Cognition and Plasticity Lab
Prof. Heleen Slagter

Meditation through the lens of predictive processing

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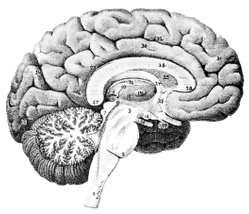

Overview:

Elements of Predictive Processing

Elements of Meditation

Interaction

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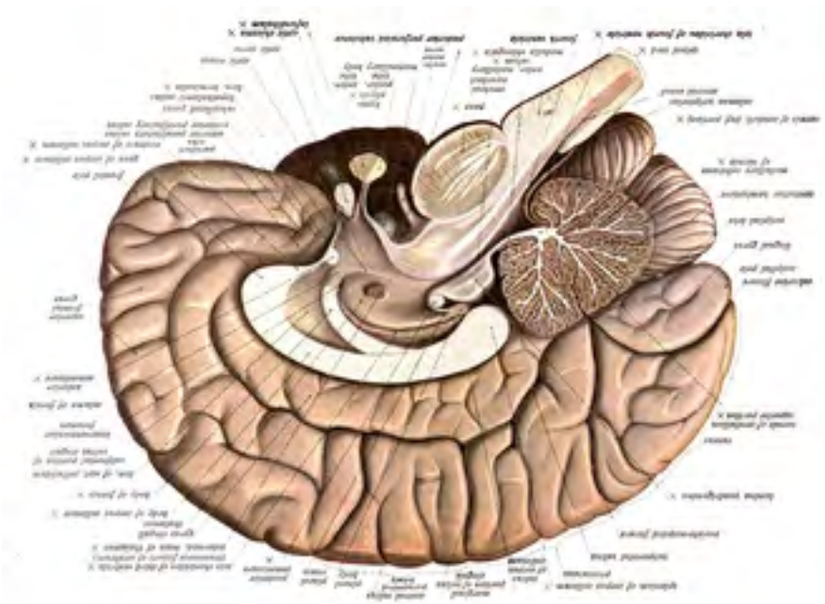

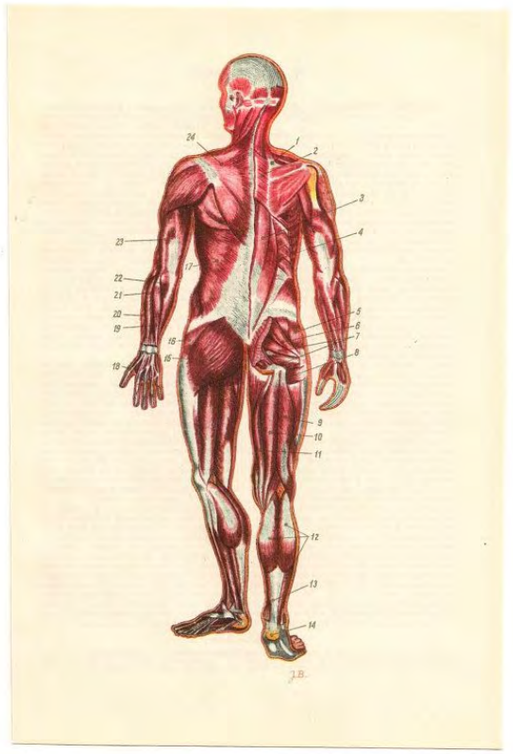
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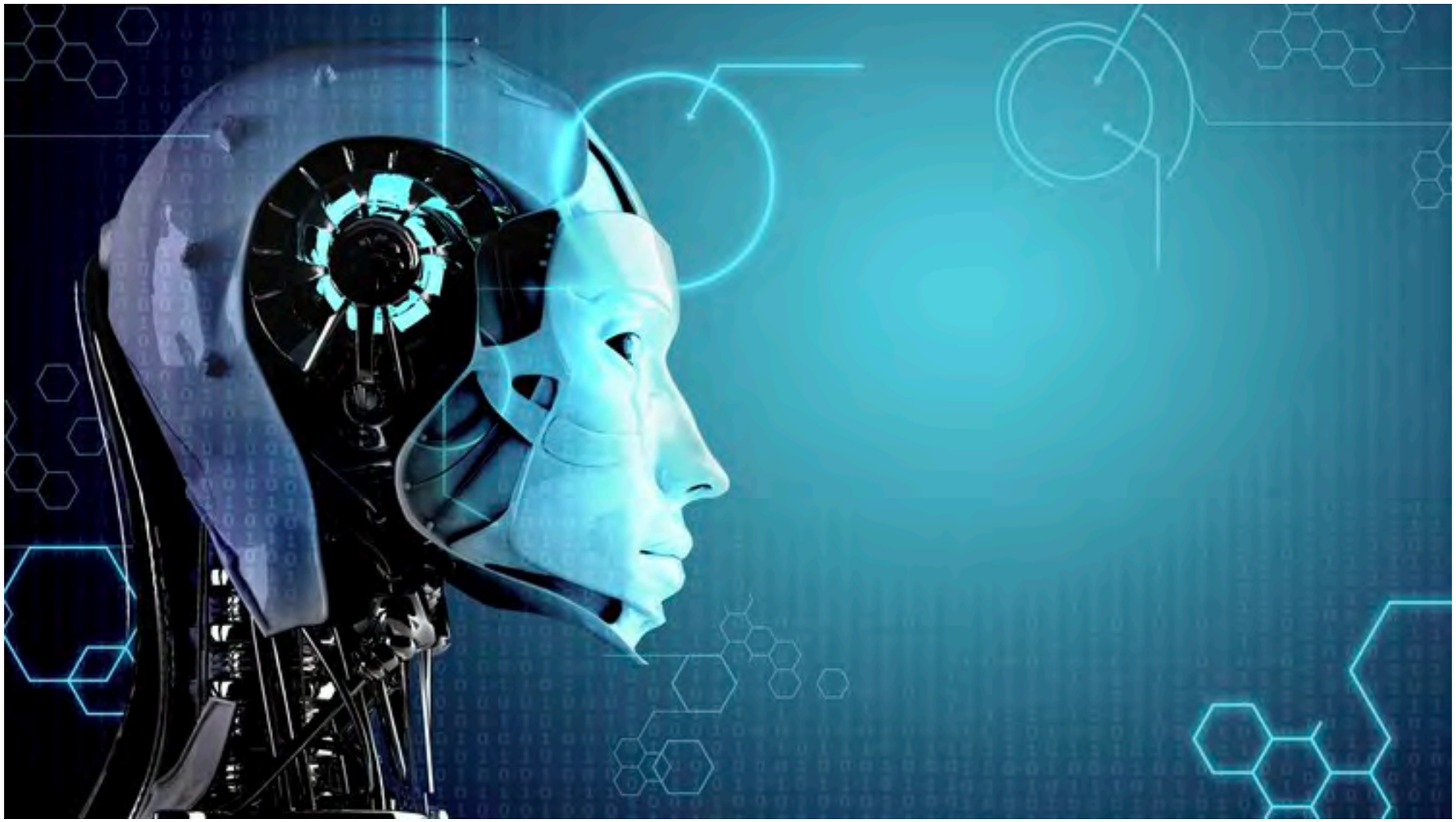

“…the only person who truly understands Karl Friston’s free energy principle may be Karl Friston himself.”

Shaun Raviv - Wired, 2018

Fristonian ± English

Jakob Hohwy (2013)
Andy Clark (2013)

Key elements of predictive processing:

An organisms survival depends on… “precision weighted prediction error minimisation”

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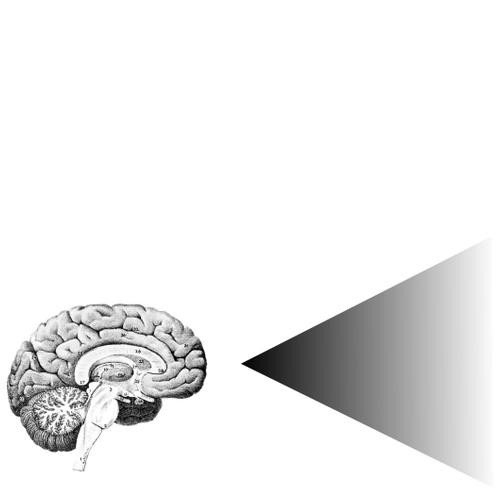
Key elements of predictive processing:

An organisms survival depends on… “precision weighted prediction **error minimisation**”

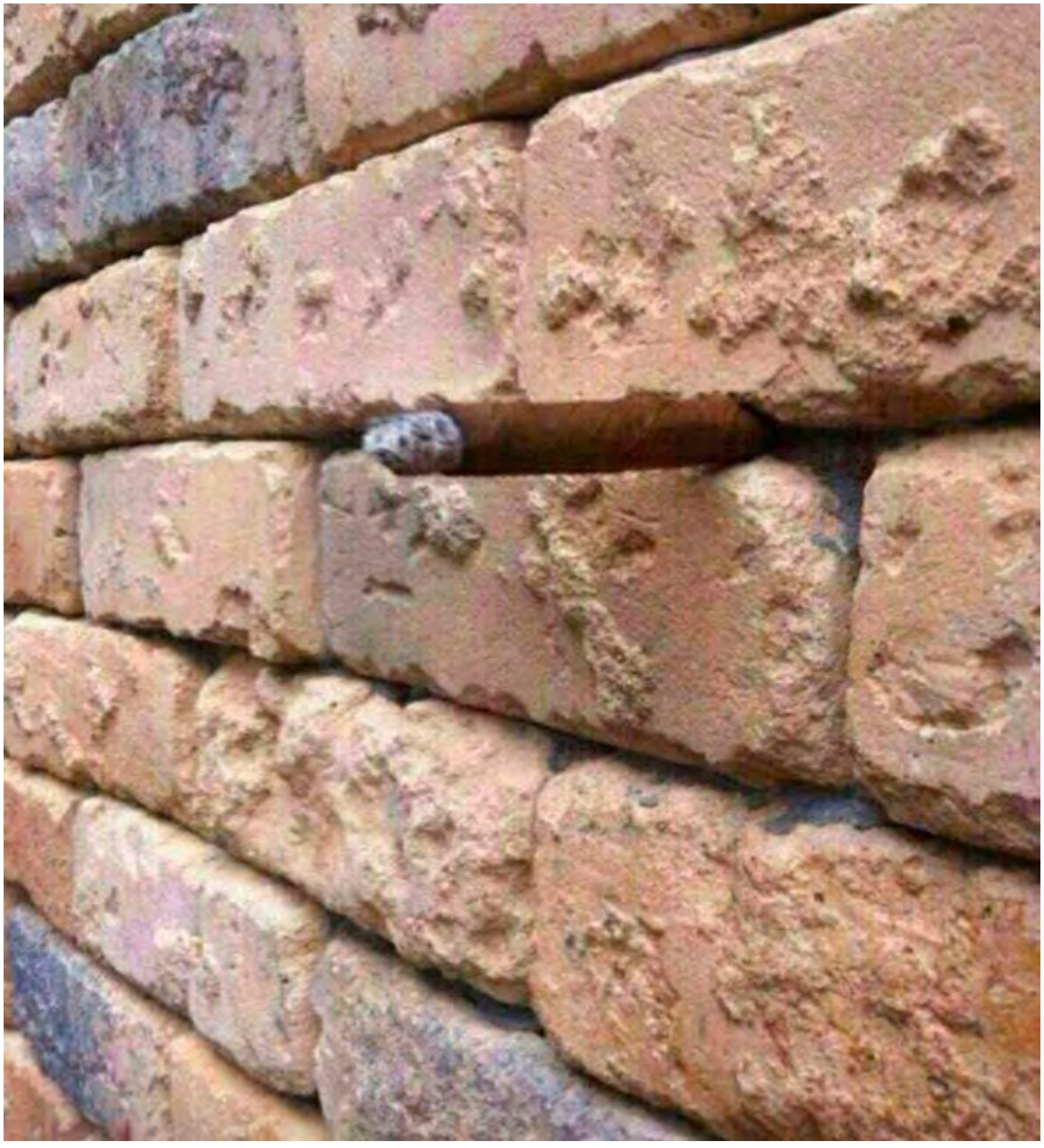
Key elements of predictive processing:

PREDICTION



The brain is continually predicting sensory input based on its best guess…

Perception and experience is a "…controlled hallucination" (Anil Seth, 2017)



Key elements of predictive processing:

PREDICTION ERROR

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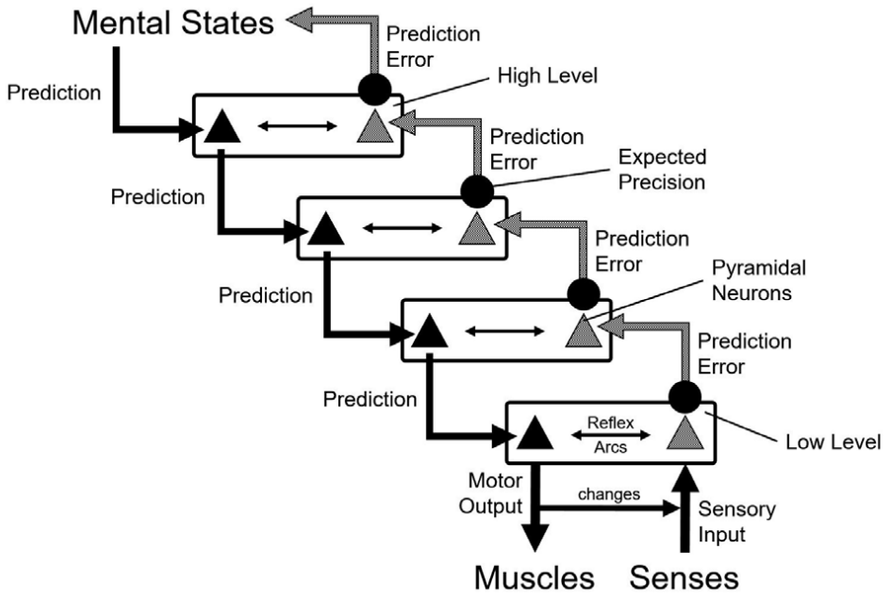


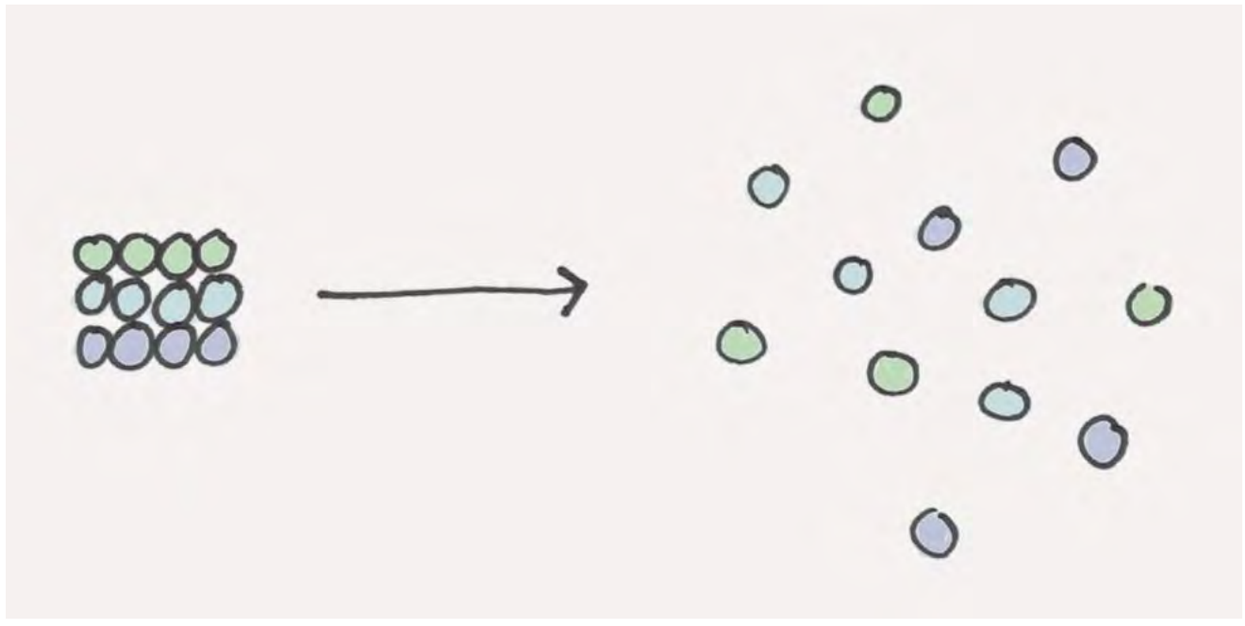
$$P(A|B) = \frac{P(B|A) \times P(A)}{P(B)},$$

…a probabilistically rational way to update beliefs given prior belief and new data

Key elements of predictive processing:

ERROR MINIMISATION

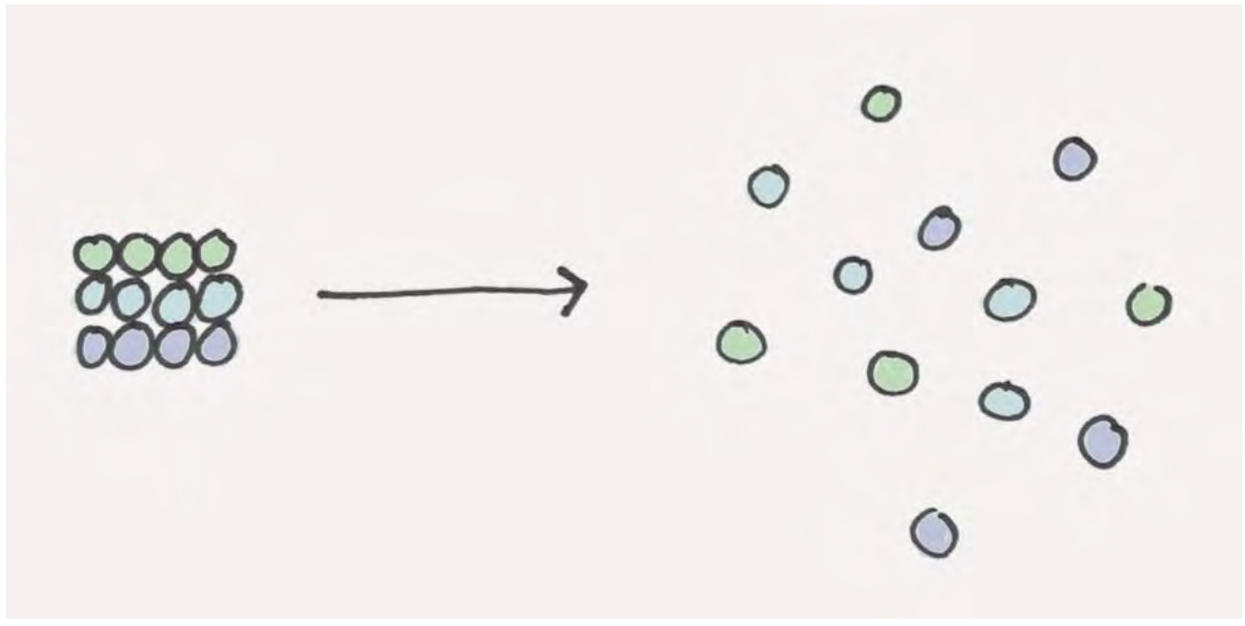
Low error = Low entropy = A useful model = Appropriate behaviour = Organism



Key elements of predictive processing:

ERROR MINIMISATION

High error = High entropy = A bad model = Inappropriate behaviour = No organism



Key elements of predictive processing:

ERROR MINIMISATION

Revise

Confirm

ERROR MINIMISATION

Revise

Perceptual inference:

Through *perceptual* inference, we reduce prediction error (equivalent to entropy) by updating our models so that they are more consistent with sensory inputs.

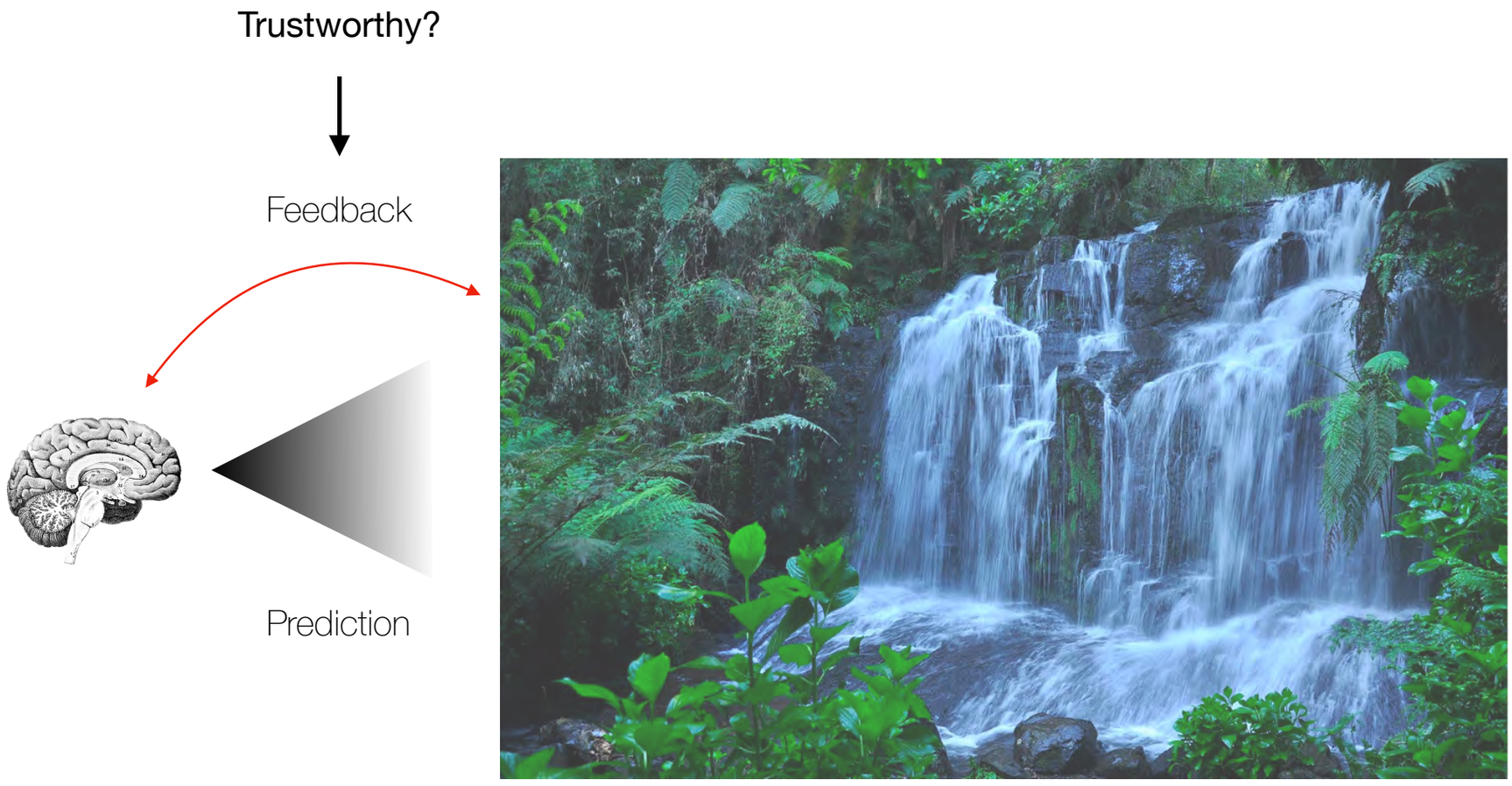
Confirm

Active inference:

Through *active* inference, we reduce prediction error (equivalent to entropy) by moving the body or our attention in a way that makes our prediction seem true.

Key elements of predictive processing:

PRECISION WEIGHTING



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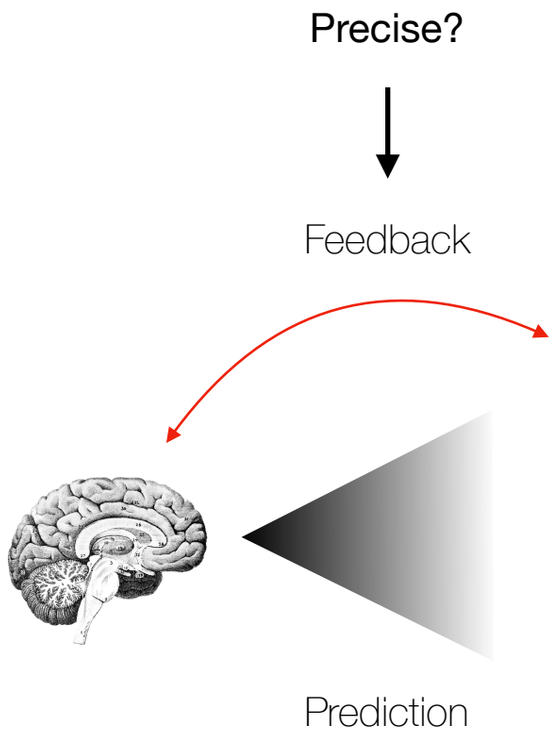
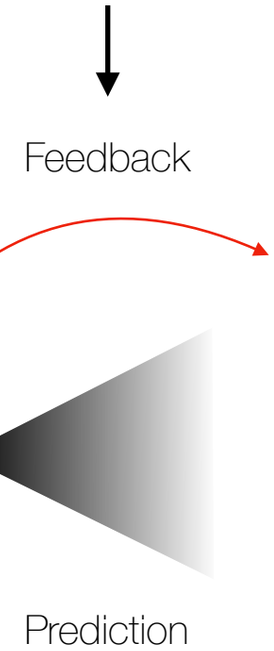


Key elements of predictive processing:

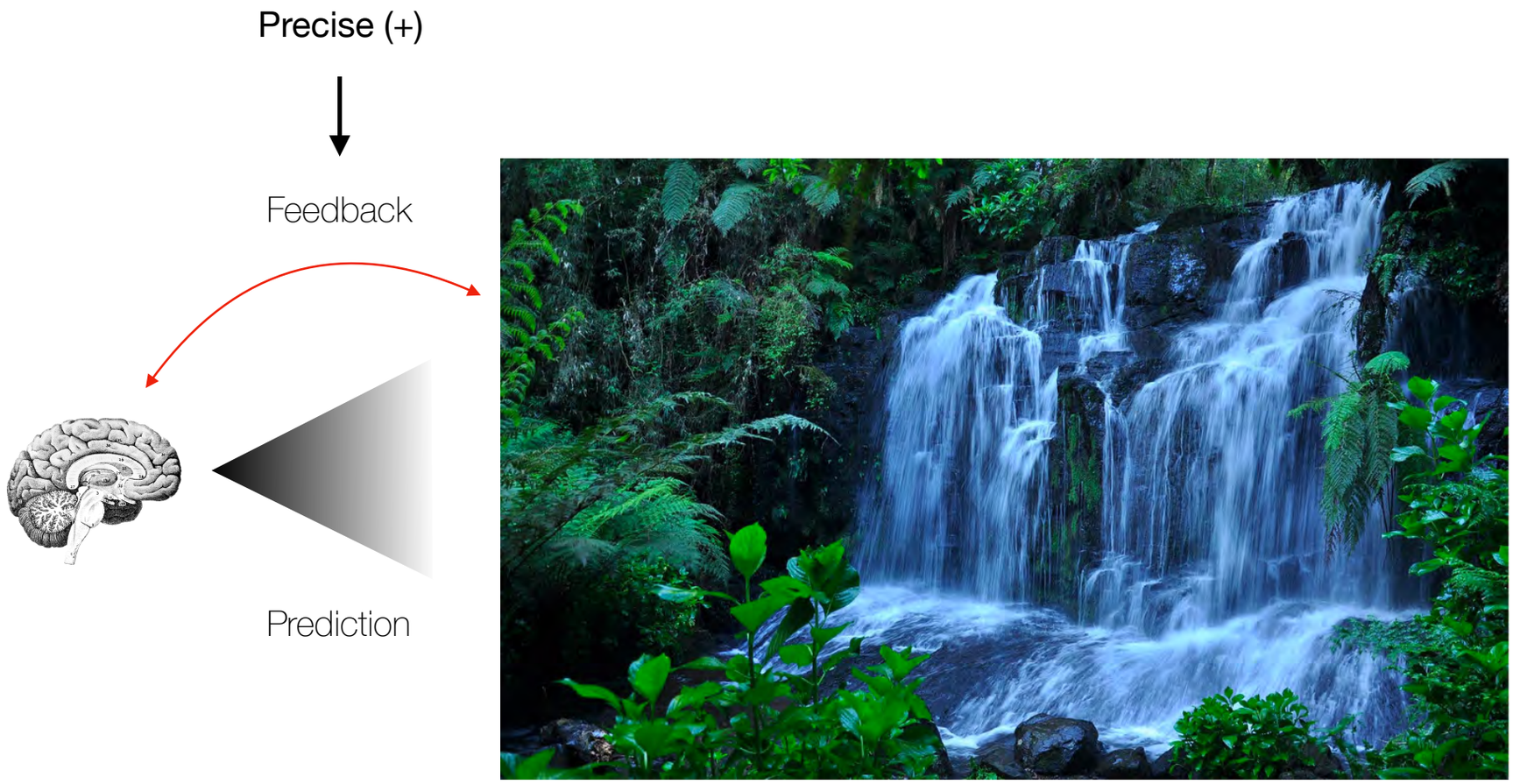
PRECISION WEIGHTING

Precise (-)



Key elements of predictive processing:

PRECISION WEIGHTING



Key elements of predictive processing:

ERROR MINIMISATION

Precise (+) Revise

Perceptual Inference

Precise (-) Confirm

Active Inference

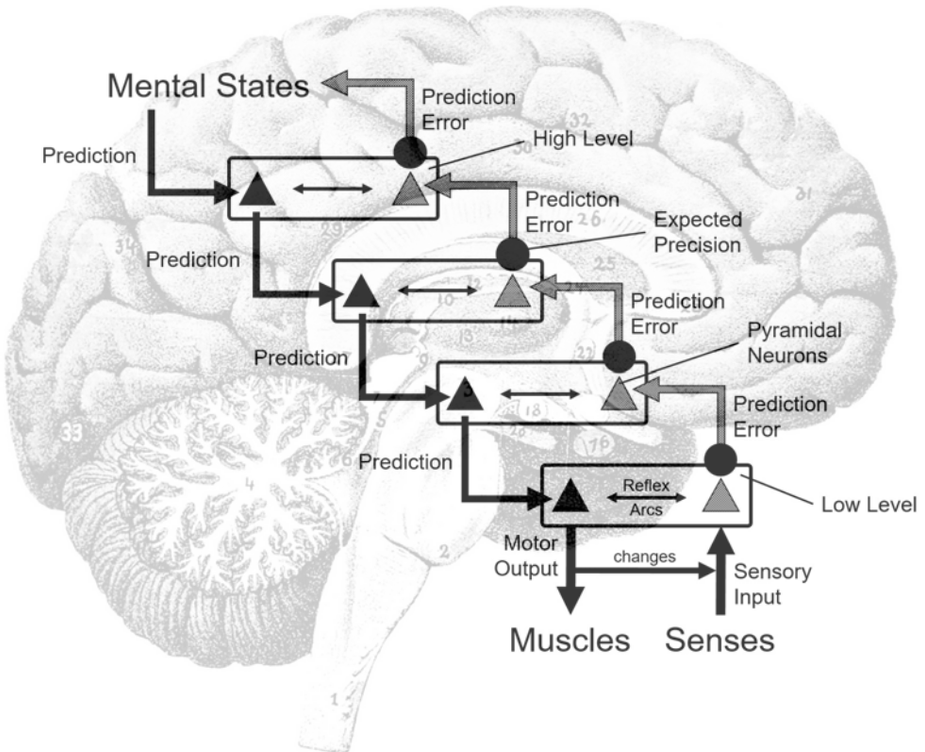
Key elements of predictive processing:

Attention & Precision Weighting

Attention is equivalent to the expected precision of sensory input. If you pay attention to something, you deem it more trustworthy. Can be top-down or bottom-up.

Key elements of predictive processing:

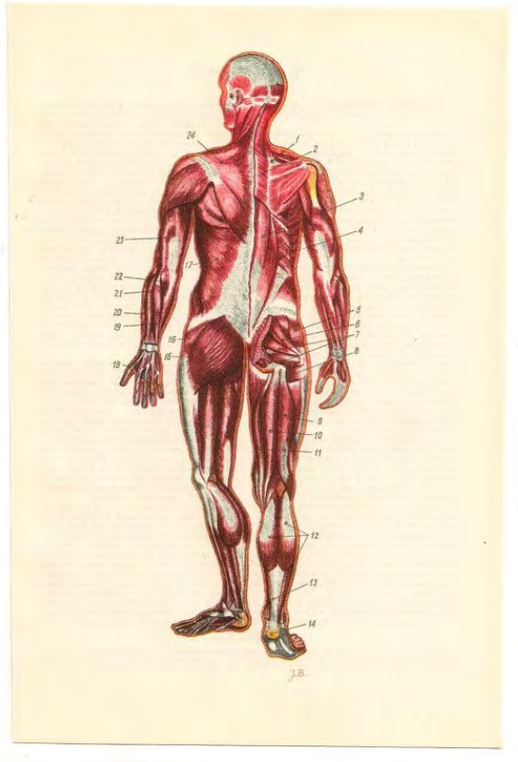
An organisms survival depends on… “precision weighted prediction error minimisation”



Key elements of predictive processing:

Prediction error

My survival depends on making my expectations and the world as harmonious as possible, so that I'm not surprised too often. Surprises are bad.



Error minimization

My main 'goal' is to make the world less surpris
make things less surprising by changing my ex
(my perception), or changing the way the worlc
(my actions).

Precision weighted

I'll change my expectations if I think the feedba
trustworthy. And I'll change my feedback if I thir
expectations are more trustworthy.

Hierarchical

I do this a lot, all the time, on multiple levels.

Everything we do and experience is in service of reducing surprises by fulfilling fantasies

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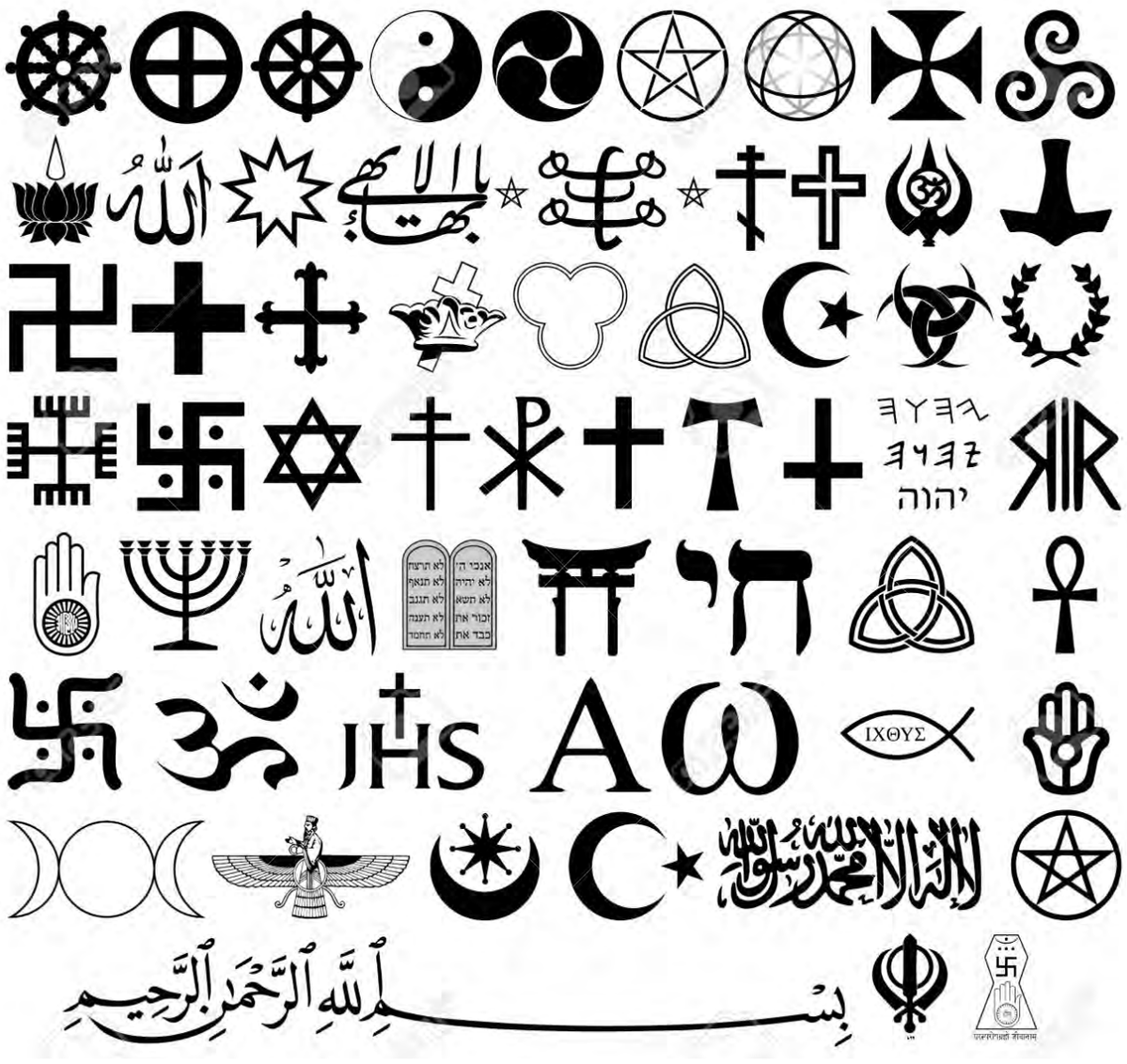
Key elements of meditation:



Focused Attention

Open Monitoring

Non-Dual

Lutz, Slagter, Dunn, & Davidson, 2008 - *Attention Regulation and Monitoring in Meditation*

Dunne, 2005 - *Toward an Understanding of Non-Dual Mindfulness*

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Advaita Vedanta (in India) ± 500 BCE.

Mahāmudrā (in Tibet) : ± 700 CE.

Dzogchen (in Tibet) : ± 800 CE.

Shikantaza (in Japan) : ±1100 CE.

Ashtavakra Ghita (400-1400 BCE)

Set your body aside. Sit in your own awareness.
Meditate on the Self. One without two…
In meditation, he does not meditate.

Karma Wangchûg Dorjé (1556 -1587):

Do not pursue the past. Do not usher in the future.
Rest evenly within present awareness, clear and nonconceptual.

An interpretation of an inscription by Hongzhi Zhengjue (1091—1157):

“[silent illumination] involves withdrawal from exclusive focus on a particular sensory or mental object to allow intent apprehension of all phenomena as a unified totality. This *objectless* meditation aims at a radical, refined nondualism that does not grasp at any of the highly subtle distinctions to which our familiar mental workings are prone and which estranges us from our experience. Such subject-object dichotomization is understood as artificial, a fabrication…” (Leighton, 2000)

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Mindfulness (2017) 8:27–37
DOI 10.1007/s12671-015-0438-x

ORIGINAL PAPER

Remembrance of things to come: a conversation between Zen and neuroscience on the predictive nature of the mind

Giuseppe Pagnoni[1] · Fausto Talten Guareschi[2]

Published online: 12 August 2015

Abstract The notion of the brain as a predictive organ following Bayesian principles has been steadily gaining favor in neuroscience. This perspective, which has broad theoretical and applicative consequences, suggests also a novel way to look at the mind-body processes mobilized by meditative practices. In this article, the topic is introduced and subsequently explored as a conversation between a neuroscientist (GP) and the abbot of a Zen Sōtō monastery (FTG). We believe that such 'mutual perturbations' between the third-person descriptions provided by scientific research and the phenomenological depth of Buddhist lore have a great potential for advancing our understanding of both brain function and meditation.

Keywords Predictive coding · Meditation · Bayes · Free energy · Autopoiesis · Neurophenomenology · Zen · Zazen

Thompson 2003). While the number of studies on the cognitive and neural effects associated with meditation has shown an impressive growth in the last decade, the neurophenomenological programme has not flourished as fast as initially hoped. A potential factor lies in the lack of a theory of brain function that is general enough, yet enough articulated, to provide a plausible interpretative framework for both the neural and the mental domain. A promising candidate in this sense is the recent formulation by Friston (2010) of the minimization of free energy as a unifying explanatory principle for a strikingly large variety of neural, cognitive and biological processes. In the following, the main features and implications of this theory are illustrated and discussed as an informal dialogue between a neuroscientist (GP) and the abbot of a Zen Sōtō monastery (FTG).

GP

The contemplative exercise through the lenses of predictive processing: A promising approach

Giuseppe Pagnoni*

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Abstract

The theory of predictive processing in the comprehensive articulation proposed by Karl Friston is a framework that boasts an impressively wide explanatory power in neurobiology, where processes apparently as diverse as perception, action, attention, and learning unfold, and are coherently orchestrated, according to the single general mandate of free-energy minimization. In the present opinion piece, I argue that the adoption of this theoretical perspective can provide a much needed unitary framework for contemplative research as well, whose explosive growth in terms of the number of published studies and amount of collected data has not been matched yet by a similarly extensive effort to theoretically organize the findings, so that a deeper understanding of meditation-related processes can be attained. After an introduction to the basic notions of predictive processing, a tentative application of the latter to the meditative exercise is discussed, taking as a paradigmatic example the Japanese Zen meditation practice of *shikantaza*. Finally, I provide a short list of experimental paradigms that seem particularly useful to test the hypotheses born out of the predictive processing approach to contemplative research.

Available online at www.sciencedirect.com
ScienceDirect
Current Opinion in Psychology
ELSEVIER

The epistemic and pragmatic value of non-action: a predictive coding perspective on meditation

Antoine Lutz[1,5], Jérémie Mattout[1] and Giuseppe Pagnoni[2,3,4]

The surge of interest about mindfulness meditation is associated with a growing empirical evidence about its impact on the mind and body. Yet, despite promising phenomenological or psychological models of mindfulness, a general mechanistic understanding of meditation steeped in neuroscience is still lacking. In parallel, predictive processing approaches to the mind are rapidly developing in the cognitive sciences with an impressive explanatory power: processes apparently as diverse as perception, action, attention, and learning, can be seen as unfolding and being coherently orchestrated according to the single general mandate of free-energy minimization. Here, we briefly explore the possibility to supplement previous phenomenological models of focused attention meditation by formulating them in terms of active inference. We first argue that this perspective can account for how paying voluntary attention to the body in meditation helps settling the mind by downweighting habitual and automatic trajectories of (pre)motor and autonomic reactions, as well as the pull of distracting spontaneous thought at the same time. Secondly, we discuss a possible relationship between phenomenological notions such as opacity and de-reification, and the deployment of precision-weighting via the voluntary allocation of attention. We propose the adoption of this theoretical framework as a promising strategy for contemplative research. Explicit computational simulations and comparisons with experimental and phenomenological data will be critical to fully develop this approach.

Introduction

In recent years, the cognitive neuroscience community has taken a substantial interest in the purported effects of contemplative practices. Most of the studies have focused on developing psychological or phenomenological models of meditation, or on investigating the behavioral outcomes, neural correlates, or changes in specific cognitive functions or biological markers of meditative practice [1,2,3*]. While this is a common developmental trajectory for pioneering research topics, we believe that significant further advances will depend on the successful modeling of the processes engaged by meditation within a mechanistic and quantitative framework of wide explanatory power, which can link together the core notions of attention, action, and perception.

The theory of predictive processing, especially in its more articulated proposal of the free-energy minimization principle (FEP) by Friston, seems to possess such an appeal [4**]. According to the FEP, biological systems fundamentally obey the single imperative of minimizing the long-term average surprise. For living beings, this means avoiding the likelihood of finding themselves in states at odds with their phenotype, and can be easily understood in terms of the physiological notion of homeostasis, where

What's common?

1. Inhibition of movement
2. Stability of attention to here and now
3. Releasing thoughts and expectations
4. Equanimous and unconditional

1. Inhibition of movement

1. Inhibition of movement

ERROR MINIMISATION

Revise

Confirm

1. Inhibition of movement

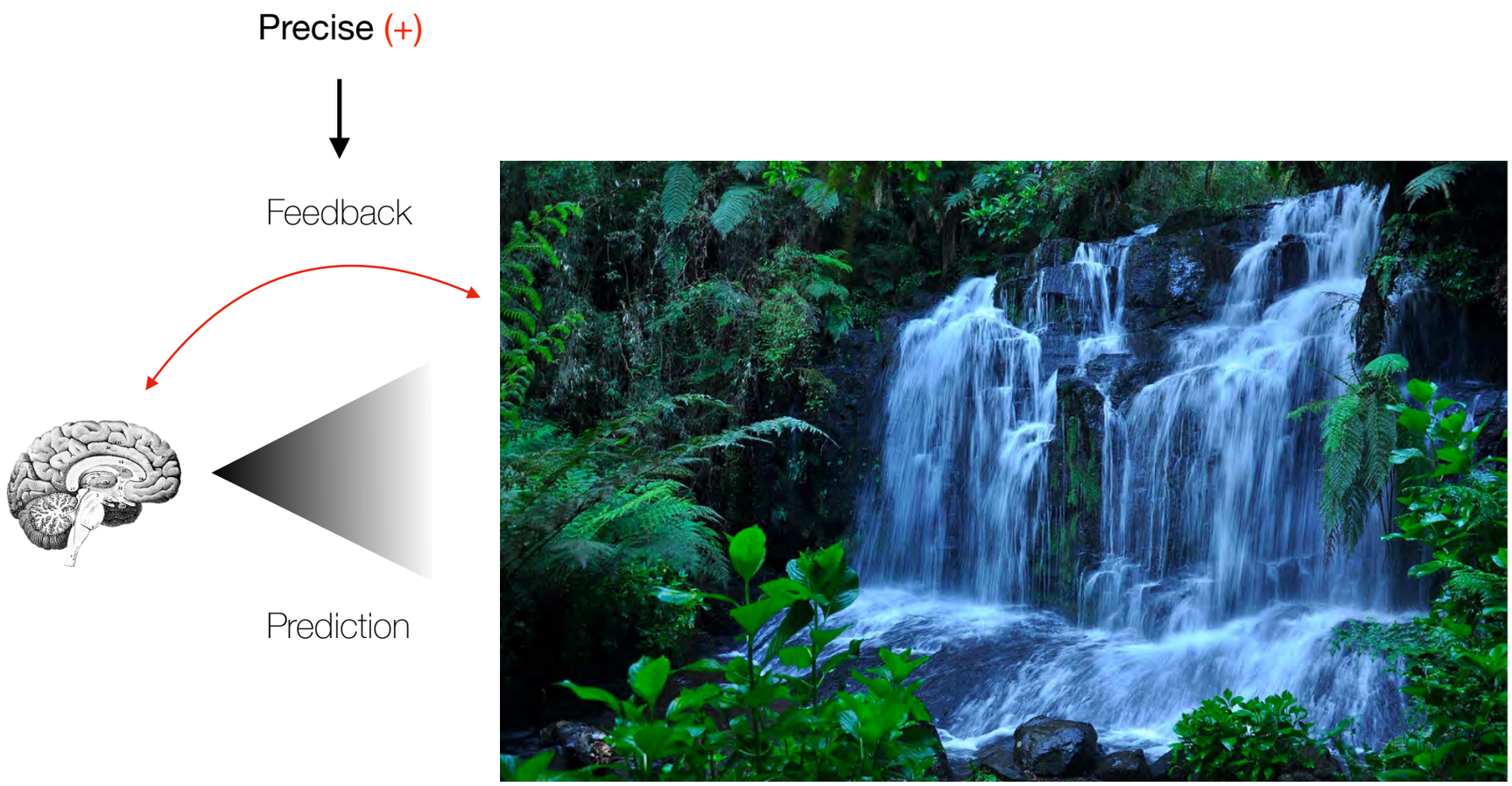
Inhibition of overt active inference through immobility of movement.

A bias towards revising one's beliefs rather than sensory inputs.

2. Stability of attention to here and now

2. Stability of attention to here and now

PRECISION WEIGHTING



2. Stability of attention to here and now

Sustained expectation of high precision for sensory and proprioceptive information, and therefore decreased expectation of high precision for thinking and conceptualisation.

Here and now experience is more trustworthy than thinking.

Inhibition of overt active inference through immobility of attention.

A bias towards revising beliefs rather than sensory inputs.

GALVÃO BERTAZZI
2016
www.galvaobertazzi.tumblr.com

3. Releasing thoughts and expectations

Weakened top-down influence and decreased frequency of high-level predictions through decreased expectation of precision for thoughts, particularly relating to autobiographical mind-wandering and goal-setting.

Releasing thoughts decreases their precision or ‘trustworthiness’, and by not actively engaging expectations or goals there may also be an accompanying decrease in prediction error (goals and expectations lead to an inconsistency between sensory input and the imagined state, and hence to actions to resolve PE).

4. Equanimous and unconditional

Decreased frequency and expected precision for high level predictions relating to evaluation and judgment.

The prediction that ‘this state is contrary to a preferable state’ may be gradually attenuated, which may result in less prediction error and less active inference.

What's common?

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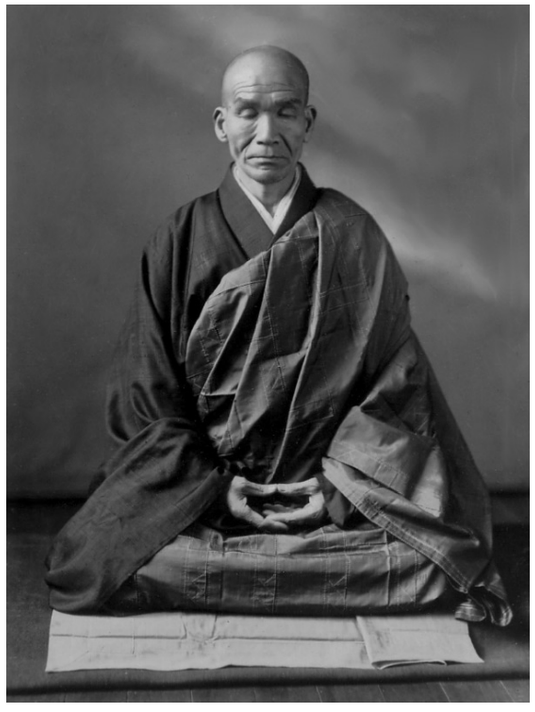
2. Stability of attention to here and now
3. Releasing thoughts and expectations
4. Equanimous and unconditional

What's common?

1. Inhibition of movement
2. Stability of attention to here and now
3. Releasing thoughts and expectations
4. Equanimous and unconditional

1. Inhibition of overt active inference through immobility of movement
2. Sustained expectation of high precision for sensory and proprioceptive information, and therefore decreased expectation of high precision for thinking and conceptualisation.
3. Weakened top-down influence and frequency of high-level predictions through decreased expectation of precision for thoughts, particularly relating to autobiographical mind-wandering and goal-setting.
4. Decreased frequency of high-level predictions relating to evaluation and judgment.



Long Term Practice

1. Strong bias towards revising beliefs to be consistent with sensory input which may result in more accurate predictions relating to proprioceptive information.
2. Initial increase in prediction errors may be later accompanied by far fewer prediction errors and therefore an overall decrease in average ‘entropy’ associated with sensory input.
3. Overall decrease in high level predictive processing and therefore further decreases in long-term average prediction errors.
4. …overall less entropy in the system (a more stable organism(?)).

(-) entropy

(+) Quiescence

(+) Wellbeing

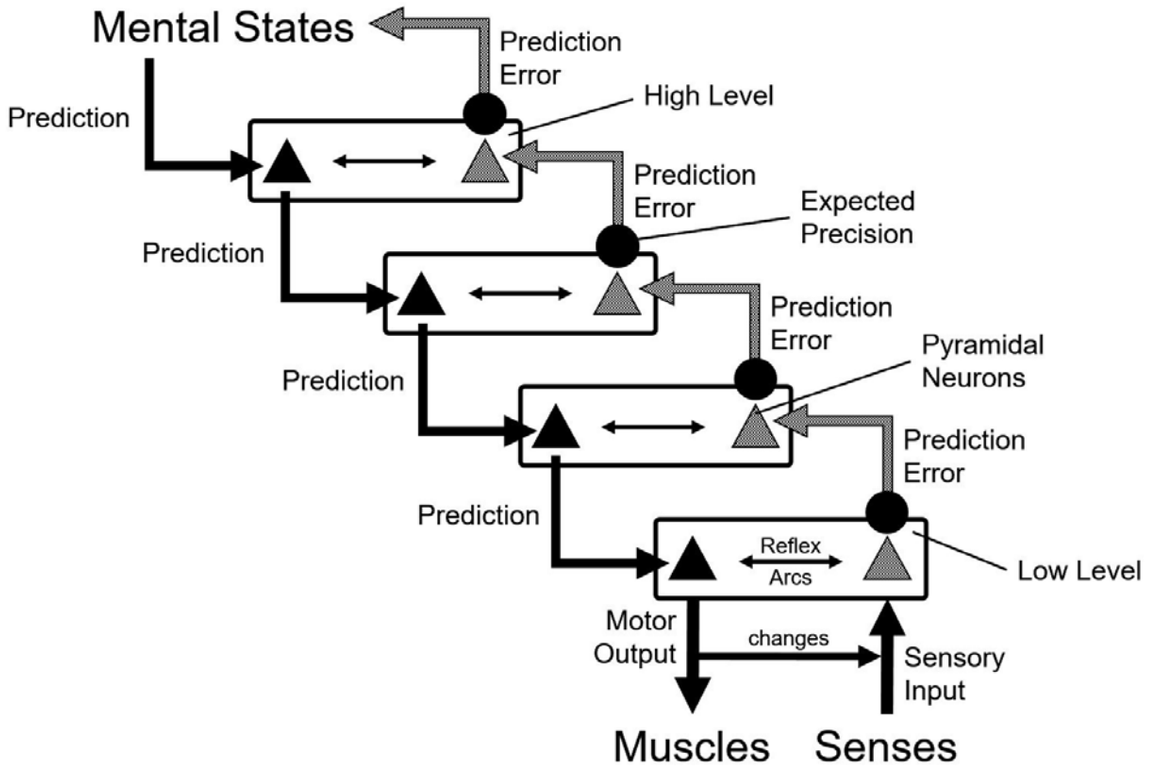
(+) Peacefulness

(+) Tranquility

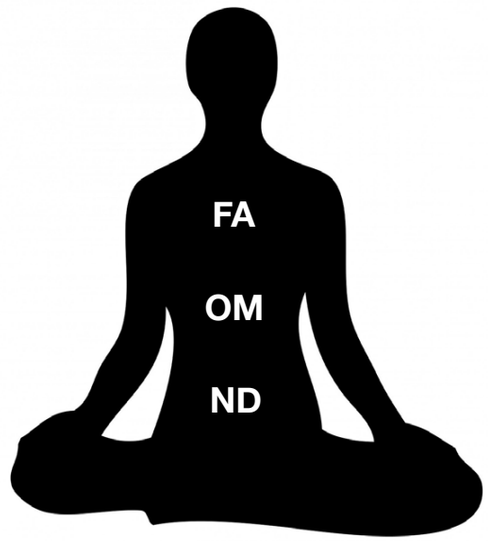
Non-Duality & ‘No Self’

Meditation disrupts the predictive processing hierarchy(?)

“[silent illumination] involves withdrawal from exclusive focus on a particular sensory or mental object to allow intent apprehension of all phenomena as a unified totality. This *objectless* meditation aims at a radical, refined nondualism that does not grasp at any of the highly subtle distinctions to which our familiar mental workings are prone and which estranges us from our experience. Such subject-object dichotomization is understood as artificial, a fabrication…” (Leighton, 2000)



High level predictions (thinking & mindwandering)



Most abstract

Thinking (concepts)

Sensing (objects of perception)

Being (subjectivity itself)

/time/self/duality

Awareness

Least abstract

Low level predictions (sensing & awareness)

The brain is a prediction machine. It creates fantasies and then tries to fulfill those fantasies in order to reduce the entropy that was caused by the fantasy. Creating an endless pursuit of fantasies that induce entropy.

Humans are craving machines. They create desires and then try to fulfill those desires in order to reduce the suffering caused by the desire. Creating an endless Samsara full of Dukkha.

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