Models of consciousness

and clinical implications

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Mind/Consciousness (perception and action) is

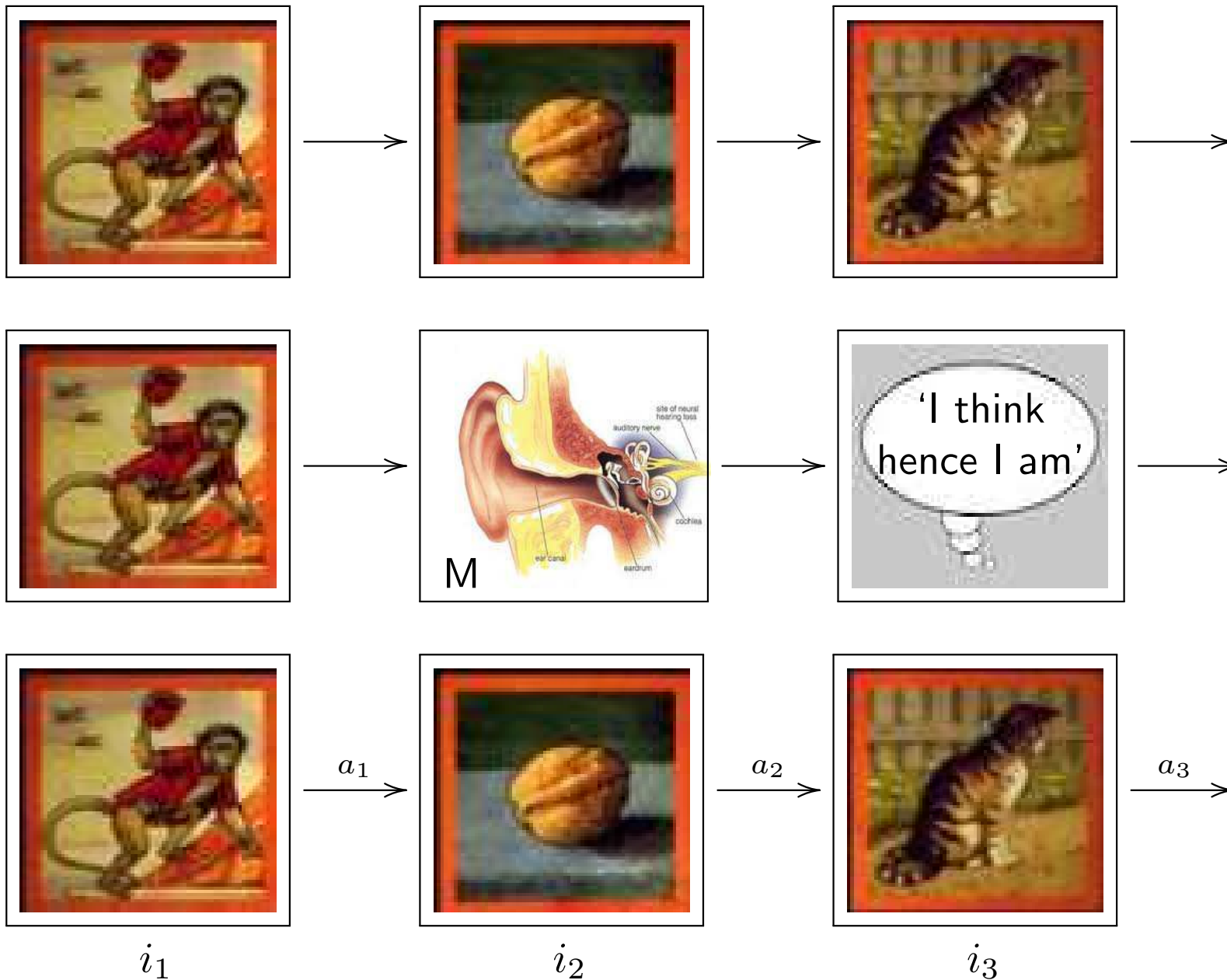   pDDD   perceivably Discrete, Decomposable, & Deterministic

    Discrete   action potential, synchronicity hypothesis,
                           thalamo-cortical pulse
                           wagon-wheel illusion, Lehmann's mental atoms

    Decomposable   de-reification, dissociation
                           (from semantic fatigue up to depersonalisation, derealisation)

    Determinism   science;
                           quantum effects do not rescue 'human dignity'

Science seems to agree with the blue part of the view

If also the red part is correct, then this has clinical (existential) implications
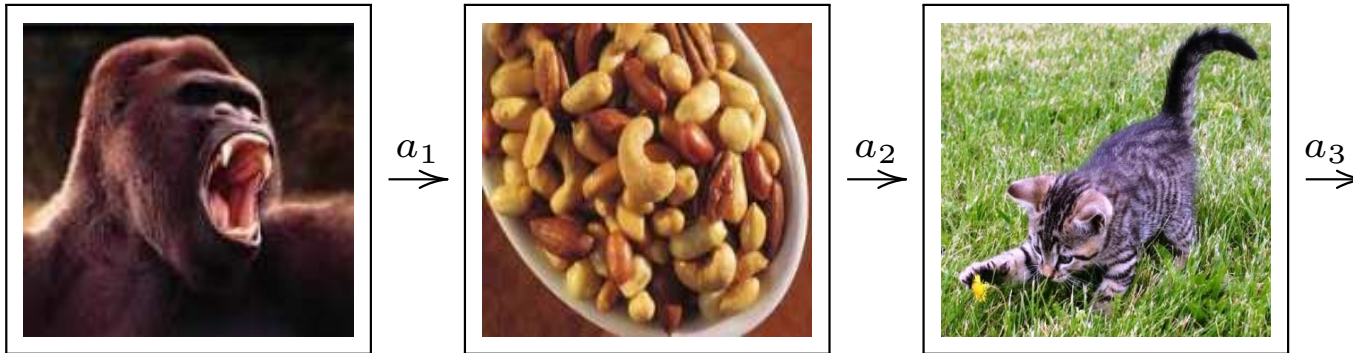
as it challenges personal identity and agency

Possible consequences [IM manual: pDDD $\mapsto$ fear $\mapsto$ 'danger' $\mapsto$ disenchantment]

    1. *avoidance/suppression*   with (dys)functional attachment (widespread)

    2. *dissociation*   clinical (phobia or delusion as repersonalisation)

    3. *domestication*   handling in a balanced way dyscoordinated conscisouness
                           through insight meditation (less familiar)

i: input, a: action

Too much restricted (stimulus-response of behaviourism)
in this way the same input results in the same action

(i_1, s_1) fear (i_2, s_2) greed (i_3, s_3) joy

Now the transitions can be subject to theory

States exist mathematically (cf kinetic theory of gasses: $s \in \mathbb{R}^{6*10^{23}}$)

We can't fully determine states, but can *reason* about them

States more than input determine what happens

States determine whether we are e.g. creative, destructive, or hesitant

in short: states determine us, but we cannot directly determine our states!

In mathematics and cybernetics the notion of state is simple, essential and effective

Proposal: also in the study of the mind/brain we need an abstract notion of state

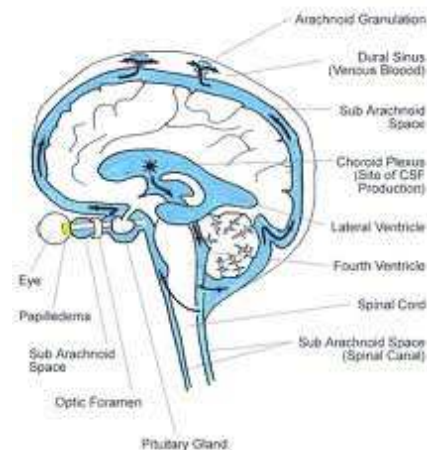The notion of state includes notions like mood, motivation, intention, ...

A state has three aspects

$$\text{state}\begin{cases} 1 & \text{phenomenological} \\ 2 & \text{behavioural} \\ 3 & \text{neurophysiological} \end{cases}$$

Possible implementations of states (aspect 3):

- collaboration between frontallobe & amygdala Salzman-Fusi [2010]

- volume transmission through the cerebrospinal-fluid Veening-Barendregt [2010]

ventricle system

- acquired associations

- ... (how is mindfulness implemented?)

Mathematical definition of state ["principle pf abstraction"]

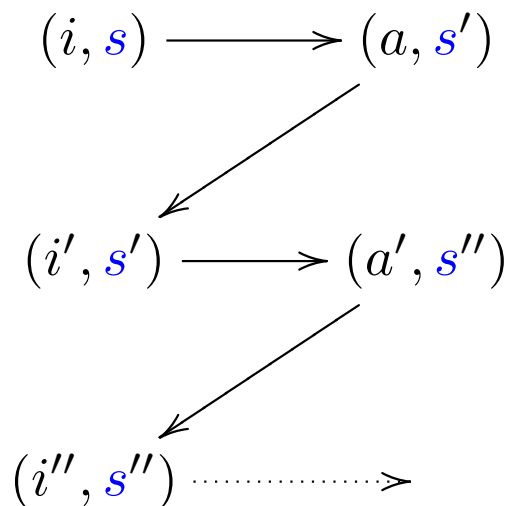being in the same state $c_1 \sim c_2 \iff \forall i, a[i \to_{c_1} a \iff i \to_{c_2} a]$

state of $S(c) = \{c' \mid c' \sim c\}$ all those c' in the same state as c

For *agents*: machines, organismes, conscious cognition and action in homo sapiens
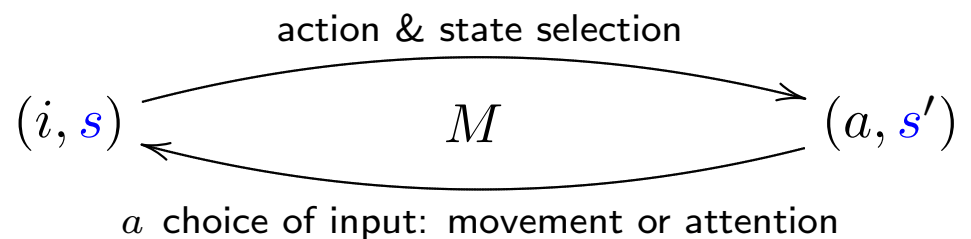
$$(i, s) \longmapsto (a, s')$$

An action a can be a movement or an attentional choice

either way actions a create new input and the scenario continues

$(i, s) \longrightarrow (a, s')$

$(i', s') \longrightarrow (a', s'')$

$(i'', s'') \dashrightarrow$

This leads to the 2-phase process

of a   *Turing machine* M

For mind: stepwise and parallel (via neural net)

action & state selection

(i, s) M (a, s')

a choice of input: movement or attention

Fuxe, Agnati [2000]	emphasize neural nets and volume transmission
Salzman, Fusi [2010]	emphsize states
Zylberberg, Dehaene et al [2011]	discreteness 'overcomes biological noise'
Barendregt, Raffone [2013]	emphasize the universality of the
	Turing model and use it to model mindfulness

A unit of AM recieves a pair $\langle a, b \rangle$ (with b slightly later than a) and stores it

Later, when asked a?, it can answer b! (Cued recall)

Theorem (de Bruijn). A large number of AM units of limited capacity and reliability can be combined to one AM unit of high capacity and very high reliability

Proof-sketch. Say we have 10^{10} small units. They are made to be ON/OFF at random in ratio $1/10^4$ (0.5s ON vs 4h OFF). Then at every moment 10^6 units are ON. These store the $\langle a, b \rangle$. At recall time there are also 10^6 ON. Of these 10^2 also had been ON during storing time. A majority vote gives the right association. ∎

Consciousness is ephemeral in this model

AM plays an important role for our personality

AM is part of our average state (trait)

AM can be reconditioned

There are three sets of data (memory) $I_1 \subseteq I_2 \subseteq I_3$ depending on availability

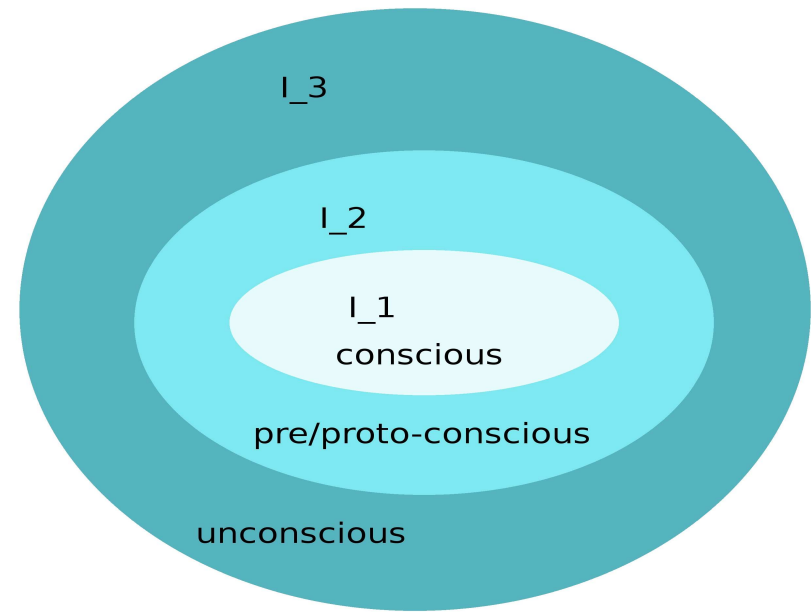I_3 possible to attend in principle (now or later)

I_2 possible to attend now

I_1 attended now (with reflection?)

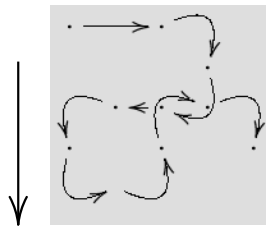| $I_3 - I_2$	unconscious
$I_2 - I_1$	pre/proto-conscious
I_1	conscious

		from $I_2 - I_1$	via	to I_1
Edelman	[1990]	*consciousness*	R	*reflective consciousness*
de Bruijn	[2003]	*subconsciousness*	R	*consciousness*
Hobson	[2009]	*protoconsciousness*	R	*higher-order consciousness*
Lamme Block	[2003] [2007]	*phenomenal consciousness*	A	*access consciousness*
Dehaene et al	[2006]	*preconsciousness*	A	*consciousness*

A: *attention*, R: *reflection*, data recollected in mind (meta-awareness)

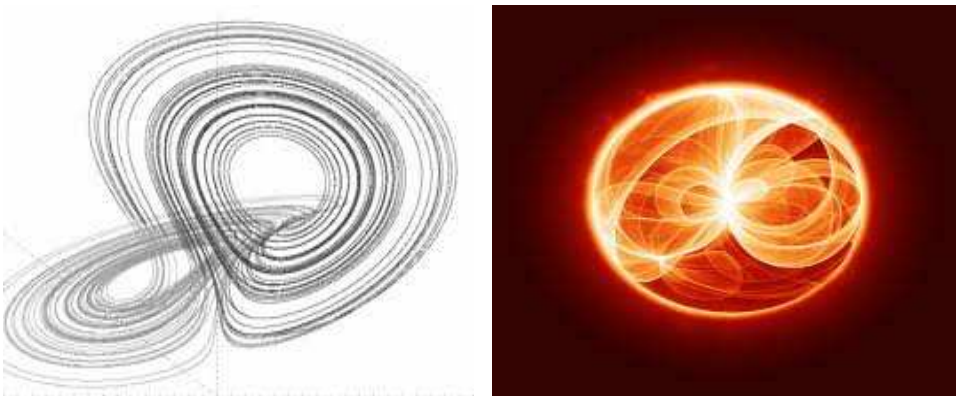Dynamical system: Every point . stands for a triple (i, s, a)

the unlimited input and action possibilities make the stream

quite varied (almost always somewhere else)

Nevertheless there are strange attractors

We may walk in (vicious) circles and get stuck

input dependent (agoraphobia)

or input independent (depression)

Monkeys like banana's so much that they don't let go

until they have eaten them: mechanism behind a monkey-trap

Insects orient themselves on the sun/moon; but also on a candle

Insight meditation (change outside evolution, using reconditioning):

● restricting senses + action; also thinking, through focussed attention

There are hindrances: being side-tracked by desire, aversion, restlessness, ...

Using effort, mindfulness, and concentration we can continue

Mindfulness: attention on (i, s, a) without judgement, purely descriptive

Observations: "O, there is angst" of "O, there is desire"

creates distance, the phenomena are seen as "unpersonal energies"

We also decouple (i, s, a) into i, s, and a

Insight meditation takes apart the 'gears' of our consciousness
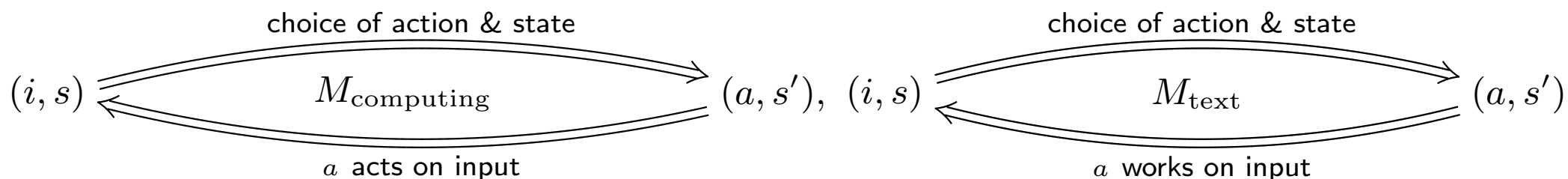
and puts them later together

How can we try to understand this?
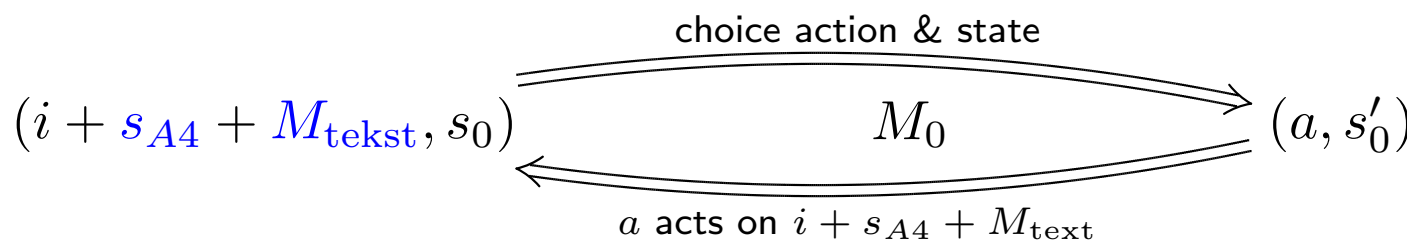
There are machines that can perform only one task

for example computing or   text-editing

ワープロ

$$(i, s) \xrightleftharpoons[a \text{ acts on input}]{\substack{\text{choice of action \& state} \\ M_{\text{computing}}}} (a, s'), \quad (i, s) \xrightleftharpoons[a \text{ works on input}]{\substack{\text{choice of action \& state} \\ M_{\text{text}}}} (a, s')$$

These can be replaced by Turing's universal machine: the computer

$$(i + s_{A4} + M_{\text{tekst}}, s_0) \xrightleftharpoons[a \text{ acts on } i + s_{A4} + M_{\text{text}}]{\substack{\text{choice action \& state} \\ M_0}} (a, s'_0)$$

For the various tasks (computing, text-editing, …)

we don't need several machines, but only one

This mechanism by Turing was voted to be UK's most important invention

Now also s and M can be changed by a

As a universal machine can perform all doable tasks (with software)

similarly homo sapiens can learn all doable tasks

first slowly using intellect, later with souplesse, internalised by a neural net

Mindfulness: meta-awareness, observation of s and M as input

Mental development (insight meditation):

1. restriction of i and a

restriction $\mapsto$ only states are changing

we may observe to run in vicious circles

2. With mindfulness the aimlessness of this is seen and the circle is broken

The stream of consciousness acts deterministically, observed using mindfulness,

but thanks to this observation it becomes less restricted: no more pretending

[Paradoxically, lack of insight causes this restriction

via the illusion that we are in control of things

"*Be an original: smoke <certain cigarette brand>*"

the reader is being asked by means of pseudo-originality to conform himself]

Discrete (stepwise) consciousness

thalamo-cortical pulse
wagonwheel illusion
trained phenomenology
  Lehmann mental atoms

States

Mathematical necessity
β-endorphin in the cerebrospinal-fluid: stabilisation of states (Veening et al.)

Effects of the practise of mindfulness

wholesome effects also for patients in acute depression (van Aalderen)
improvement attention (van den Hurk)
non-reactivity (van den Hurk)
visible happiness (Choi)
changes in cortical error-correction in patients with ADHD (Schoenberg)
meta-awareness (Whitmarsh, recent PhD submission)

  Subjects are asked to focus on one of the hands (L or R)
  Doing so there is contralateral α-reduction in EEG/MEG
  At random they are asked whether they did pay attention correctly
  Measure of mindfulness: correlation between observed and claimed attention
  Correlation better in advanced meditators ($> 1000h$) than in novices/non-meditators

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