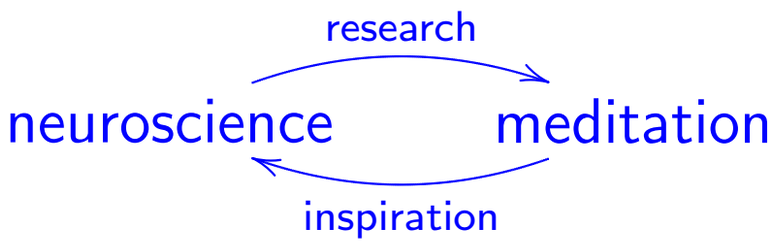
Neurocognitive models of the mind

inspired by meditation and Buddhist psychology

Henk Barendregt

Faculty of Science
Radboud Universiteit
Nijmegen, The Netherlands

Overview



0.1 Methodology

Introspection as a tool for psychology (Wund 1879) was not succesful

- Interferes with the mind
- Not objective

$\Rightarrow$ only study behaviour

Trained introspection may be an inspiration for neurophysiology

Arguments

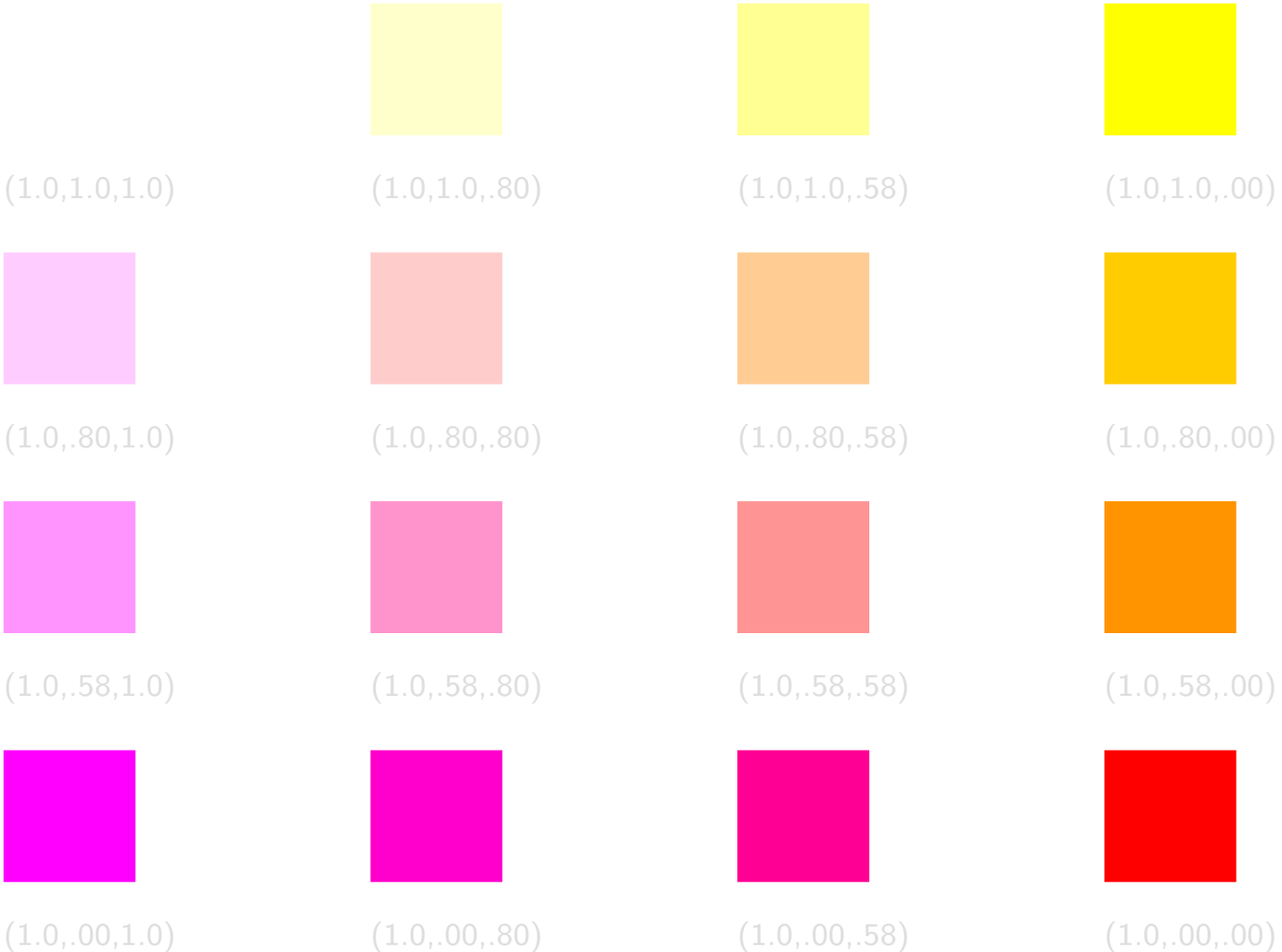
1. Mathematics is based on [trained] introspection (Husserl, Gödel)
2. The controversy about color perception ("Newton vs Goethe")

Physicists: colors are 1D, can be described by one number

Phenomenologists: colors are 3D

Goethe: colors cannot be arranged 1D or 2D such that they 'flow'
But 3D it is possible

0.2(i) Colors I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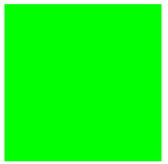

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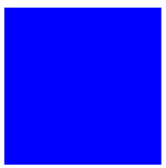

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0.3 The color controversy resolved

Hypothesis (Young and Helmholtz):

The retina has three different receptors for color vision

One wave-length creates a triplet of reactions in these three cells

This was confirmed only in 1960:

There are three kinds of cone-cells (b-, g-, r-type)

Their sensitivity profile for wavelength is different

Goethe's observation gave rise to a multi-10^{12}¥ industry

Color photograpy, TV-monitors, (computer) screens, projectors

Moral for neurophysiology:

Colors are 1D at their production and 3D at their perception

Both phenomenology and science are important and should interact

1.1 Consciousness & Meditation

Consciousness: object & mind-state (intuitive definition)

Object	what we see, hear, feel, smell, taste, or think
State	how we do this with e.g.

flexibility, compassion, concentration, greed, hatred, restlessness

states can be positive, variable, negative

Often people optimize content

wanting a large house, a beautiful partner, a fast car

With the tacit assumption that it brings happiness

But the mortgage can be high, the partner demanding and the gas rare

Better:	optimize states	'weather'
Still better:	optimize average states	trait, 'climate'

Importance of mind-states

Mind-states make the difference whether we are

creative	carve the miroku Buddha
	compose the Aria & variations in the Italian style
	invent relativity theory
are dull	do not dare to be creative
destructive	cause a crime
	violence (to others, in the family, ourselves)
	the financial crisis
	a war
	destroy the world

1.3 Goal of forms of meditation

In meditation one optimizes the states, abstracting from content

Two types of meditation:

concentration meditation (samadhi)	↑ positive states	compassion, friendliness
insight/wisdom meditation (vipassana)	↓ negative states	deconditioning

All living beings are conditioned

Unicellular organisms swim towards food, away from poison

But some are over-conditioned

Some insects fly into candles

Some monkeys hold onto bananas; makes them vulnerable

Homo sapiens

Worse than wine or opium
is the venom in your green eyes
that makes me fall into a deep abyss

Baudelaire

1.4 Mental development

Concentrate on observing breathing (meditation object)

Pay attention to sensory input and its processing

One comes to see the interacting groups discussed in the Hanya Shingyo:

1. input, 2. feeling (pleasant, unpleasant), 3. cognition, 4. state of mind, 5. action

Disentangle the 'coalitions': pain = pure pain + reaction against it

Disentangle: input, feeling, cognition, states, actions

If there is pain, do not consider yourself as someone that has pain,
but as 'someone that sees pain'. Better even*: as 'just seeing pain'*

This should be practised all the time (one uses qualia)

Use *mindfulness*: non-interfering observation, disidentification (Husserl: *epoche*)

Hanya Shingyo:

The five groups in their own being are empty and free from suffering

De-reification

1.5 The transformation

After dilligent practise the meditator comes to see

The three fundamental characteristics (limited view)

non-permanence	suffering	non-self
chaos, flux	nausea, unbearable	beyond control

Apparent loss of 'agency' $\longmapsto$ need for an emergency exit

Emergency exit	strong feelings: anxiety, paranoia, disenchantment
Proper exit	development of more mindfulness

Continued practise: development of Equanimity, Calm, Bliss

After 'determination' and 'surrendering' the characteristics become

The three fundamental characteristics (absolute view)

non-permanence	nirwana	non-self
change	peace	freedom

2.1 Theory: mechanism of mindfulness

Mindfulness: being aware in special way

- with attention
- non-reactive
- directed to phenomena in the present moment (not to concepts)

Ancient literature on mindfulness suggest it is related to *attention*, *flexibility*, *non-reactivity*, increased *recollection* (familiar variables)

Increased attention, flexibility, and non-reactivity have been found (cross-sectional studies; longitudinal study for the first two markers)

No relation between mindfulness and recollection has been found

(mindfulness as measured by questionaires: are these questionable?)

2.2 Papers

Mindfulness meditation associated with alterations in bottom-up processing: Psychophysiological evidence for reduced reactivity van den Hurk, Janssen, Giommi, Barendregt and Gielen *International Journal of Psychophysiology*, November 2010, 78(2),151-157

[Meditators had less 'Intersensory Facilitation Effects']

Greater efficiency in attentional processing related to mindfulness meditation van den Hurk, Giommi, Gielen, Speckens, and Barendregt *Quarterly Journal of Experimental Psychology*, June 2010, 1168-1180.

[Meditators were more flexible and efficient in dealing with information]

2.3 Pending Papers: (neuro)psychological

Improvements in attention related to intensive practice of mindfulness meditation. Longitudinal ANT study. Van den Hurk, Giommi, Barendregt, Gielen.
[Longitudinal ANT study. Showing an improved orienting of attention after retreat and again a greater efficiency in overall attentional processing, but only in highly experienced meditators]

Mindfulness: a set of learnable skills? van den Hurk, Wingens, Giommi, Barendregt
[Both cross-sectional and longitudinal study with questionnaire data. An attempt was made to see whether the psychological construct of mindfulness can be seen as a set of learnable skills]

An investigation of the role of attention in Mindfulness-Based Cognitive Therapy for recurrently depressed patients. Van den Hurk, Janssen, Giommi, Gielen, Spekens, Barendregt.
[Randomized clinical trial with recurrently depressed patients tested on the Attentional Network Task (ANT)]

Mindfulness meditation associated with changes in response bias: a study on the recognition of emotional facial expressions. Van den Hurk, Van Schie, Barendregt
[Cross-sectional affective go/nogo study. Showing preliminary evidence to suggest a change towards a more positive bias in processing emotional information]

Working memory and Self Referential processing investigated via EEG and Mindfulness.

Whitmarsh, Brandmeyer, van Schie & Barendregt

[Theta band changes during externalized and internalized attention tasks (n-back & trait adjective)

and possible behavioral/performance related with measures of mindfulness questionnaires]

2.4 Pending papers: clinical

Improved Autobiographical Memory specificity after Mindfulness-based Cognitive Therapy (MBCT) in patients with recurrent depression: a failure to replicate using a self-report format. van Aalderen, Raes, Giommi, Williams, Speckens

[Effects of MBCT on Autobiographical Memory, in a subsample of the original RCT]

The Effectiveness of Mindfulness-Based Cognitive Therapy (MBCT) in a Population of Recurrent Depressed Patients with and without Current Depressive Symptoms, a Randomized Controlled Trial van Aalderen, Donders, Giommi, Spinhoven, Barendregt, Speckens
[Randomized Controlled Trial for direct post-effects of MBCT on depression; rumination and mindfulness skills (questionnaires)]

Work in progress: longitudinal MRI experiment determining changes in gray and white matter

Subjects before and after a retreat vs controls

Default brain, DTI

3.1 The Abhidhamma model AM_0

Main thesis in physics (Feynman):

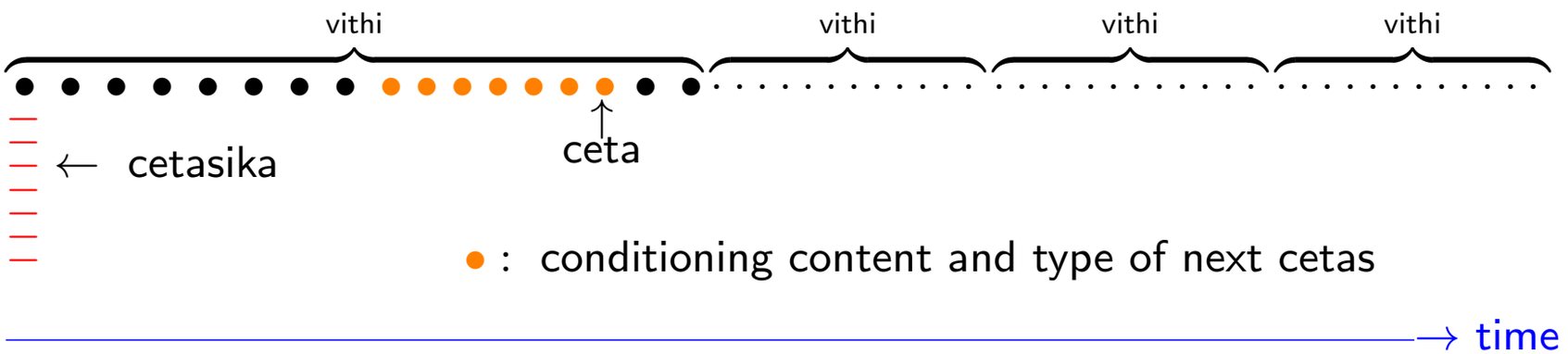
Matter is not continuous, but atomic (atoms exist in space)

Main thesis of the Abhidhamma (250 BC) & Abhidharma (400 AD):

Consciousness is not continuous, but discrete (in time)

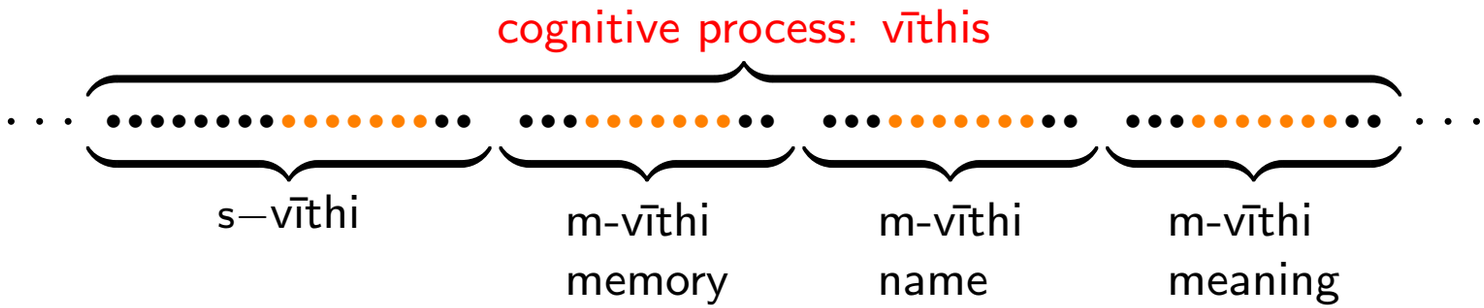
acting on three levels (in physics: molecules, atoms, elementary particles)

Cetas	'mental atoms'	existing in time
Cetasikas	'mental elementary particles'	acting in parallel
Vīthis	'mental molecules'	acting in a serial way

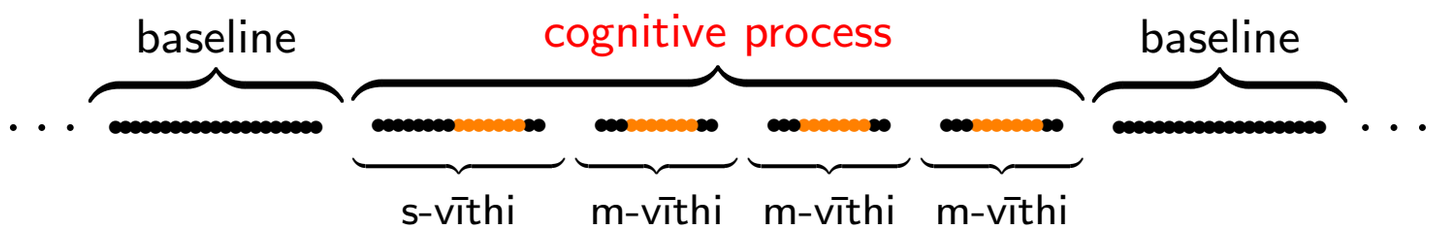


Cognitive-emotional unit

Cognition and emotion



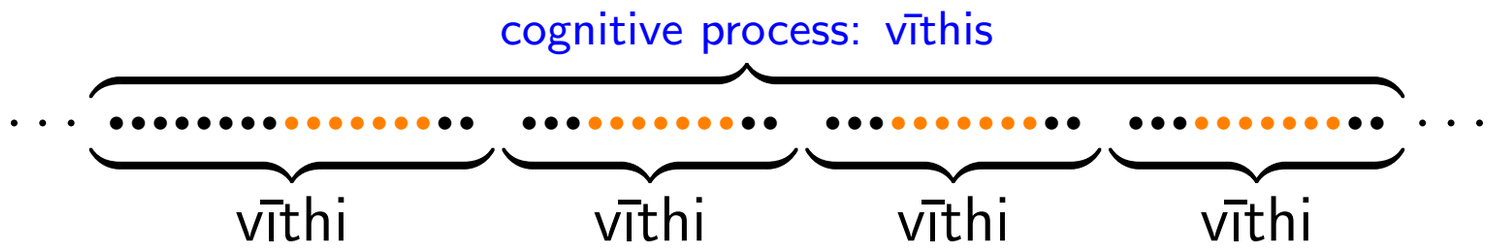
Baseline (sequence of birth cetas)



3.3 Consequences: Neurotic core of the mind

Thinking is encoded in the cognitive process of consecutive vīthis

Feelings are present as cetasika in a repeated ceta •



These two may conflict:
the vīthis may suppress the ceta feeling
but this feeling starts to lead a life of its own

This is an implementation of Freud's notion of
fight between the id and the super-ego

Freud's observation was that the id can be very stubborn
This is consistent with the conditioning force of cetas

3.4 Consequences: Psychotic core of the mind

If cognition is composed, then it may fall apart

This is a natural explanation of dissociation

The AM_0 sees this as disidentification (differentiation)

A *jamais vu* is the separation of sound and meaning
Here the cognitive process is separated in a decent way

If feelings are too strong, it may collapse in a more dramatic way
the vīthi may fall apart, causing secondary reactions of panic

Relatives, friends and even the medical establishment
may not know how to deal with this properly
causing a negative spiral often reinforced by anti-psychotic drugs

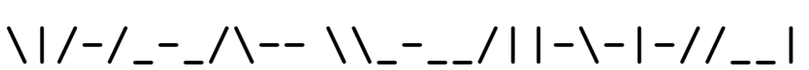
The AM_0 shows that it may be worthwhile to study the claim by some psychoanalysts that psychoses can be cured
The model also shows why a psychosis is serious: it is real!

3.5 Consequences: Cover-up

Ordinary consciousness can be rendered stylistically as follows.

(1)

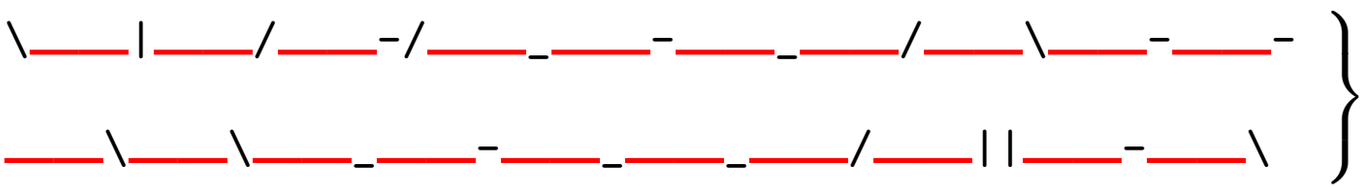
Broken psychotic cognition looks like (▬ : fear)



(2)

(3)

Then the movie gets 'covered-up' with strong self-reinforcing feelings



(4)

Obtaining a fobia (J.T. Barendregt)

Depersonalization, derealization, desomatization $\mapsto$ cover-up with fear

Also other ways to cover-up: angriness, desire, [drugs]

Has been repeatedly observed during meditation retreats

3.6 Model of human 'cognition'

Human: $\text{Input} \times \text{State} \mapsto \text{Output} \times \text{State}$

Non essential differences with Turing Machine

- specialized input places: 6 senses
- different types of actions: bodily output, speech, mental output
- transition function programmed by a neural net

Better than 'stimulus–response' model and unifies the two AI views

Simon-Newell: symbol-rule based & serial

connectionist: signal based & parallel

Using concentration we can (partially) observe their operating system

Evidence: attentional blink decreases (Slagter [2007])

In order to cognize the world we must *reify*
During differentiation we temporarily stop this
Then we do it again, but knowingly

The astonishing axioms

Process	brain is discrete and deterministic
Cover-up	usually this is symptomatically covered-up
	in meditation / under stress it can be seen
	this often causes fear, paranoia, disenchantment
Reconditioning	the fear can be domesticated

1. Discreteness

Need for integration of different senses: synchronous pulses [von der Malsburg]

The thalamo-cortical pulse (30ms)?

Mental atoms in multichannel EEG maps can be distinguished [Lehmann]

There are 4 types of atoms, each of about 100ms

In schizophrenics: shorter duration and permuted order

In meditators shorter duration

Wheel illusion [van Rullen]

2. Cover-up (states of consciousness)

Strong concentration ($\mapsto$ one doesn't mind strong pain),
has similar effects as putting opioids in the liquor
Compatible with volume transmission through the liquor

Veening, Barendregt: The regulation of brain states by neuroactive substances distributed via the cerebrospinal fluid; a review. *Cerebrospinal Fluid Research*, 7(1), 2010

Veening, de Jong, Barendregt: Oxytocin messages via the cerebrospinal fluid – behavioral effects; a review. *Physiology & Behavior*, 101 (2), 193-210 2010

These papers give evidence to the liquor hypothesis:

CSF facilitates volume transmission of neuroactive substances determining brain/behavioural states

other mention of the thesis: Cushing-Goetsch [1910], Borison [1980], Nicholson [1999], Sewards & Sewards [2003], Skipor et al. [2008]

4.3 Implementing states: cerebrospinal fluid (CSF)

There is ample evidence that several mind-sub-states run via the CSF

Oxytocin (OT) concentration and functions in blood and CSF differ

Production of OT in blood/CSF via axons/dendrites of same cells

CSF release is regulated actively

reaches targets fast (minutes), longer half-life than in blood

OT is meaningful message at targets in CSF:

- behavioral column in hypothalamus
- paracrine core in brainstem (physiological changes)
- cortex layers 2, 3 (memory & learning)
- olfactory bulb (trust)
- nose lymphatics

Similar results for β-endorphin: effect euphoria and analgesia

Other global effects through the liquor: CRF, urocortin

2. (contn'd) Cover-up via CSF (not plasma!)

Origin	Signal	Receptor	Function
PHV, SON@hypoth	Oxytocin	Behavioural comlumn paracrine core cortex olfactory lymphatics	'trust' physiological reactions as NGF, memory, learning
magn.cel.N@hypoth.	Vasopressin	PVN	powerdominance
hypoth.	CRH		fear
hyopth.	LHRH	PAG	sexual
pineal gland	Melatonin	premammilary hypoth	sexual, CSF production
POMC@AN	β-endorphin	PAG	feeding, sexual, painreduction

■ dendritic release

3. Mindfulness: papers mentioned in section 2

Zen poem

Before my practice
mountains were mountains
and rivers were rivers
After I got insight
mountains were no longer mountains
and rivers were no longer rivers
But now, having attained final rest,
mountains are really mountains
and rivers are really rivers

Ch'ing Yuan Wei-hsin (Tang Dynasty)

Poem about selflessness

Well-known moral principle in many religions:

If one acts well, then one receives good results

If one acts badly, then one receives bad results

Therefore act well

Dispeller of enchantment

No one acts
No one receives
All phenomena come alone
This is the right view

In: *The path of purification*
Buddhagosa, 400 A.D.