Autism and the predictive mind
Context blindness 2.0

PETER VERMEULEN, PhD

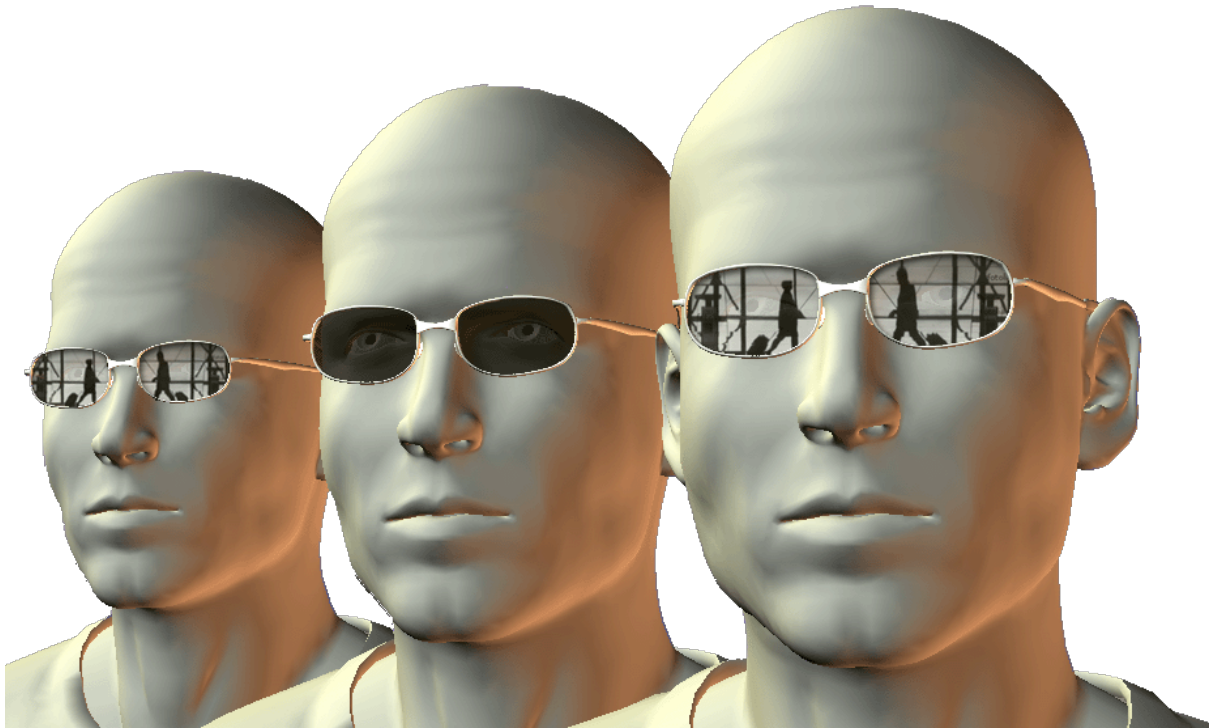
AUTISM in CONTEXT

from neurodiversity to neuroharmony

www.petervermeulen.be

twitter

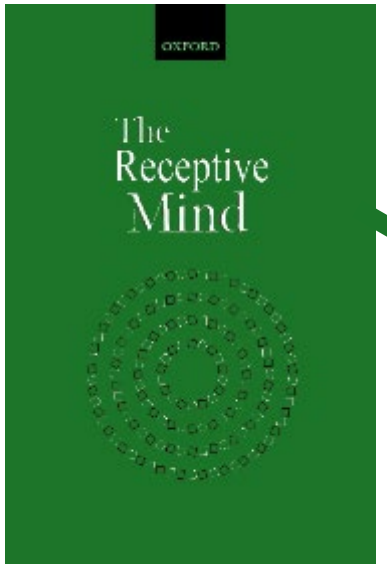
peter_autisme



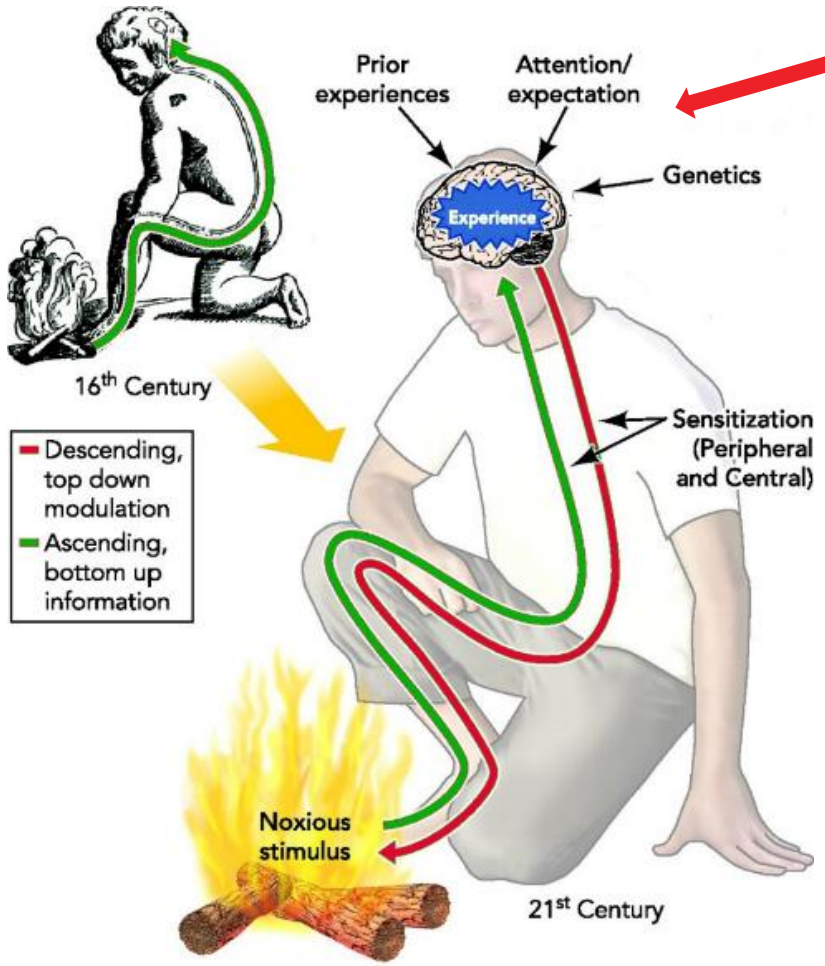
Autism friendliness

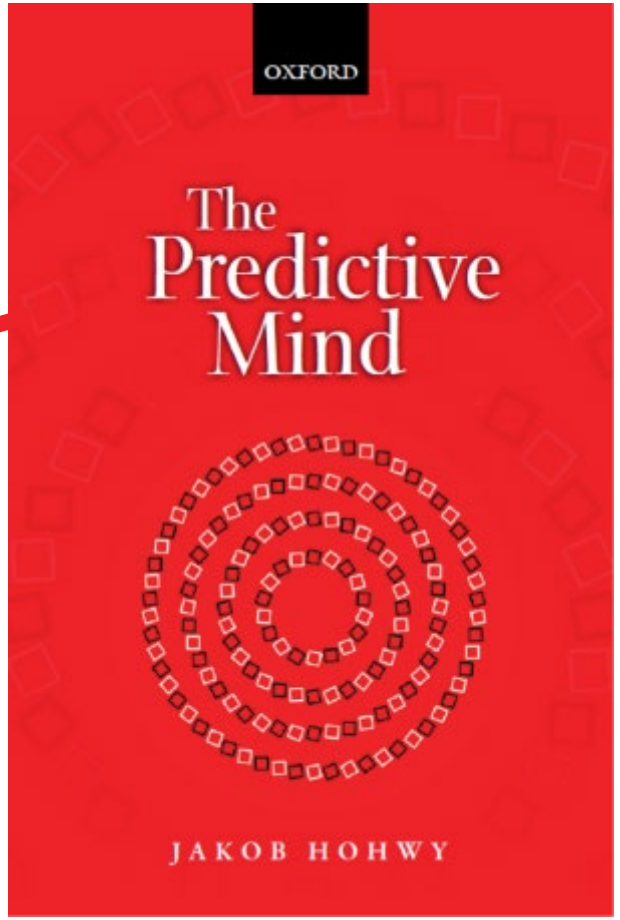
- An autism friendly approach starts from an understanding of autism from within!

- Knowledge of “autistic thinking” is the key to success in education and treatment!

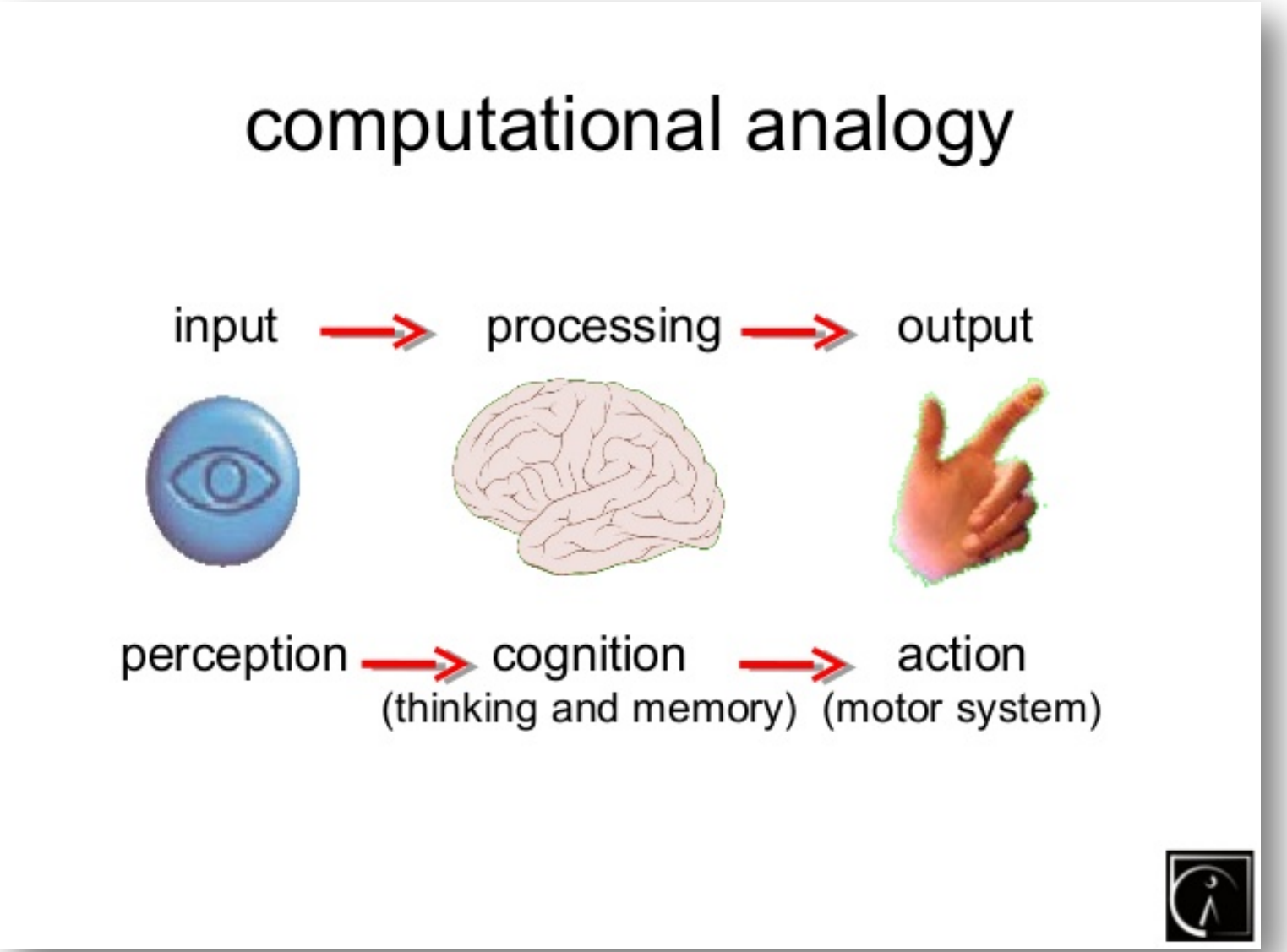


Copernican revolution in brain science





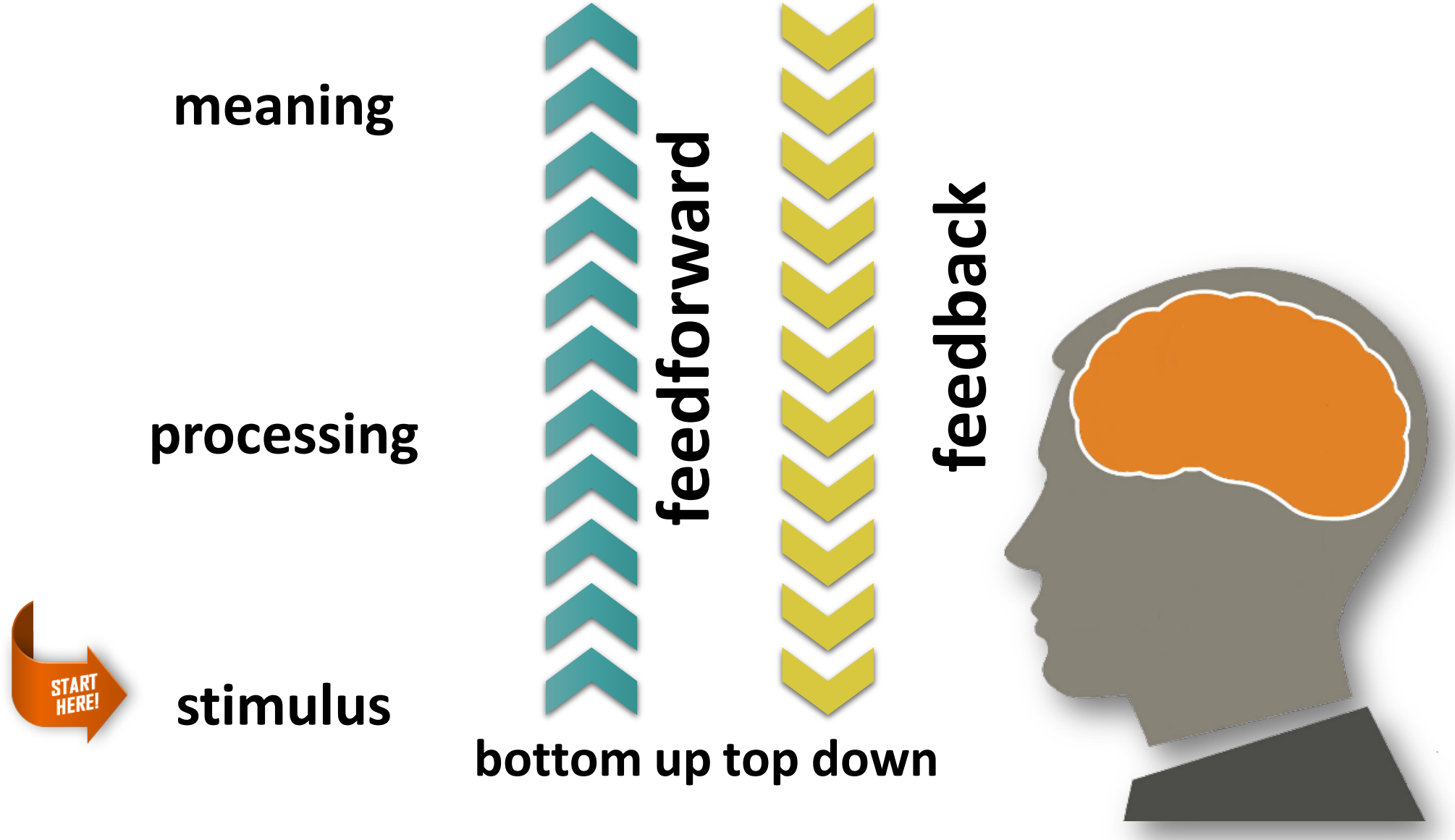
Default idea about the brain



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



But it works like this

prediction

Checking prediction (prediction error)

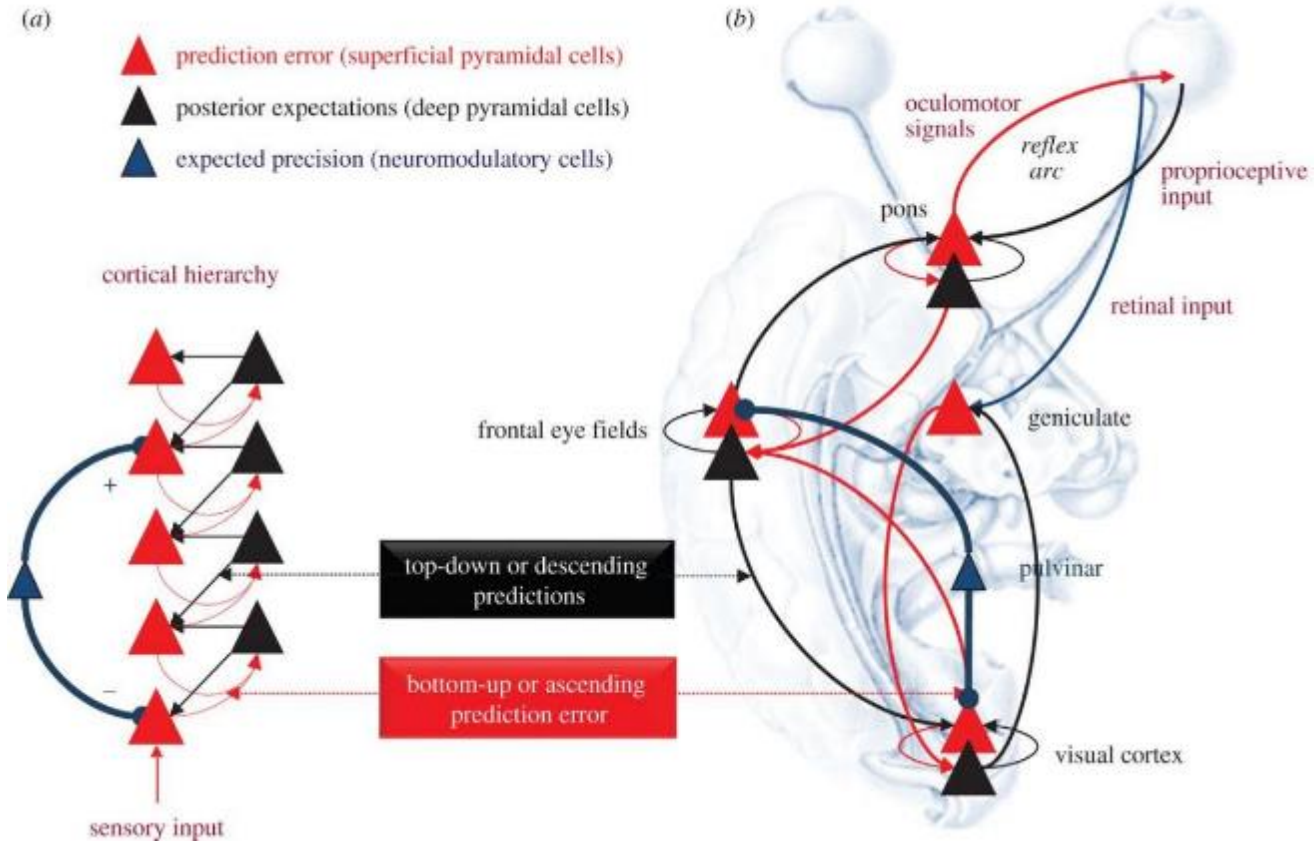
stimulus

feedback

feedforward

bottom up top down

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

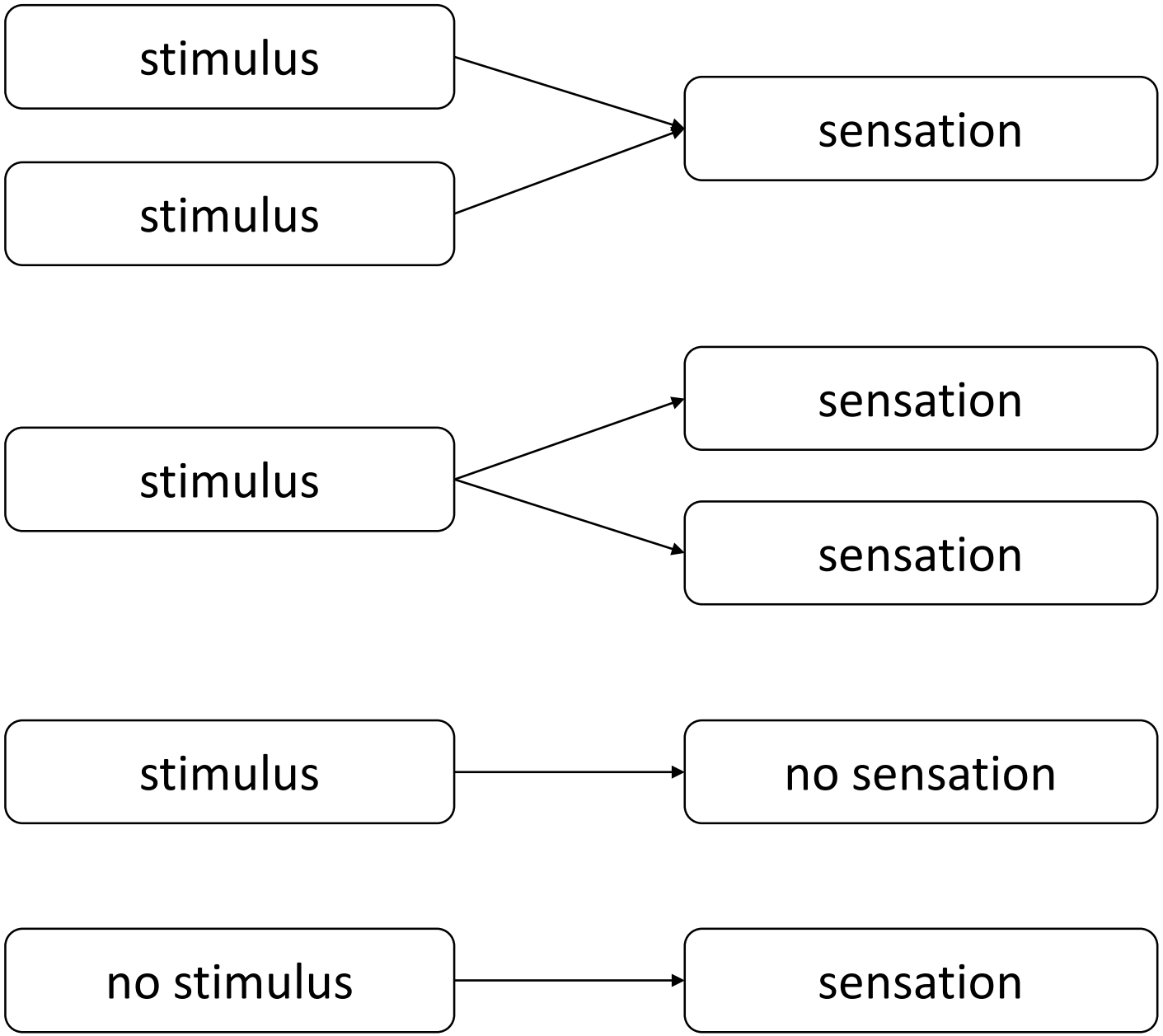


From *The Lancet*

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
stimulus
sensation
stimulus
sensation
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)

Psychological Bulletin

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

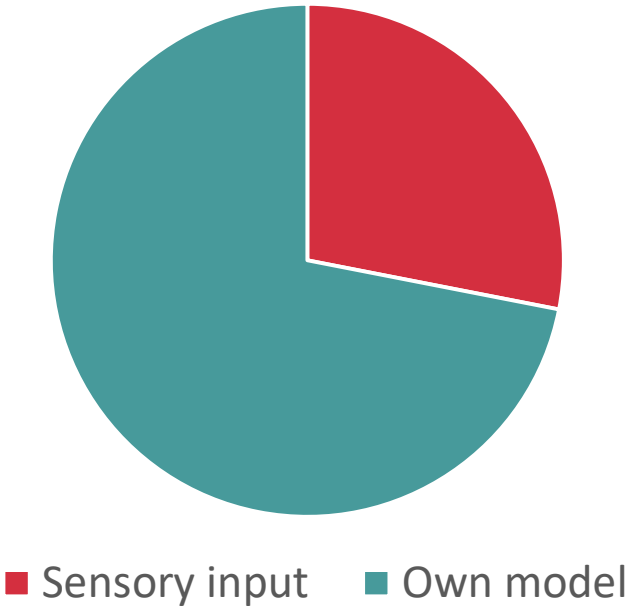
Colin J. Palmer, Rebecca P. Lawson, and Jakob Hohwy

Online First Publication, March 23, 2017. http://dx.doi.org/10.1037/bul0000097

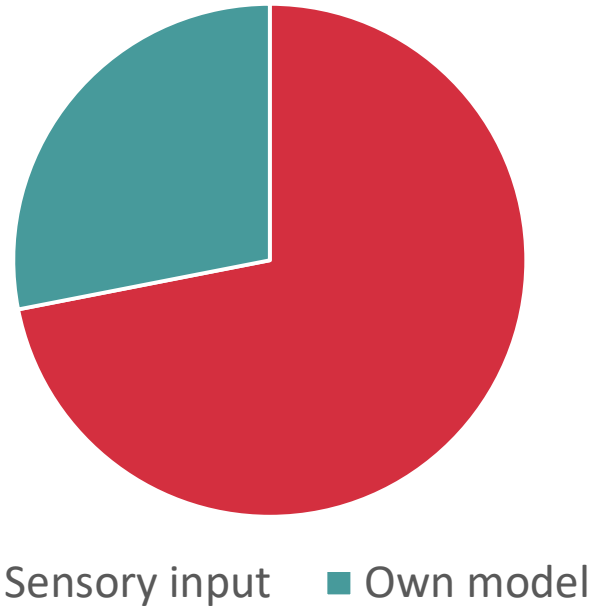
The autistic brain treats sensory input as more informative than its own model of the world (based on prior information)

The weight given to sensory input or own expectations depends on the context

Known environment

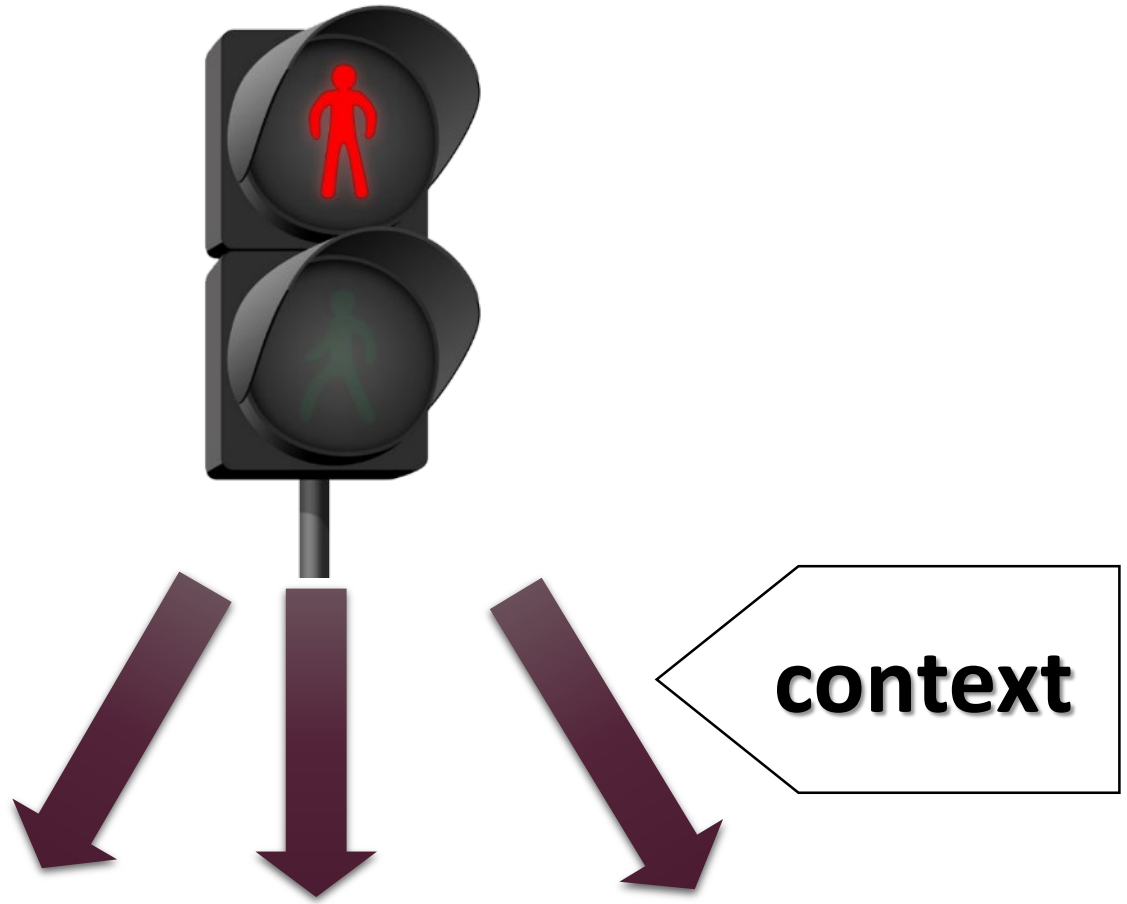


Unknown environment



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



Go back!

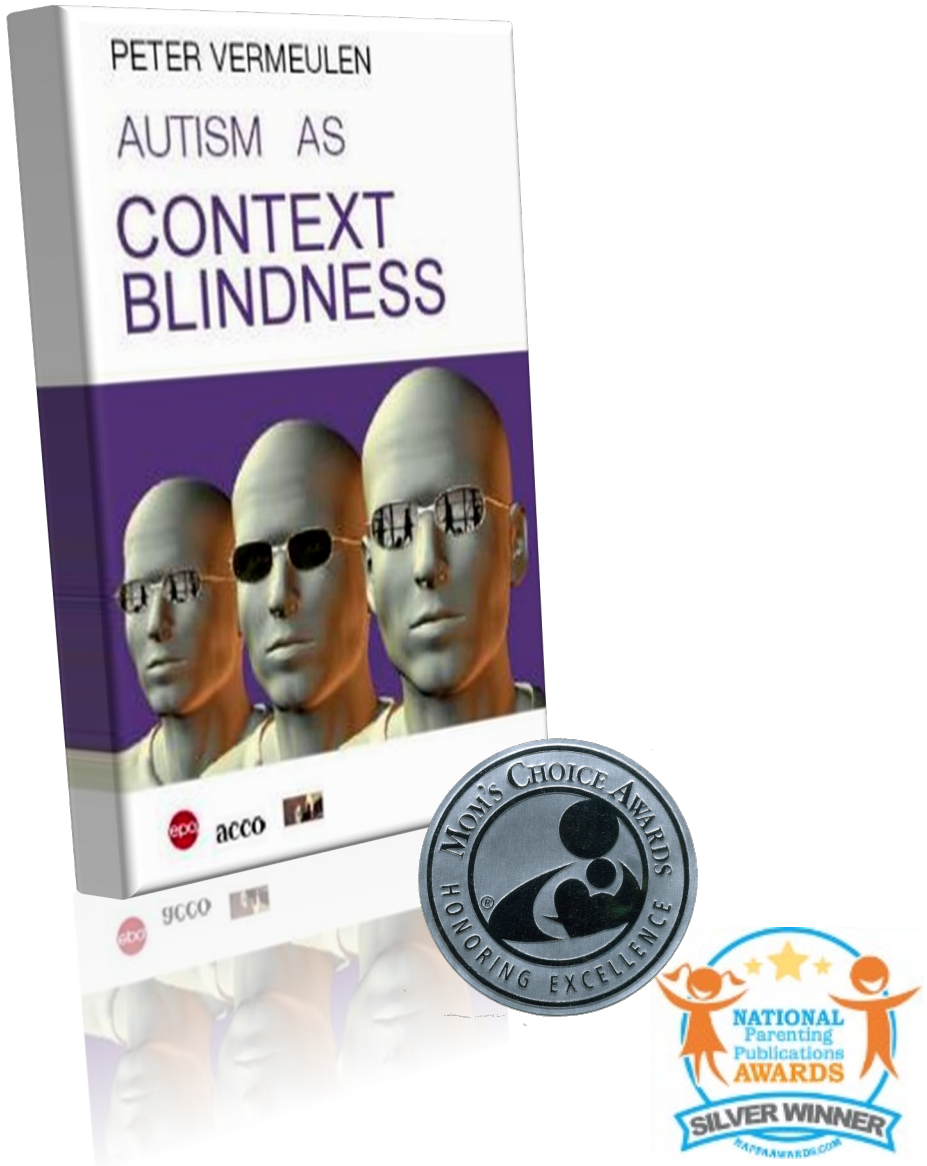
Stop!

Don’t stop!

Nothing has an absolute meaning! Everything depends on context.

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

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:

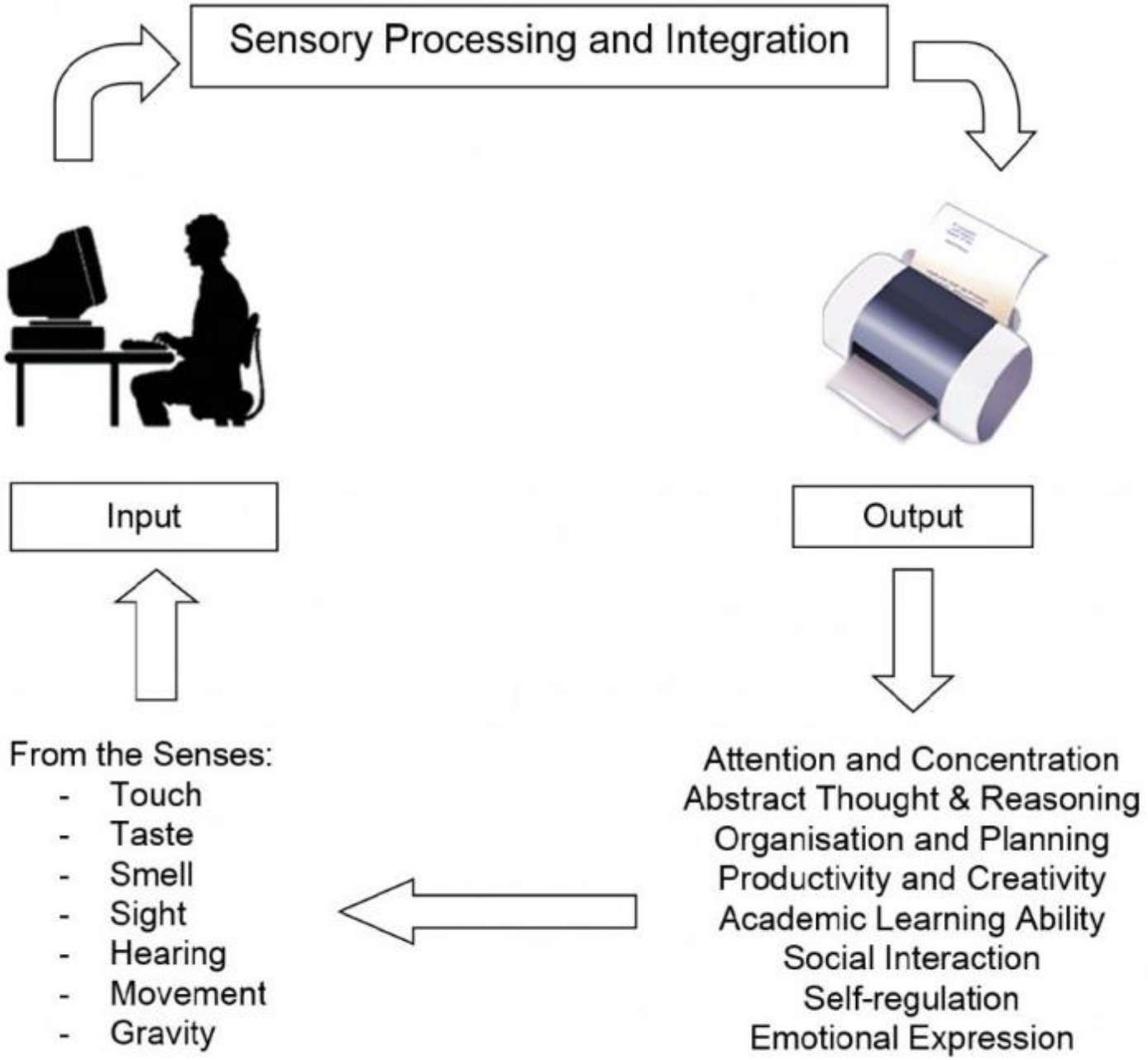
Reduced ability to use the context unconsciously and **spontaneously** to generate **predictions** about the world and process **prediction errors**.

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



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-

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 stimuluation 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.

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

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]

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

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No stronger sensory response, but stronger experience of stimuli

RESEARCH ARTICLE

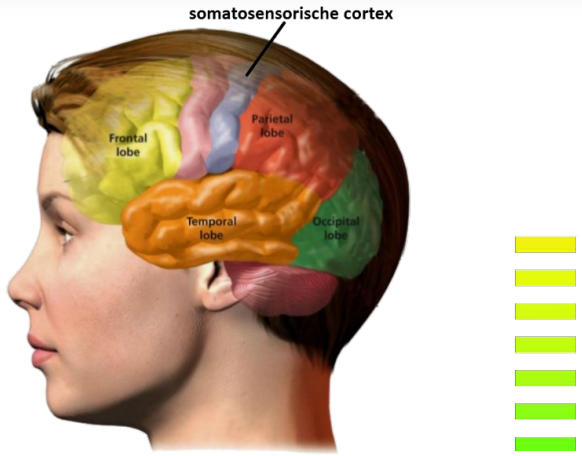
Perceptual and Neural Response to Affective Tactile Texture Stimulation in Adults with Autism Spectrum Disorders

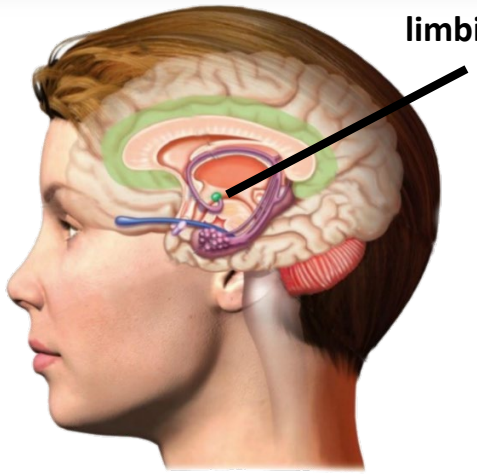
Carissa J. Cascio, Estephan J. Moana-Filho, Steve Guest, Mary Beth Nebel, Jonathan Weisner, Grace T. Baranek, and Gregory K. Essick

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





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

REVIEW NEUROREPORT

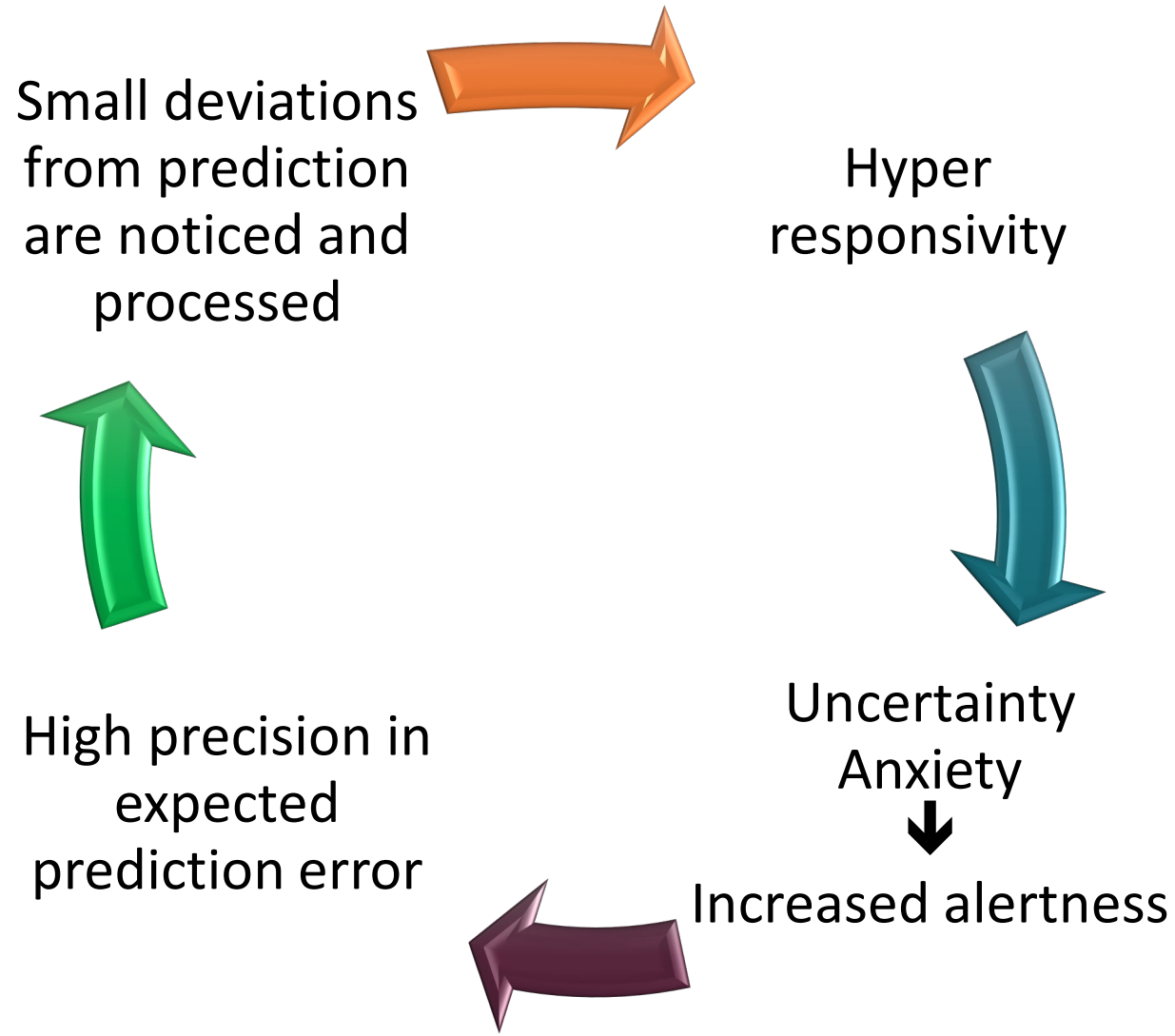
Why can't you tickle yourself?

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

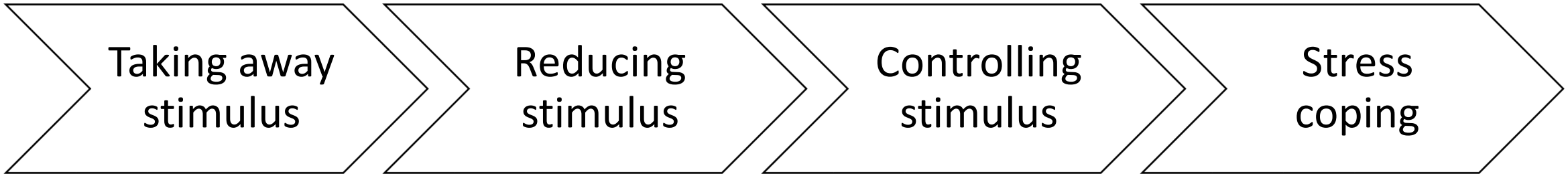
Wellcome Department of Cognitive Neurology, Institute of Neurology, University College London, 12 Queen Square, London WC1N 3BG, UK

[CA]Corresponding Author

Sensory or anxiety and uncertainty?



Strategies for sensory issues: traditional way



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

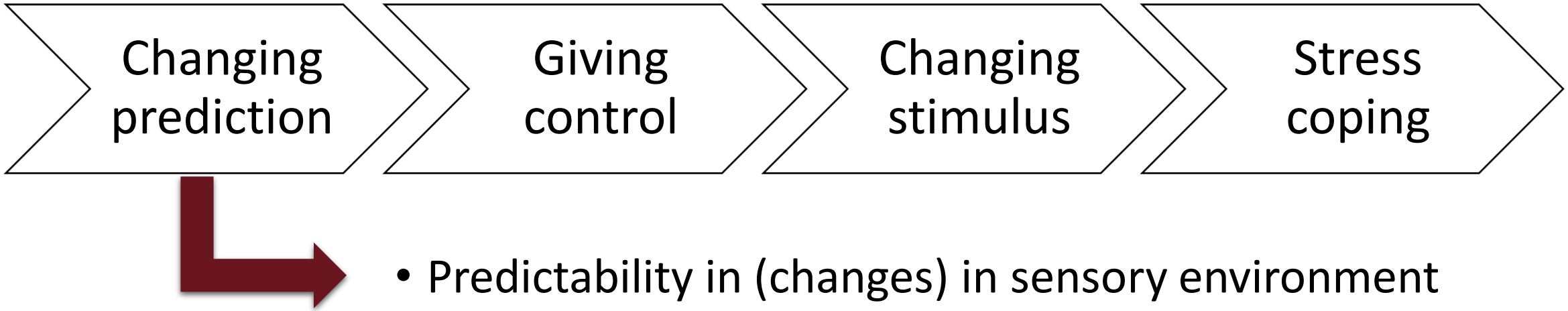
- Do not eliminate sounds, but make sounds predictable and controllable :
- Working on '**feedforward**' (*prediction*) instead of 'feedback‘ (*stimulus*)

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

(prediction errors = stress / unpleasant)

Strategies for sensory issues?

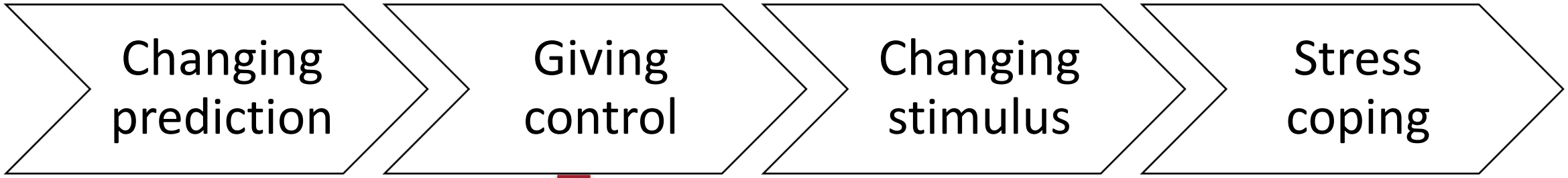
Tackle the prediction errors!



- 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 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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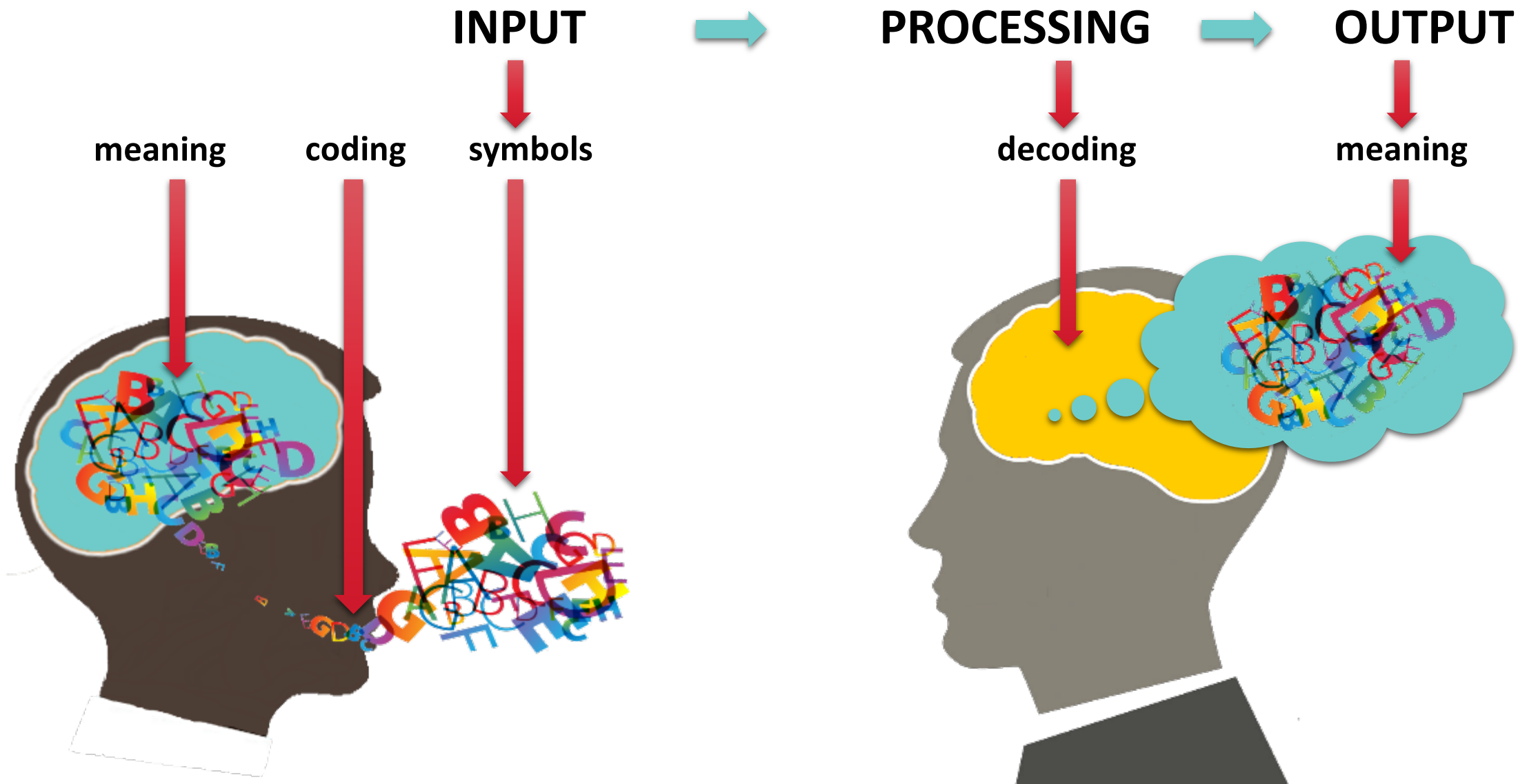
Received 6 August 2014, in revised form 2 April 2015

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

Understanding language and communication: old model



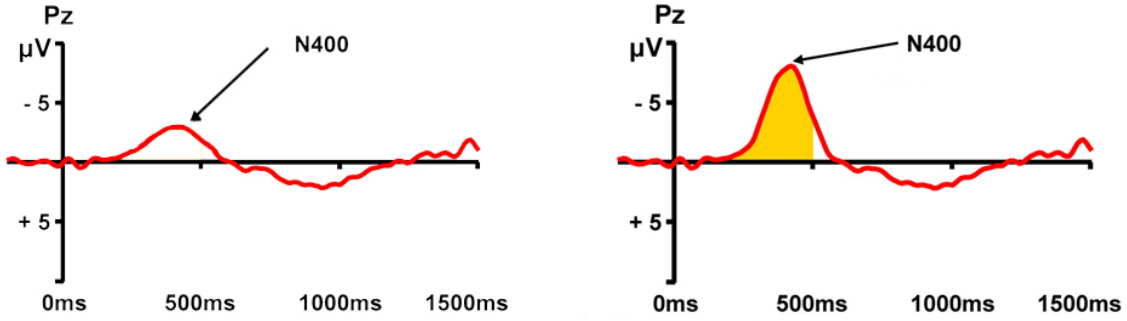
Understanding language and communication: new model

stimulus ⇄ **prediction error** ⇄ **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**



Jan eet friet met mayonaise

Jan eet friet met schoen.

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

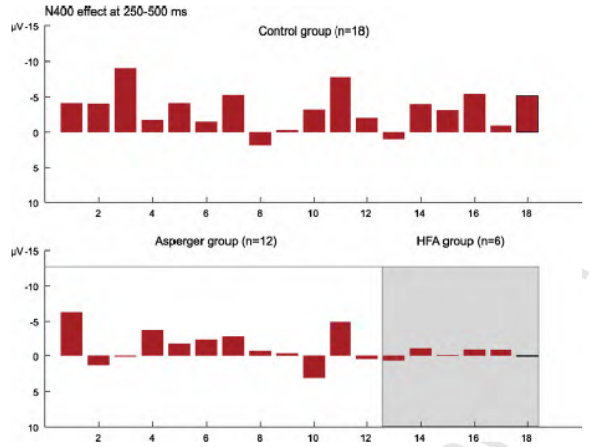


Fig. 4. Mean amplitude of the N400 effect (incongruent condition minus congruent condition in latency window 250–500 ms averaged over FCz, Cz, and Pz) for each individual participant. Negative values are plotted upward.

Special issue Cortex, July 2015

ELSEVIER

Cortex

Volume 68, July 2015, Pages 155–168

Special issue: Prediction in speech and language processing

Special issue: Review

A predictive coding framework for rapid neural dynamics during sentence-level language comprehension

Ashley G. Lewis[a, b], Marcel Bastiaansen[a, c]

Understanding language = predicting language!

Context and communication

Nothing has an absolute meaning, remember?

So, whatever we use to communicate…

words

gestures

pictures

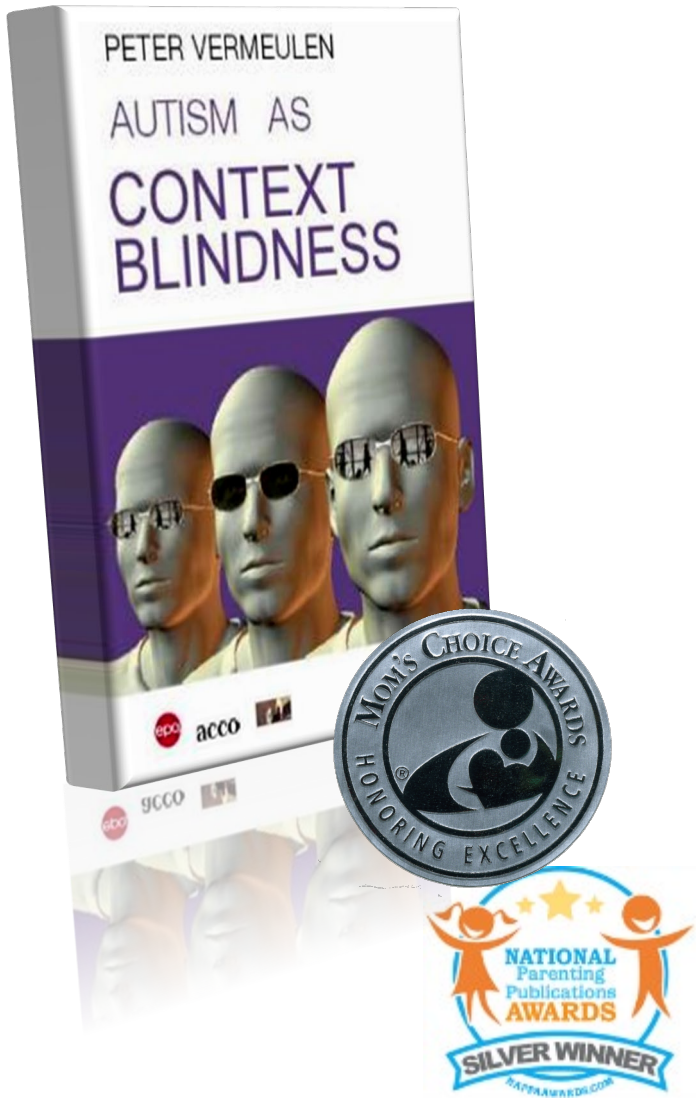
objects

…their meaning is never fixed, but depending on the context

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***

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

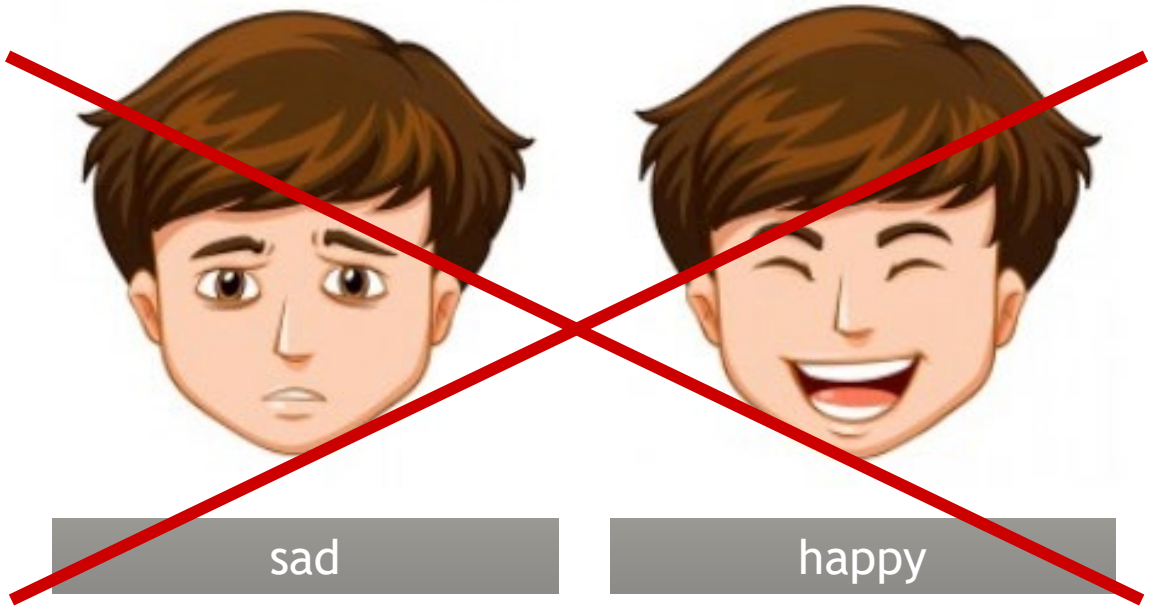
And now
something
about the actors
in the movie

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!!

emotion review

Emotion Review
Vol. 5, No. 1 (January 2013) 60–65

ISSN 1754-0739
DOI: 10.1177/1754073912451331
er.sagepub.com

Inherently Ambiguous: Facial Expressions of Emotions, in Context

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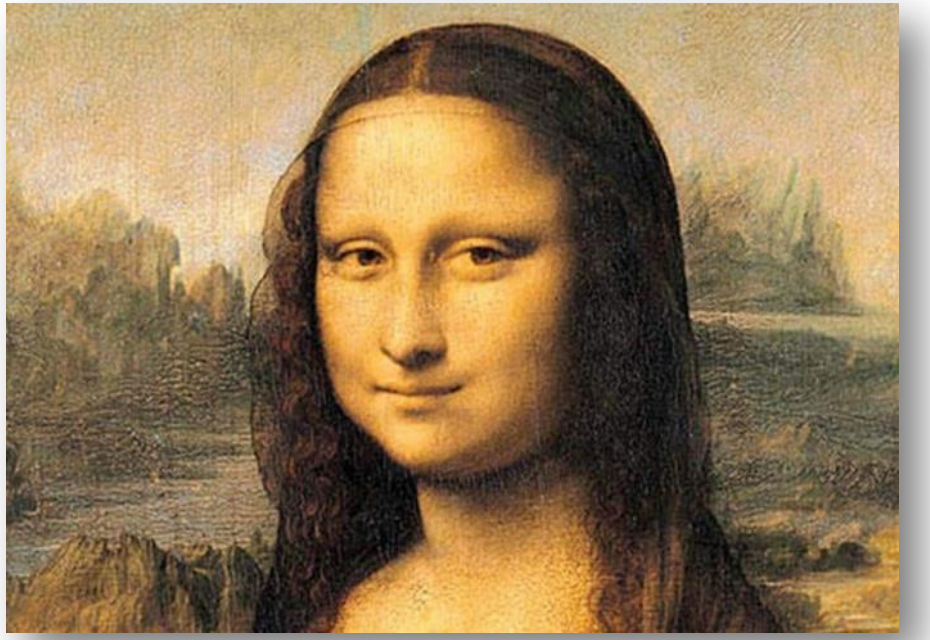


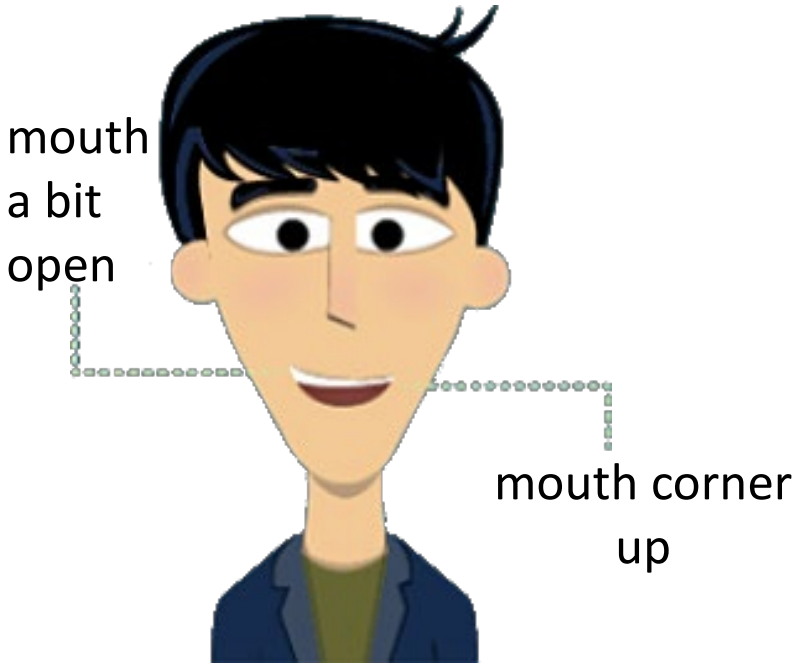
Recognizing emotions

prediction error

prediction

CONTEXT

He's pleased!



Again: context…

aps ASSOCIATION FOR PSYCHOLOGICAL SCIENCE

Current Directions in Psychological Science
20(5) 286–290

DOI: 10.1177/0963721411422522
http://cdps.sagepub.com
SAGE

Context in Emotion Perception

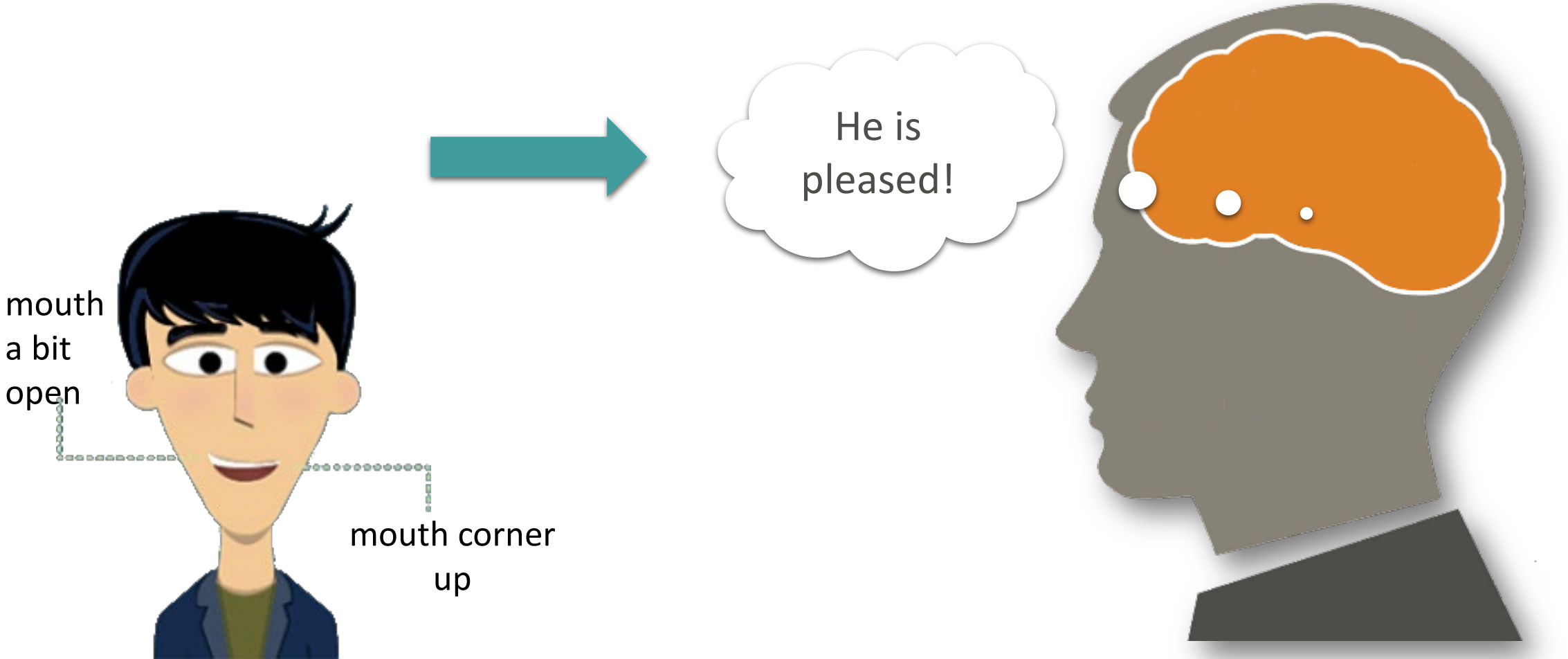
Lisa Feldman Barrett[1,2], Batja Mesquita[3], and Maria Gendron[1]
[1]Department of Psychology, Boston College, [2]Department of Psychiatry and the Martinos Center for Biomedical Imaging, Massachusetts General Hospital/Harvard Medical School, and [3]Department of Psychology, University of Leuven, Belgium

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.

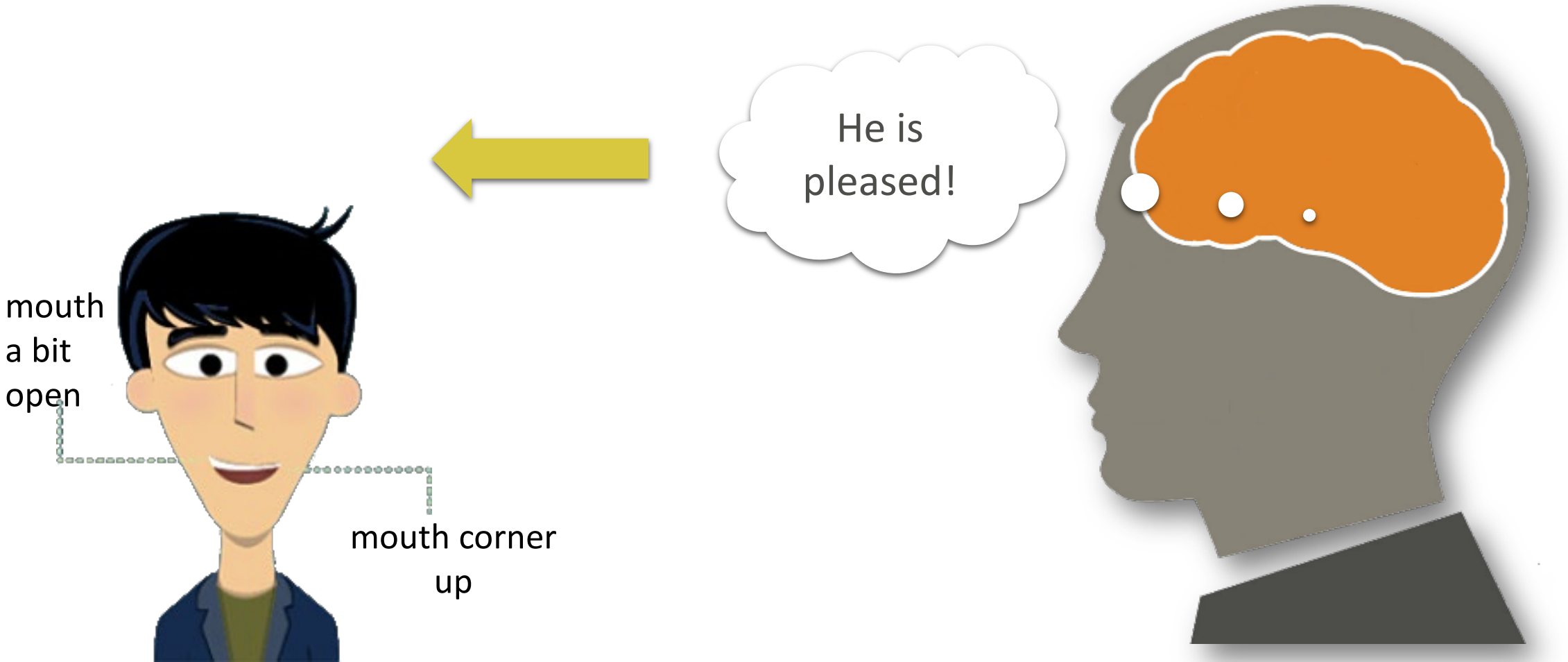
So, we thought emotion recognition went like this:

Reading emotions FROM faces



But it actually goes like this:

Reading emotions INTO faces



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)

frontiers in NEUROSCIENCE

FOCUSED REVIEW
published: 03 September 2014
doi: 10.3389/fnins.2014.00270

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

Sandra Baez*[1,2,3] *and Agustin Ibanez*[1,2,3,4,5]

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[2] *UDP-INECO Foundation Core on Neuroscience (UIFCoN), Diego Portales University, Santiago, Chile*
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[4] *Universidad Autónoma del Caribe, Barranquilla, Colombia*
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Context and social cognition

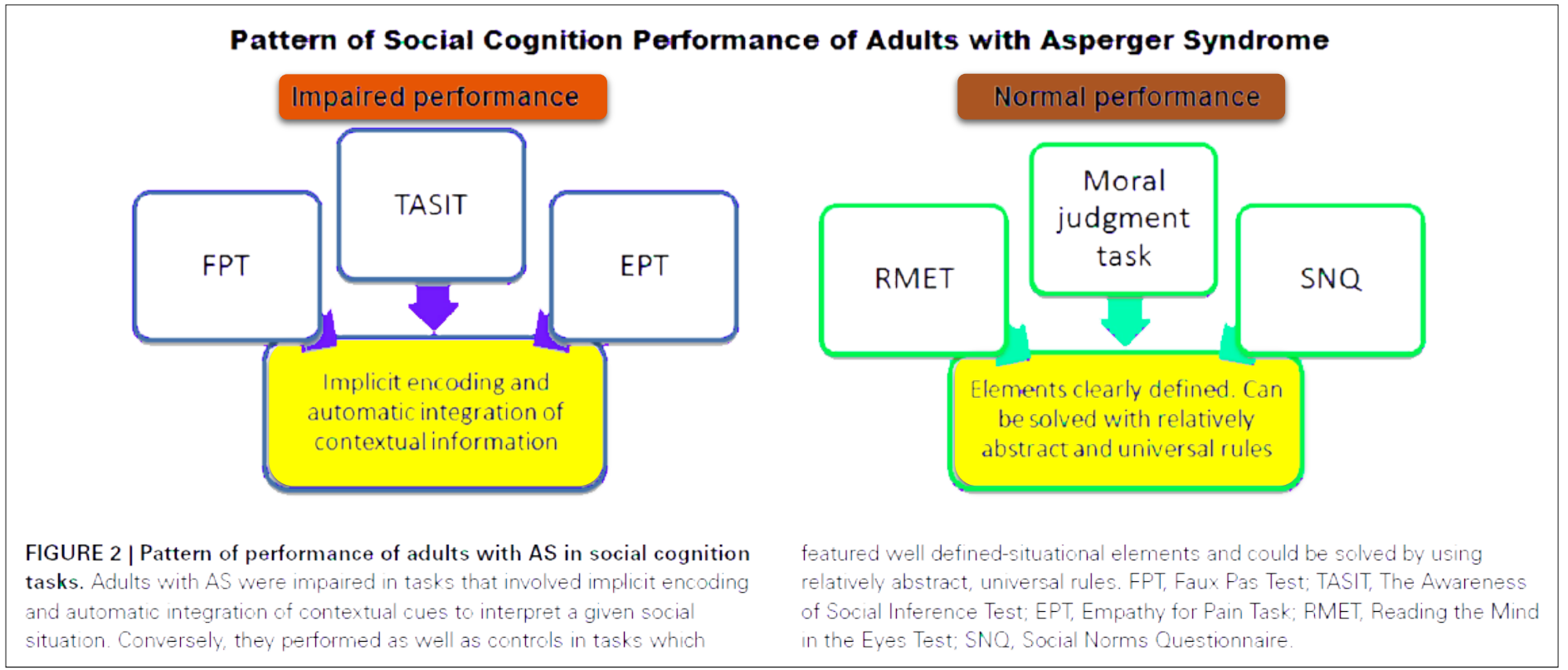

FIGURE 2 | Pattern of performance of adults with AS in social cognition tasks. Adults with AS were impaired in tasks that involved implicit encoding and automatic integration of contextual cues to interpret a given social situation. Conversely, they performed as well as controls in tasks which featured 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*…

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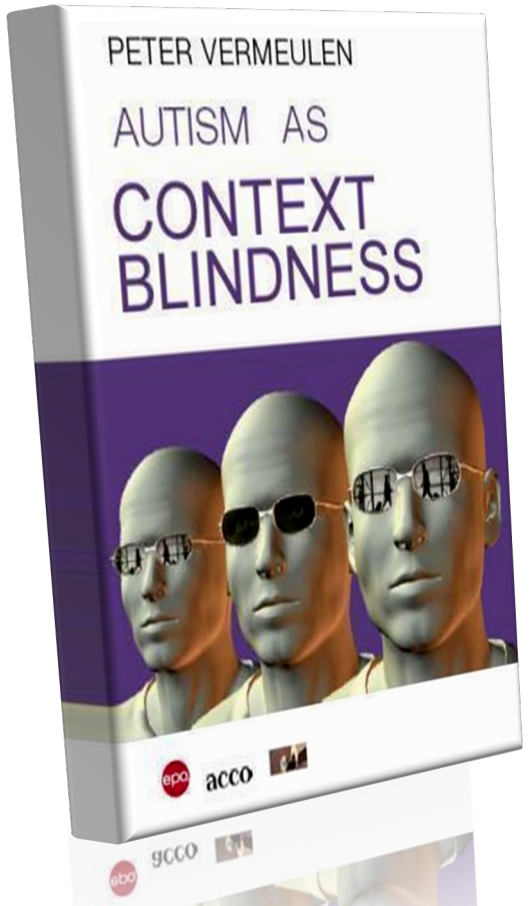

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