Autism and the predictive brain: absolute thinking in a relative world

PETER VERMEULEN,
PhD

AUTISM in CONTEXT
from neurodiversity to neuroharmony

www.petervermeulen.be

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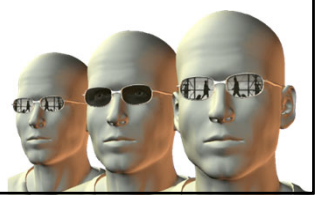

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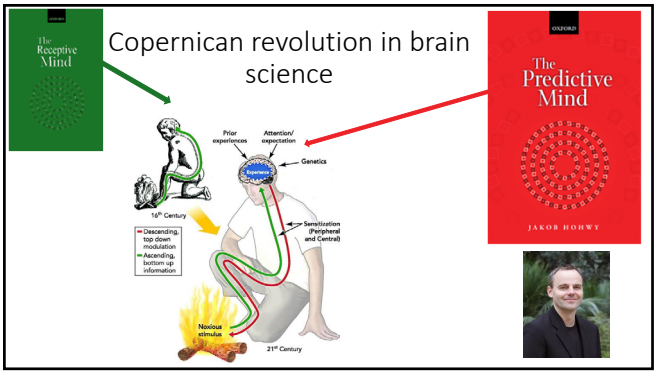
Autism friendliness

- There is no such category as “autistic behaviors”, only “human behaviors (Barry Prizant)
- 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!

2

Copernican revolution in brain science



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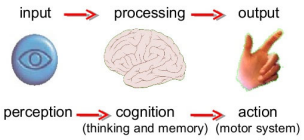
Default idea about the brain

computational analogy



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

- 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)
- So, the brain does not wait until it gets information. It anticipates the sensory input by predicting = making smart guesses.
  - Unconscious predictions
  - Probabilities
- The brain can make smart guesses because it uses context,
- This is known as: **the predictive mind**

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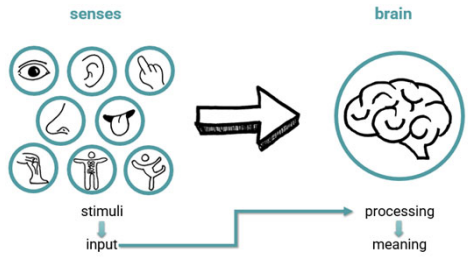
So, it does NOT work like this



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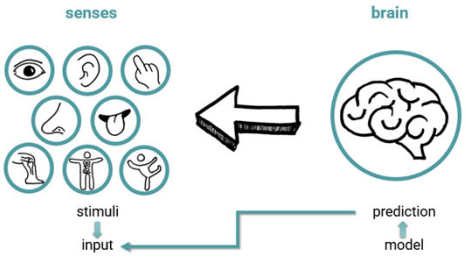
But it works like this



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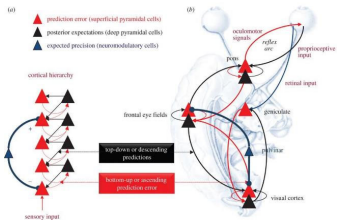
The brain does not process stimuli, only what is different from the stimuli it predicted: prediction errors.



From *The Lancet*

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Prediction errors

- The brain has only one goal:
  helping us to survive by minimizing prediction errors, either by
  - learning (updating the model) or by
  - changing the world (updating the world)
- 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 or normal variation (irrelevant)
- Relevant, so something that should lead to learning or action

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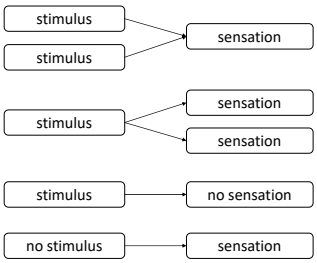
Sensory input is highly unreliable



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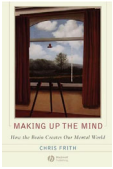
Perception is controlled hallucinating.

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

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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%.**

Information is meaningless (Beau Lotto)

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Predictive mind

Predicts the sensory input and then processes the prediction error (= difference predicted and actual input)

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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)

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2014, Vol. 121, No. 4, 649–675

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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

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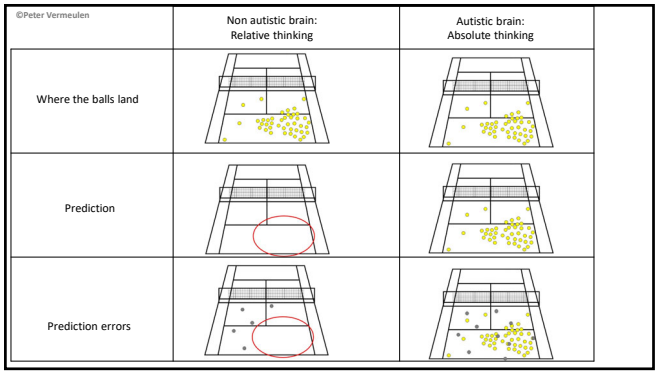

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Temple Grandin: My mind is a web browser

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Wkh#edodqfh#ri#kqfhuwdlqw

High confidence in own model → low precision
Low confidence in own model -> high precision
The weight given to prediction errors is based on the degree of (un)certainty

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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

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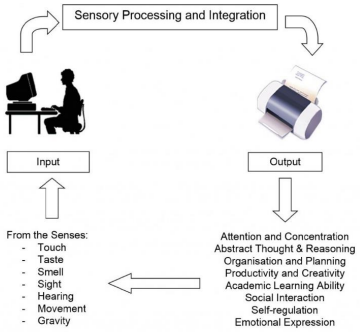
Our ideas about sensory issues are based on the old computer metaphor



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Important difference!

Hypersensitivity:
- Physiological response
- Sensory threshold

≠

Hyperreactivity:
- Psycho-emotional / behavioural response

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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.

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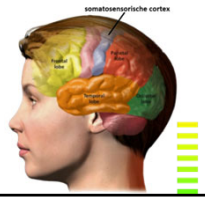
No stronger sensory response, but stronger experience of stimuli

RESEARCH ARTICLE

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

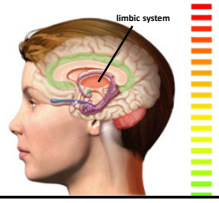
Carissa J. Cascio, Estephan J. Moana-Filho, Steve Guest, Mary Beth Nebel, Jonathan Weisner, Grace T. Baranek, and Gregory K. Essick



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

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



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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 …

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

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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-

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Uncertainty drives anxiety, sensory issues in autism

BY ANN GRISWOLD | 6 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

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]

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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

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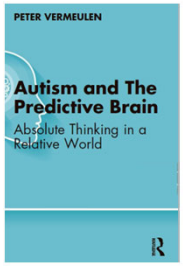

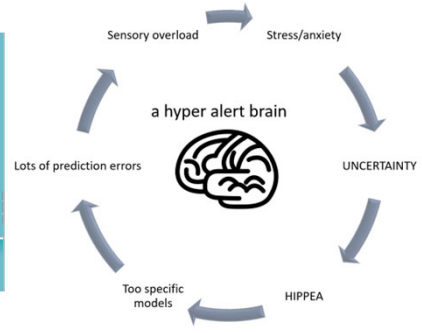

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Strategies for sensory issues: traditional way

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*)

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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

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Strategies for sensory issues?

Tackle the prediction errors!

Changing prediction → Giving control → Changing stimulus → Stress coping

Perception, 2015, volume 44, pages 569 – 586

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

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

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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
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

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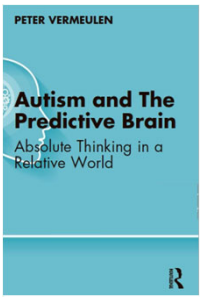

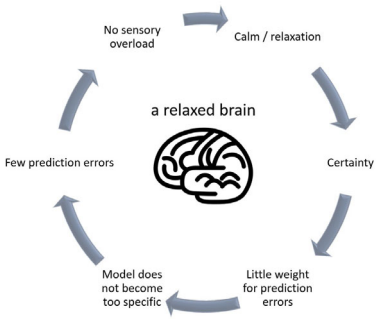

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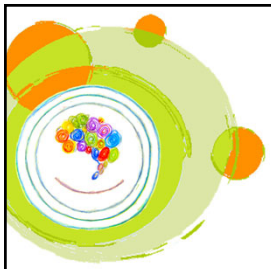

H.A.P.P.Y.

Happiness in Autism Personal Project for Young people

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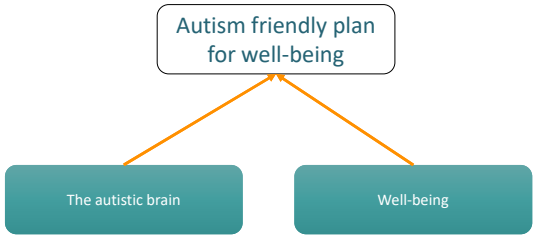
What is H.A.P.P.Y. ?



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H.A.P.P.Y.

developing evidence based, personalized and autism friendly strategies that aim at increasing the wellbeing of an autistic individual

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10 well-being strategies

1. Accepting and loving yourself
2. Good Feeling toolbox
3. Flow activities
4. Physical exercise
5. Problem focused coping strategies
6. Emotion focused coping strategies
7. Positive thinking
8. Gratitude
9. Kindness
10. Personal projects: learning something new

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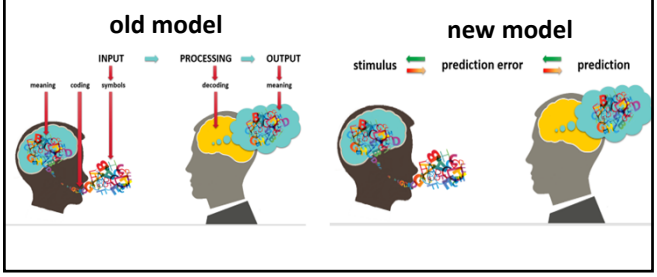
Understanding language and communication:



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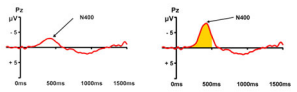
Context and predicting language and communication

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)



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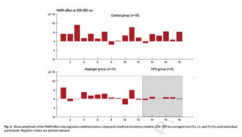
Jan eet friet met schoen.



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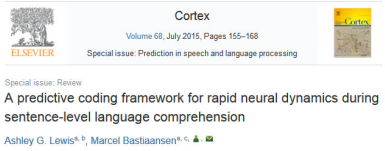
Special issue Cortex, July 2015



Understanding language = predicting language!

If the person cannot predict, then slow down your communication and push the context button

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Context

- Does not only help us to predict and recognize communication
- It also helps us to avoid all the confusion of the ever changing meanings of what people say or show us

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Context and communication

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***

So, give time to process and 'push the context button'

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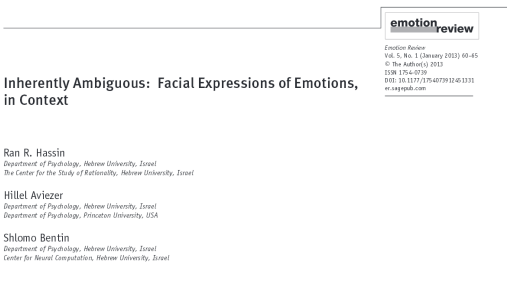
Facial expressions: inherently ambiguous!!



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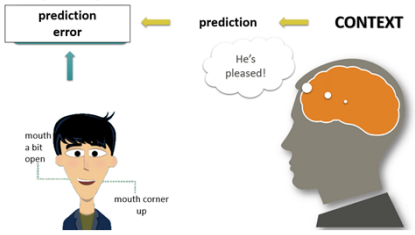
We don't read emotions FROM faces,
we read emotions INTO faces

Recognizing emotions



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Again: context…

aps
ASSOCIATION FOR PSYCHOLOGICAL SCIENCE

Context in Emotion Perception

Current Directions in Psychological Science
20(5) 286–290
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DOI: 10.1177/0963721411422522
http://cdps.sagepub.com
SAGE

Lisa Feldman Barrett[1,2], Batja Mesquita[3], and Maria Gendron[1]
[1]Department of Psychology, Boston College, [2]Department of Psychiatry and the Martinos Center for Biomedical Imaging, Massachusetts General Hospital/Harvard Medical School, and [3]Department 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.

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Context more important than the face!

But people with autism rely on the face, not the context!

autism

Short Report

Emotion recognition from congruent and incongruent emotional expressions and situational cues in children with autism spectrum disorder

Autism
1–5
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DOI: 10.1177/1362361314535676
aut.sagepub.com
SAGE

Dina Tell and Denise Davidson

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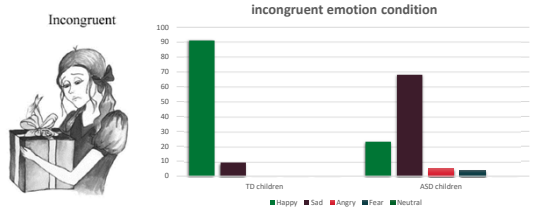
Context more important than the face!

But people with autism rely on the face, not the context!



Tell & Davidson (2014)

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So we should teach people with autism to PREDICT emotions, using context, not faces

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Predictive coding explains social deficits in autism

PHILOSOPHICAL TRANSACTIONS B

rstb.royalsocietypublishing.org

Research

Cite this article: von der Lühe T, Manera V, Barisic I, Becchio C, Vogeley K, Schilbach L. 2016 Interpersonal predictive coding, not action perception, is impaired in autism. *Phil. Trans. R. Soc. B* **371**: 20150373. http://dx.doi.org/10.1098/rstb.2015.0373

Interpersonal predictive coding, not action perception, is impaired in autism

T. von der Lühe[1,†], V. Manera[2,†], I. Barisic[3], C. Becchio[4,5], K. Vogeley[1,6] and L. Schilbach[1,7]

[1]Department of Psychiatry, University Hospital Cologne, 50937 Cologne, Germany
[2]CoBtek Laboratory, University of Nice Sophia Antipolis, 06103 Nice, France
[3]Cognitive Science Department, ETH Zürich, 8092 Zürich, Switzerland
[4]CIMON Cognition Motion and Neuroscience Unit, Fondazione Istituto Italiano di Tecnologia, Genova, Italy
[5]Department of Psychology, University of Turin, Turin, Italy
[6]Research Centre Juelich, Institute of Neuroscience and Medicine (INM-1), 52428 Juelich, Germany
[7]Max Planck Institute of Psychiatry, 80804 Munich, Germany

LS, 0000-0001-5547-8309

This study was conducted to examine interpersonal predictive coding in individuals with high-functioning autism (HFA). Healthy and HFA partici-

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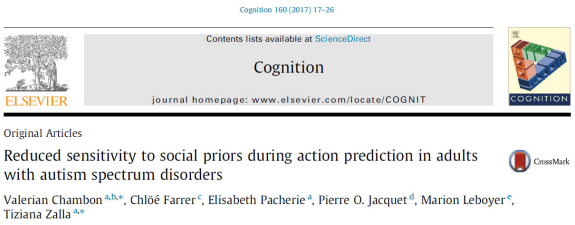
Despite intact Theory of Mind difficulties predicting what other people will do



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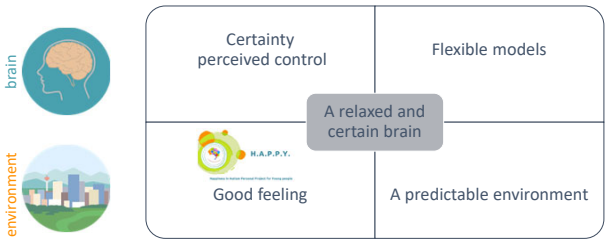
Autism friendly approach: basic ingredients



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Hopefully you could put all the information *in context*…

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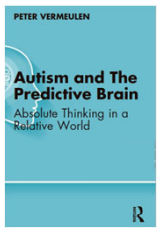

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