Autism and the predictive mind
Context blindness 2.0

PETER VERMEULEN, PhD

AUTISM in CONTEXT
from neurodiversity to neuroharmony

www.petervermeulen.be
twitter
peter_autisme
Autism friendliness

• An autism friendly approach starts from an understanding of autism from within!

• Knowledge of “autistic thinking” is the key to success in education and treatment!
Copernican revolution in brain science
Default idea about the brain

computational analogy

input → processing → output

perception → cognition → action
(thinking and memory) (motor system)
What’s wrong with our current ideas about the brain?

• Information processing is not linear
• Sense making is not just integrating all the details of the sensory input
  • There isn’t enough time to calculate and make that puzzle! (Daniel Kahneman)
  • Processing all the sensory input (computing) is not very helpful for survival! (Smilodon story)
• So, the brain does not compute, It guesses,
• And it can make smart guesses because it uses context,
• This is known as: the **predictive mind**
So, it does NOT work like this

- stimulus
- processing
- meaning

feedforward

bottom up top down

feedback
But it works like this

Checking prediction (prediction error)

stimulus

prediction

feedback

feedforward

bottom up top down
The brain does not process stimuli, only what is different from the stimuli it predicted...

From *The Lancet*
We cannot avoid prediction errors

That’s why the brain uses a variable precision of its own predictions (and of the expected sensory input)

That precision defines the filter in our brain
stimulus → sensation

stimulus → sensation

stimulus → sensation

stimulus → no sensation

no stimulus → sensation
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
Predictive mind

Predicts the sensory input and then processes the prediction error (= difference predicted and actual input)
Autism and the predictive mind: hypotheses

- Not enough, too broad predictions (hypo-priors) (Pellicano & Burr, 2012)
- Too specific predictions (Hohwy, 2015; Brock, 2012; Qian & Lipkin, 2011)
- HIPPEA: High, Inflexible Precision of Prediction Errors in Autism (Van de Cruys e.a., 2013, 2014)
- An imbalance of the precision ascribed to sensory evidence relative to prior beliefs. (Friston e.a., 2013; Lawson, Rees & Friston, 2014)
Autism and the predictive mind: context!

• In ASD, the dysfunction of prediction based on context may impair the ability to adapt quickly to an ever changing socio-emotional world. (Gomot & Wicker, 2012, p. 245)

• In particular, we think autism is associated with an inability to flexibly adjust the degree of precision in a different context. (Van de Cruys e.a., 2013, p.97-98)

• Autism may be related to problems with making predictions sensitive to the wider context.” (Palmer e.a., 2015)

• Comparably, reduced global processing in autism may reflect a reduced role for top-down predictions in integrating sensory features into a more broadly coherent or context-sensitive percept.” (Palmer e.a., 2017)
Hypothesis Palmer, Lawson, Hohwy (2017)

The autistic brain treats sensory input as more informative than its own model of the world (based on prior information)
The weight given to sensory input or own expectations **depends on the context**

How much weight you give to a prediction error depends on how certain you are about your model of the world and the predictions based on that model (Lawson, Mathys & Rees, 2017)
Living in a relative (VUCA) world

Nothing has an absolute meaning! Everything depends on context.

Therefore, our brain became an expert in using context for making quick and smart guesses.

Go back!  Stop!  Don’t stop!
Autism as context blindness

Context blindness:
Reduced ability to use the context *spontaneously* when giving meaning to (especially vague, ambiguous and abstract) stimuli.
Autism as context blindness 2.0

Context blindness 2.0:
Reduced ability to use the context unconsciously and **spontaneously** to generate predictions about the world and process prediction errors.
Autism as a prediction disorder

This new idea could change our ideas about many things in autism such as:

• Sensory issues and what to do about them
• Communication
• Emotion recognition and how to teach socio-emotional skills
Our ideas about sensory issues are based on the old computer metaphor.
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

PREDICTIVE CODING IN AUTISM

(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-
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
Uncertainty drives anxiety, sensory issues in autism

BY ANN GRISWOLD / 8 APRIL 2016

Sensory overload in autism may stem from hypervigilant brain

BY NICHOLETTE ZELIADT
29 JULY 2019

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

Louise Neil¹ · Nora Choque Olsson² · Elizabeth Pellicano¹,³
No stronger sensory response, but stronger experience of stimuli

Interventions should focus on the limbic system, rather than on the sensory system...
The brain does not receive sensory input, it predicts it and processes the prediction errors.

Predictability plays a major role in sensory issues.
Sensory or anxiety and uncertainty?

Small deviations from prediction are noticed and processed

High precision in expected prediction error

Hyper responsivity

Uncertainty Anxiety

Increased alertness
Strategies for sensory issues: traditional way

- Taking away stimulus
- Reducing stimulus
- Controlling stimulus
- Stress coping

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)
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!

- Knowing how to ‘control’ the stimulus
- Generating a competitive stimulus (again: predictability!)
The sensory experiences of adults with autism spectrum disorder: A qualitative analysis

Ashley E Robertson§, David R Simmons
School of Psychology, University of Glasgow, UK; e-mail: ashleyerobertson@icloud.com
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
Understanding language and communication: old model
Understanding language and communication: new model

stimulus \rightarrow prediction error \rightarrow prediction
Context and predicting language and communication

The brain makes quick guesses about what someone is going to say or show, based on context

- **N400**
- **Lexical priming**
- **N400 lower in people with autism** (Pijnacker e.a., 2010)

---

![Graph showing N400 waveforms](image)

- **Jan eet friet met mayonaise**
- **Jan eet friet met schoen.**

---

*Fig. 1: Mean amplitude of the N400 effect in congruent condition minus congruent condition in lexically violated (100-300 ms) time window (averaged across FCz, C1, and C2 for each individual participant. Negative values are plotted upward).*
A predictive coding framework for rapid neural dynamics during sentence-level language comprehension

Ashley G. Lewis\textsuperscript{a, b}, Marcel Bastiaansen\textsuperscript{a, c}.
Context and communication

Nothing has an absolute meaning, remember?

So, whatever we use to communicate...

Let’s start!

words
gestures
pictures
objects

...their meaning is never fixed, but depending on the context
What is difficult for people with ASD, is to find out what something (a word, a sentence, a gesture, a picture etc.) means *in this context*.
Context helps predicting communication

If your brain is context blind, it will have difficulties predicting (and hence understanding) communication.
Pushing the context button in communication

I will now ask you something about yesterday

And now something about the actors in the movie

OK, Let’s now move on to question #2.
Context and emotion recognition

Relation facial expression – emotion is not fixed

We never see facial expressions out of context
Facial expressions: inherently ambiguous!!

Inherently Ambiguous: Facial Expressions of Emotions, in Context

Ran R. Hassin
Department of Psychology, Hebrew University, Israel
The Center for the Study of Rationality, Hebrew University, Israel

Hillel Aviezer
Department of Psychology, Hebrew University, Israel
Department of Psychology, Princeton University, USA

Shlomo Bentin
Department of Psychology, Hebrew University, Israel
Center for Neural Computation, Hebrew University, Israel
Recognizing emotions

prediction error

prediction

CONTEXT

He’s pleased!

mouth a bit open

mouth corner up
Context in Emotion Perception

Lisa Feldman Barrett¹,², Batja Mesquita³, and Maria Gendron¹
¹Department of Psychology, Boston College, ²Department of Psychiatry and the Martinos Center for Biomedical Imaging, Massachusetts General Hospital/Harvard Medical School, and ³Department of Psychology, University of Leuven, Belgium

Abstract

We review recent work demonstrating consistent context effects during emotion perception. Visual scenes, voices, bodies, other faces, cultural orientation, and even words shape how emotion is perceived in a face, calling into question the still-common assumption that the emotional state of a person is written on and can be read from the face like words on a page. Incorporating context during emotion perception appears to be routine, efficient, and, to some degree, automatic. This evidence challenges the standard view of emotion perception represented in psychology texts, in the cognitive neuroscience literature, and in the popular media and points to a necessary change in the basic paradigm used in the scientific study of emotion perception.
So, we thought emotion recognition went like this:

Reading emotions FROM faces

He is pleased!
But it actually goes like this:

Reading emotions INTO faces

He is pleased!

mouth a bit open

mouth corner up
So we should teach people with autism to **PREDICT** emotions, using context, not faces
Predictive mind, context and social interaction

Action perception is not simply a reflection of what happens, but a projection of what will happen next.

(von der Lühe e.a., 2016)
Context and social cognition

Social cognition in ASD only impaired when context is involved

(Baez, Ibanez et al., 2012; 2014)

The effects of context processing on social cognition impairments in adults with Asperger’s syndrome

Sandra Baez¹,²,³ and Agustin Ibanez¹,²,³,⁴,⁵

¹ Institute of Cognitive Neurology (INECO) and Institute of Neuroscience, Favaloro University, Buenos Aires, Argentina
² UDP-INECO Foundation Core on Neuroscience (UCIFCon), Diego Portales University, Santiago, Chile
³ National Scientific and Technical Research Council (CONICET), Buenos Aires, Argentina
⁴ Universidad Autónoma del Caribe, Barranquilla, Colombia
⁵ Australian Research Council, Centre of Excellence in Cognition and its Disorders Sydney, NSW, Australia
Context and social cognition

FIGURE 2 | Pattern of performance of adults with AS in social cognition tasks. Adults with AS were impaired in tasks that involved implicit encoding and automatic integration of contextual cues to interpret a given social situation. Conversely, they performed as well as controls in tasks which featured well-defined situational elements and could be solved by using relatively abstract, universal rules: FPT, Faux Pas Test; TASIT, The Awareness of Social Inference Test; EPT, Empathy for Pain Task; RMET, Reading the Mind in the Eyes Test; SNQ, Social Norms Questionnaire.

Source: Baez & Ibanez (2014)
Contextualized teaching

• Do not use decontextualized materials
• Do not teach ‘skills’ but start from contexts
• Link behaviours always to contexts

Starting a conversation
Pushing the context button helps to ‘predict’ an uncertain world with all its ever changing meanings.
Hopefully you could put all the information in context...