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The Biology of Reality Testing - Implications for Cognitive Education

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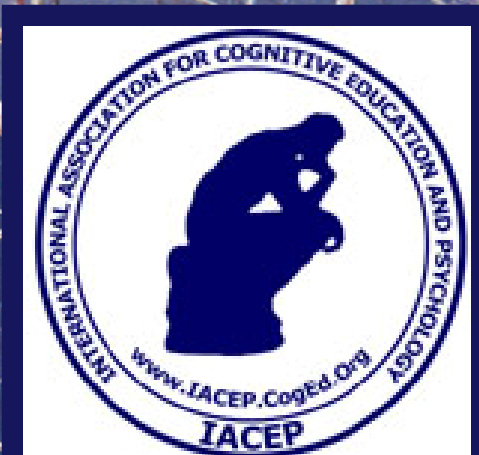
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The Biology of Reality Testing

and its implications for cognitive education

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February 5, 2010

We derive our beliefs...



Roger Bacon (1268)

“...through argument and experience.

Argument brings conclusions and compels us to concede them,

but does not cause certainty nor remove the doubts

in order that the mind may remain at rest in truth,

unless this is provided by experience.”



Kant: "The senses cannot think,
the understanding cannot see."

Traditional Paths to “Truth”

- **FEELING**

- Emotion, autonomic arousal

- **AUTHORITY**

- social referee; more knowledgeable other

- **REASON**

- “understanding cannot see”; apparent coherence; textual integrity; external validation

- **SENSORY PERCEPTION**

- “senses cannot think”; correspondence; internal validation

– Felipe Fernández-Armesto ..



TRUTH is a BELIEF

Belief is the psychological state in which an individual is more-or-less confident in the **validity** of a proposition.

(confidence can translate into biological fitness)

Validity can be more-or-less **internal**

(limited generality; e.g., individual enhances self-confidence) or **external** (broad generality; e.g., enhancing social confidence)

VALIDITY

- ***INTERNAL VALIDITY*** (*narrow context*)
- ***Confidence*** in percept can be increased by **consistent reconfirmations** of personal experiences; highly reliable repetitions.... Private; enhances **self-confidence**

- ***EXTERNAL VALIDITY*** (*broad context*)
- ***Confidence*** in percept requires that it is perceived to be of enlarged generality, applicable to comparable situations in other individuals or contexts.... Social, shared experience; enhances **social confidence**

HOW IS BELIEF ESTABLISHED?

This report explores the proposition that teaching effectiveness can be enhanced by accommodating the key differences between **two complementary and deeply engrained modes of reality testing, each predominantly centered in different hemispheres of the brain.**

Correspondence

Coherence

HOW IS CORRESPONDENCE ESTABLISHED?

- Establishing ***CORRESPONDENCE*** involves matching perceptions of world based on sensory input – to the “real world.”
- A cascade of *error-detecting* mechanisms exists from neuromuscular reflexes through intentional consciousness, involving expectations
 - For example, “error-related negativity” in brain waves are detectable before consciousness awareness of an error (Falkenstein)

HOW IS COHERENCE ESTABLISHED?

- Establishing *COHERENCE* involves categorizing percepts, creating narrative flow in context with previous and ongoing parallel and collateral percepts (a wholly internal process)
- We have a capacity to assemble multiple specific percepts into plausible, coherent sequences
 - For example, left hemisphere “interpreter,” assembling wholes from fragments (Gazzaniga 1999; Turk et al. 2003)

MOTIVATION for ESTABLISHING CONFIDENCE

REALITY-TESTING becomes progressively urgent as dissonances are revealed between a percept and the experience base.

As the experience base expands personal beliefs must be reconciled with shared beliefs throughout socialization.

OPTIMIZATION comes in to play when the real or perceived **COST** of assimilating or accommodating new percepts is greater than the real or perceived **BENEFIT**

DISORDERS of BELIEF?

Distinguishing remembered or imagined experiences from ongoing experience is not trivial

- The neurophysiological substrate of memory and imagination are almost identical
- “Flashback” can appear to be a new experience



DISORDERS of BELIEF?

Acceptance of experience that doesn't correspond to external reality: kinds of hallucinations; Bonnet's Syndrome (filling in scotoma); dismorphic body; pareidolia. (False positive (confident match with memories); Type I Error; overly trusting, gullible)

Denial of experience that corresponds to external reality: agnosias: eg, visual (left occip), associative, anosognosia (denial of dysfunction / right cerebral cortices), prosopagnosia (faces) (False negative (failure to match with memories); Type II Error; overly skeptical, wary)



HOW IS CONFIDENCE ESTABLISHED?

Reality testing becomes progressively urgent as the experience base expands and personal beliefs are reconciled with shared beliefs throughout socialization.

For example: dream content can be taken for reality until the enlarging experience base creates a crisis of belief : “it *must* have been a dream.” **OR** new highly validated experience can reintegrate older invalidated experiences that were “meaningless at the time” ... a kind of novelty blindness

RECALLED IMAGINATION, IMAGINED MEMORIES

Episodic **memory** and plausible personal **imagination** share a consistent network of associated brain regions connected in a distributed network of neural modules

...some of which may support self-schema and familiarity processes, and contribute to the brain's ability to distinguish real from imaginary memories.

Hassabis et al., 2007



REVIEW and LIMITATION

Confidence in the validity of any percept throughout development is related to the interplay of these key processes.

As organisms develop, the experiential “reference base” of previous percepts is enlarged and refined.

Motivation to enlarge the “reference base” is more or less intentionally energized by two variables: the real or apparent NEED for additional experience and the COSTS AND BENEFITS of obtaining that experience.

Metaphoric aside

LIKE GENES, percepts can be individual or clusters;

They are pleiotropic (individuals serve multiple functions)

The narratives they contribute to are polygenic (have multiple inflowing streams of information)

They can compete with each other for expression

They are enabled or disabled by epigenetic interactions with the present environment, including stressors



COHERENCE is COMFORTING

“A world that can be explained even with bad reasons is a familiar world. But on the other hand, in a universe divested of illusions and lights, man feels an alien, a stranger. . . .”

Albert Camus

A “predictable” world is *much* less stressful

correspondence and coherence
evidence and theory
past and future

These two domains – one rooted in the past, the other in imagination– collaborate in creating a “sense of confidence in a belief,” not least, one’s *self*.

Increasing the degree of confidence in the validity of a belief enhances biological fitness ... ecologically, there is an “optimal” cost/benefit ratio for a given level of confidence

Organisms often continue to try to increase confidence depending on *perceived* urgency and resources ... and can become addictive (“search and solve” is pleasurable)

An Aside on Chance and Necessity: the intrinsic imperfection of knowledge

Our inner world, *umwelt*, of necessity provides an abstraction *at best*.

- **Experience and neuroplasticity are limited**
- **Seven +/- two items in short-term memory**
- **Neuronal activity recycling time**
- **Lateral inhibition ... extrapolation and interpolation ... a neurological “confirmation bias”**

PHYSIOLOGY

Autonomic, affective, and cognitive integration of feedback representations of arousal:

- **anterior cingulate cortex** is implicated in generating autonomic changes, while
- **insula and orbitofrontal cortices** may be specialized in mapping visceral responses.
- **ventromedial prefrontal cortex** is recognized to support processes of internal (self-) reference that predominate in states of rest and disengagement and which putatively serve as a benchmark for dynamic interactions with the environment.

(Critchley 2005)



PHYSIOLOGY

STRESS RESPONSES are evoked by **REAL** or **PERCEIVED** challenges to an organism's ability to meet its needs

SUBCLINICAL STRESS is evoked by modest challenges to homeostasis, including **COGNITIVE DISSONANCE**, an apparent mismatch between internal perceptions and external reality; challenges to the narrative that confers biologically valuable confidence.

Stress modulates neural function

STRESS is a coordinated suite of responses to real or perceived challenges to an organism's ability to meet its needs

As Camus observed, a predictable world is less stressful

Novelty evokes more or less stress depending on the perceived urgency of its challenge: information is **ASSIMILATED** or **ACCOMMODATED** by an organism's world model.

Stress modulates neural function

- It is of interest that the system specialized for establishing **CORRESPONDENCE** is localized in the **RIGHT HEMISPHERE**, also associated with selective activation by novel percepts.
- **SUCH NOVELTY** is uniquely associated with activation of autonomic functions (affect, stress) that proactively **ALERT** to novelty and reactively **COPE** with novelty, seeking to return to equilibrium with as little cost as possible

Are beliefs more important than truth?

TRUTH and STRESS



SELF-DECEPTION serves a vital function (Daniel Goleman's use of Ibsen's term: "Vital Lies" 1985)

"You can't handle the truth!" (Jack Nicholson in In "A Few Good Men," 1992)

DENIAL ---The more-or-less "...willing suspension of disbelief..." (Wordsworth) – is that the *function of art?* ... to provide a safe zone for exploring the otherwise troubling, stress-evoking truth?

Or of myth? ("theory used to be an "enchanted circle")



LEFT HEMISPHERE

Coherence: creates a consistent belief system – works to “save appearances”

(Ramachandran 1998)

Probabilistic reasoning

(Osherson et al 1998)

Abstract object recognition

(Marsolek 1999)

Activated by familiar percepts

(Goldberg 2001)

RIGHT HEMISPHERE

Correspondence: “skeptical,” tests reality and if damaged, confabulation runs rampant

(Ramachandran 1998)

Deductive reasoning

(Osherson et al 1998)

Specific object recognition

(Marsolek 1999)

Activated by unfamiliar percepts

(Goldberg 2001)





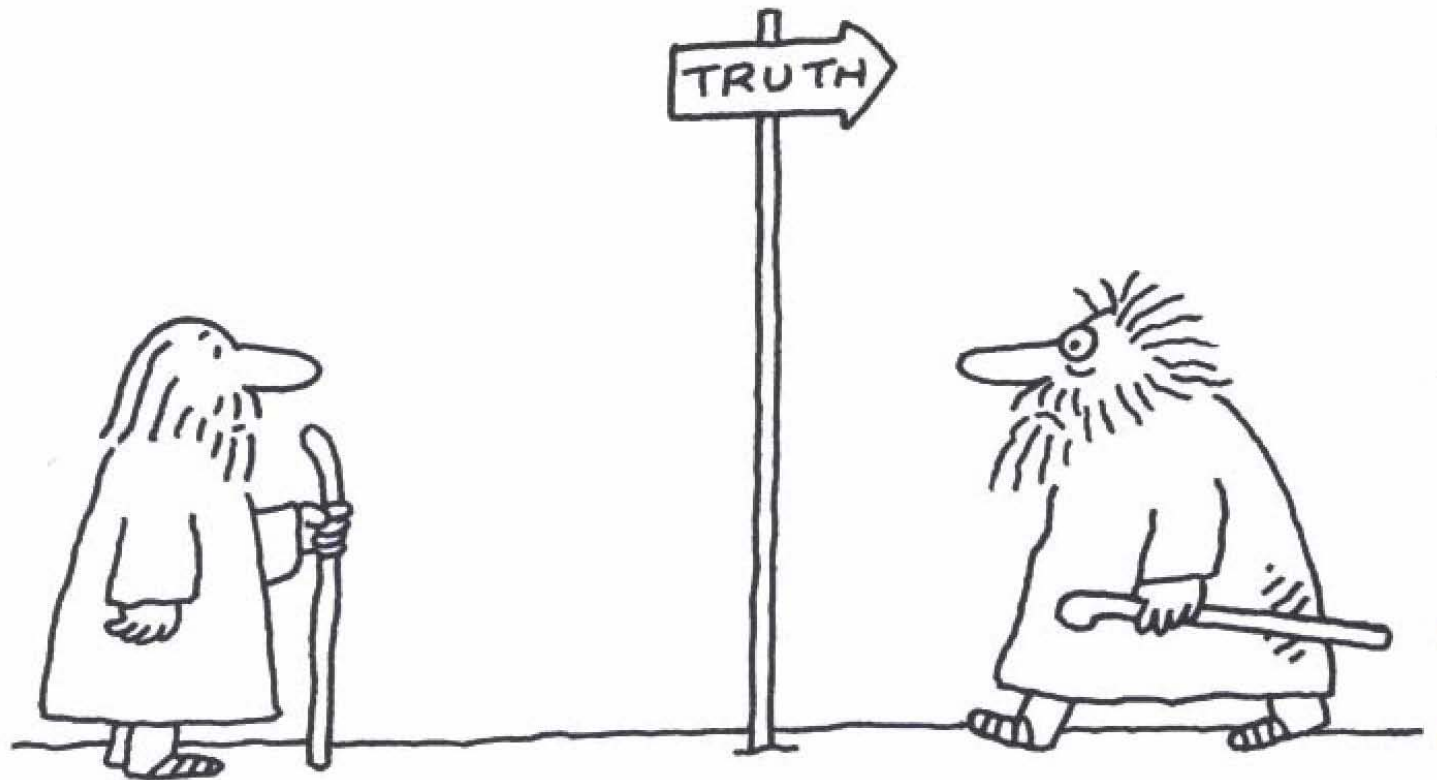
"Our life is an apprenticeship to the truth that around every circle another can be drawn; that there is no end in nature, but every end is a beginning, and under every deep a lower deep opens"

--Ralph Waldo Emerson

Take-home

- Establishing *correspondence* and *coherence* are separate but complementary processes with unique neurological substrates
- Neurological substrates are differentially subject to real or perceived stressors and are enabled and impaired by different levels of stress.
- Stress profiles of “controllable” vs. “uncontrollable” stress have different dynamics.

Can we handle the truth?



C. G. Barrett