIS OF THE KNEE

J. BRUCE MOSELEY, M.D., KIMBERLY O'MALLEY, PH.D., NANCY J. PETERSEN, PH.D., TERRI J. MENKE, PH.D., BARUCH A. BRODY, PH.D., DAVID H. KUYKENDALL, PH.D., JOHN C. HOLLINGSWORTH, DR.P.H., CAROL M. ASHTON, M.D., M.P.H., AND NELDA P. WRAY, M.D., M.P.H.

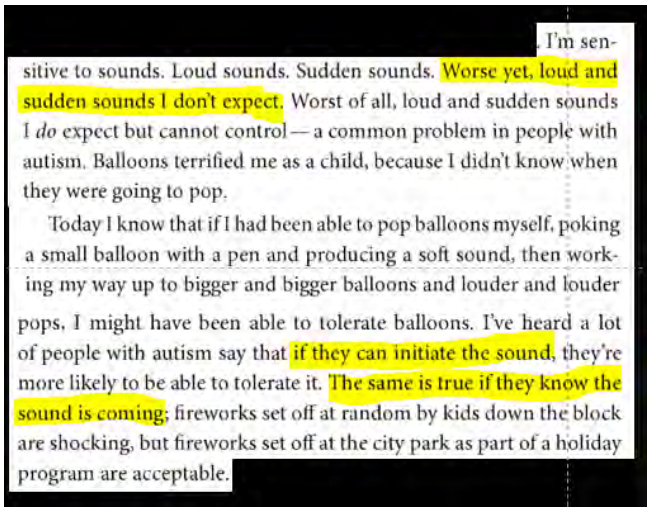
Virtual "SnowWorld" Helps Burn Victims Cope with Extreme Pain

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



I'm sensitive to sounds. Loud sounds. Sudden sounds. Worse yet, loud and sudden sounds I don't expect. Worst of all, loud and sudden sounds I *do* expect but cannot control — a common problem in people with autism. Balloons terrified me as a child, because I didn't know when they were going to pop.

Today I know that if I had been able to pop balloons myself, poking a small balloon with a pen and producing a soft sound, then working my way up to bigger and bigger balloons and louder and louder pops, I might have been able to tolerate balloons. I've heard a lot of people with autism say that if they can initiate the sound, they're more likely to be able to tolerate it. The same is true if they know the sound is coming; fireworks set off at random by kids down the block are shocking, but fireworks set off at the city park as part of a holiday program are acceptable.

Temple Grandin

The role of contextual 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

Predictability, not repetition is helpful

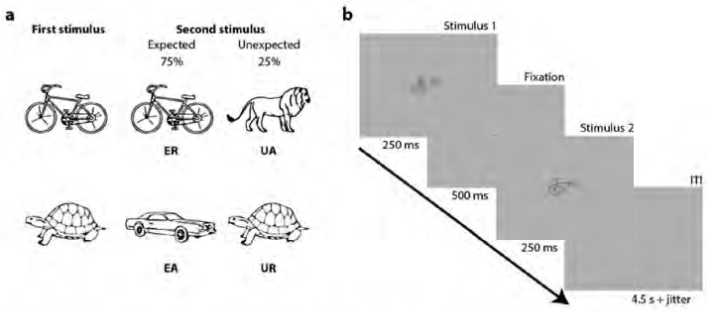

Fig. 1 – Perceptual expectations paradigm. (a) Examples of fixed stimulus pairings. During a practice task, participants implicitly learned that some stimuli are most likely to repeat, whereas others are most likely to alternate, thus creating expected repetitions (ER) and expected alternations (EA), 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.

Predictability is not the same as repetition

When you expect variation, a new stimulus will not create a prediction error

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!*) → **stimming**

The importance of control

Perception, 2015, volume 44, pages 569–586

doi:10.1068/p7833

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

Ashley E Robertson§, David R Simmons
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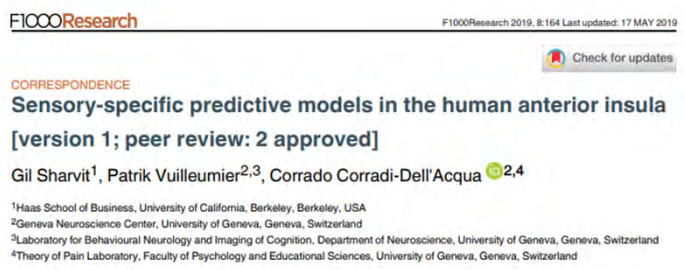
Received 6 August 2014, in revised form 2 April 2015

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

Relaxing the brain and stimulus reactivity

This will be bad → stress ↗ → hyperreactivity
You will be OK → stress ↘ → no hyperreactivity



F1000Research F1000Research 2019, 8:164 Last updated: 17 MAY 2019

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]

[1]Haas School of Business, University of California, Berkeley, Berkeley, USA
[2]Geneva Neuroscience Center, University of Geneva, Geneva, Switzerland
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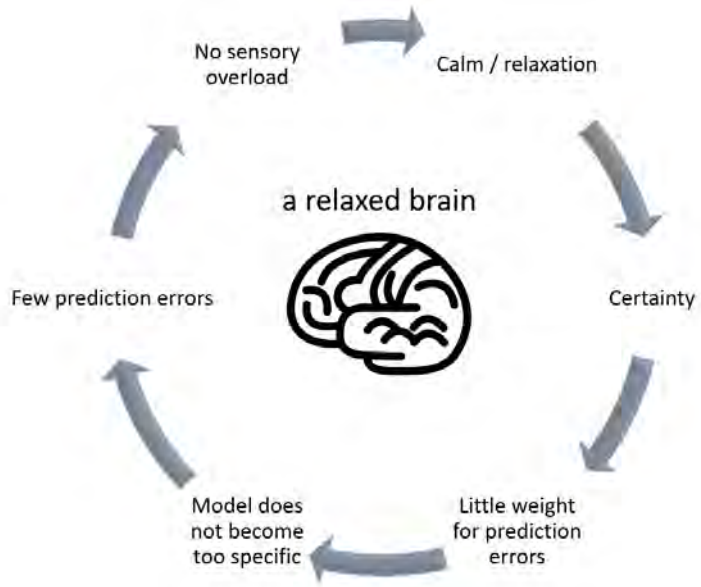
[4]Theory of Pain Laboratory, Faculty of Psychology and Educational Sciences, University of Geneva, Geneva, Switzerland

A relaxed brain can tolerate more input



Relaxing the brain and stimulus reactivity

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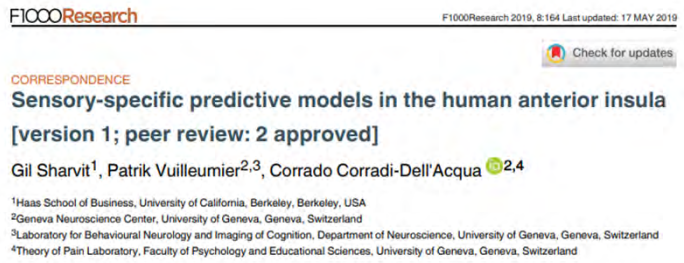

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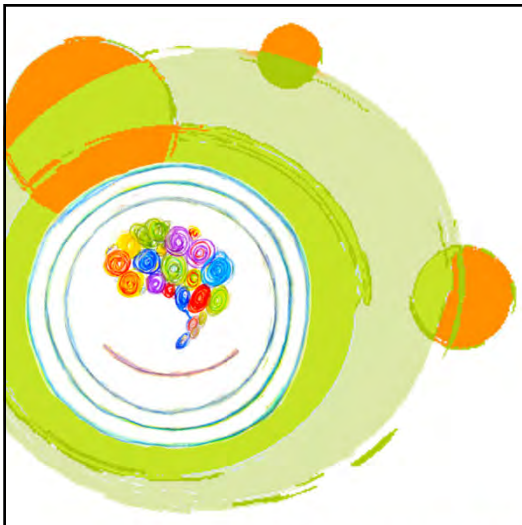
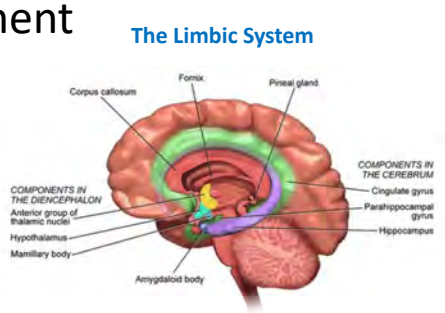


H.A.P.P.Y.

Happiness in Autism Personal Project for Young people

How to help autistic people cope with sensory overload?

- Make stimuli predictable and understandable, so the world becomes safer
- Use their interests (when 'in the flow' the world around seems to disappear…)
- Give control over the sensory environment → also allow stimming
- Work on well-being and good-feeling

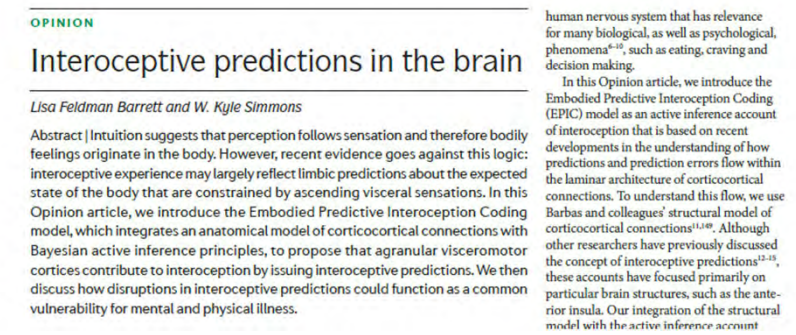


Hyporeactivity in autism

- Mainly in interoception

EPIC: Embodied Predictive Interoception Coding

Barrett & Simmons (2015)



PERSPECTIVES

OPINION

Interoceptive predictions in the brain

Lisa Feldman Barrett and W. Kyle Simmons

Abstract | Intuition suggests that perception follows sensation and therefore bodily feelings originate in the body. However, recent evidence goes against this logic: interoceptive experience may largely reflect limbic predictions about the expected state of the body that are constrained by ascending visceral sensations. In this Opinion article, we introduce the Embodied Predictive Interoception Coding model, which integrates an anatomical model of corticocortical connections with Bayesian active inference principles, to propose that agranular visceromotor cortices contribute to interoception by issuing interoceptive predictions. We then discuss how disruptions in interoceptive predictions could function as a common vulnerability for mental and physical illness.

human nervous system that has relevance for many biological, as well as psychological, phenomena[6–10], such as eating, craving and decision making.

In this Opinion article, we introduce the Embodied Predictive Interoception Coding (EPIC) model as an active inference account of interoception that is based on recent developments in the understanding of how predictions and prediction errors flow within the laminar architecture of corticocortical connections. To understand this flow, we use Barbas and colleagues' structural model of corticocortical connections[11,169]. Although other researchers have previously discussed the concept of interoceptive predictions[12–15], these accounts have focused primarily on particular brain structures, such as the anterior insula. Our integration of the structural model with the active inference account

Internal hyporeactivity because of external hyperreactivity

- When distracted by external stimuli, we become less accurate, less sensitive and less confident in our interoception.
- This distraction effect is bigger in people with tendency to feel distressed or worried about sensations of discomfort

Disrupted interoception by auditory distractor: Difficulty inferring the internal bodily states?

Haruki Y, Ogawa K

Preprint from PsyArXiv, 05 Dec 2021
DOI: 10.31234/osf.io/2t754 PPR: PPR428744
Preprint

Lower interoceptive accuracy in autism

HHS Public Access
Author manuscript
J Autism Dev Disord. Author manuscript; available in PMC 2023 March 08.

Published in final edited form as:
J Autism Dev Disord. 2023 March ; 53(3): 947–962. doi:10.1007/s10803-022-05656-2.

Characterizing Interoceptive Differences in Autism: A Systematic Review and Meta-analysis of Case-control Studies

Zachary J. Williams[1,2,3,4,5,*], Evan Suzman[6,*], Samantha L. Bordman[7], Jennifer E. Markfeld[2], Sophia M. Kaiser[8], Kacie A. Dunham[2,3], Alisa R. Zoltowski[3], Michelle D. Failla[9], Carissa J. Cascio[3,4,5,10], Tiffany G. Woynaroski[2,3,4,5]

Interoception in autism

Low cardiac awareness
(Garfinkel a.o., 2016; Palser a.o., 2019)

Lack of awareness of hunger, thirst, pain and the need to make bowel or bladder movements

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
  - Increase the well-being