Metacognition, Social Cognition & Psychosis

Chris Frith

Wellcome Trust Centre for Neuroimaging at University College London
Institute of Philosophy, School of Advanced Study, University of London

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What is metacognition?

Cognition about cognition

Thinking about thinking

Metacognition has two components

Monitoring: observing cognitive processes

Control: modifying cognitive processes

"A system that monitors itself (even imperfectly) may use its own introspections as input to alter the system's behaviour."

Nelson & Narens *Metamemory: A theoretical framework and some new findings* 1990

Metacognition
and schizophrenia

Many of the symptoms of schizophrenia suggest malfunctions of metacognition

Lack of insight: Denial of illness
Delusions of control: Abnormal experiences of agency
Thought insertion: 'thoughts are put into my mind'

These symptoms involve thinking about cognitive processes

Empirical studies confirm metacognitive problems in schizophrenia

Impaired self-monitoring of action
associated with delusions of control

Farrer & Frank, *Cur Psychiat Rev* 2007

Impaired source monitoring in memory
associated with hallucinations

Moritz et al, *Psychol Med* 2003

Impaired insight
associated with poor social function

Lysaker et al, *Schiz Res* 2010

But these problems are restricted to an explicit form of metacognition

Impairment at the voluntary level of action control
not at the automatic level

Delevoye-Turrell et al, *Neurorep* 2002

Impaired source memory for 'remember'
no impairment for 'know'

Danion et al, *Arch Gen Psychiat* 1999

Impaired conscious priming
unimpaired subliminal priming

Del Cul et al, *Arch Gen Psychiat* 2006

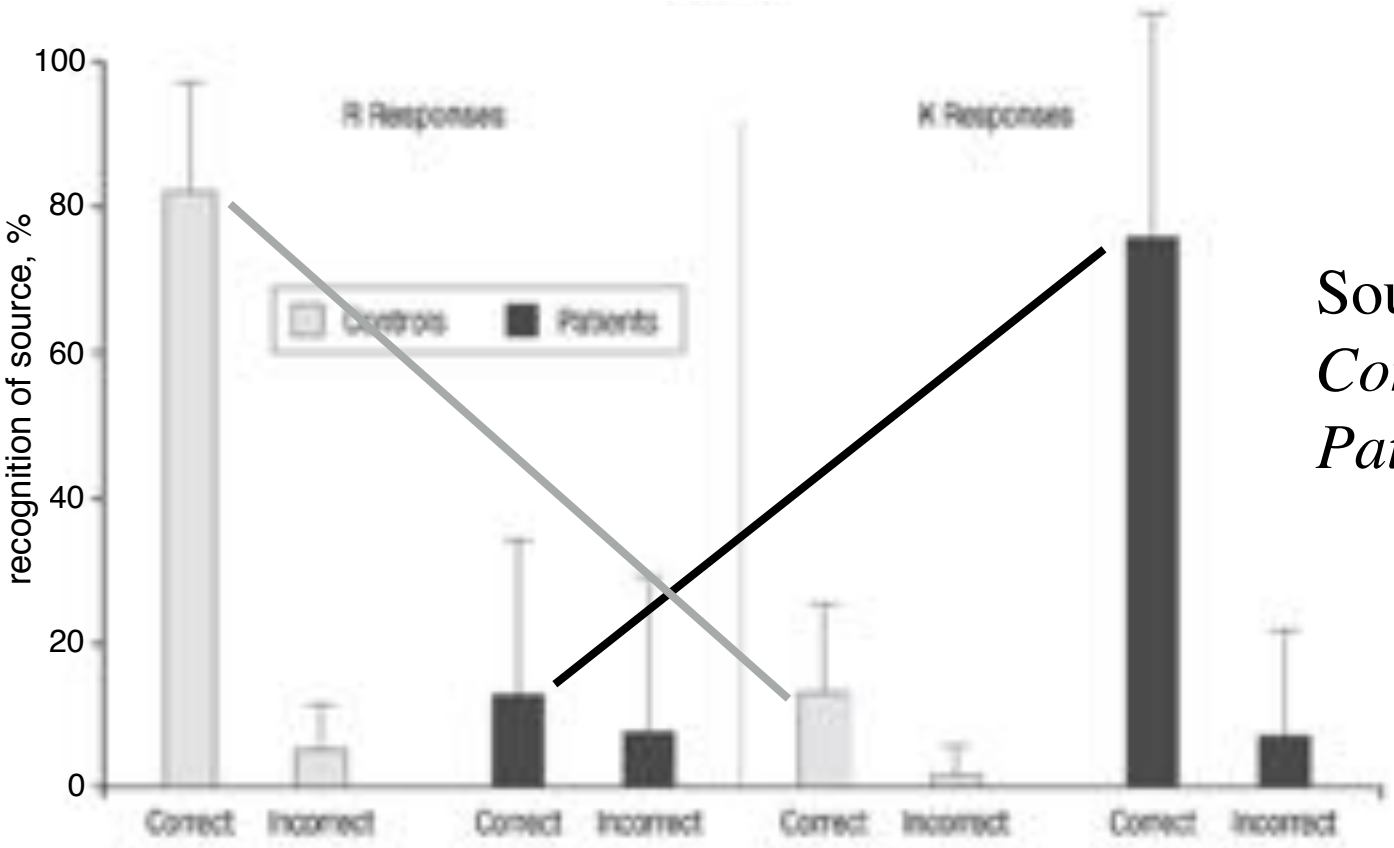
Impaired metacognitive accuracy
unimpaired first-order performance

Bliksted et al, *Cog Neuropsychiat* 2016

Source memory

Remember (R): *explicit recollection of the event*

Know (K): *implicit feelings of familiarity*



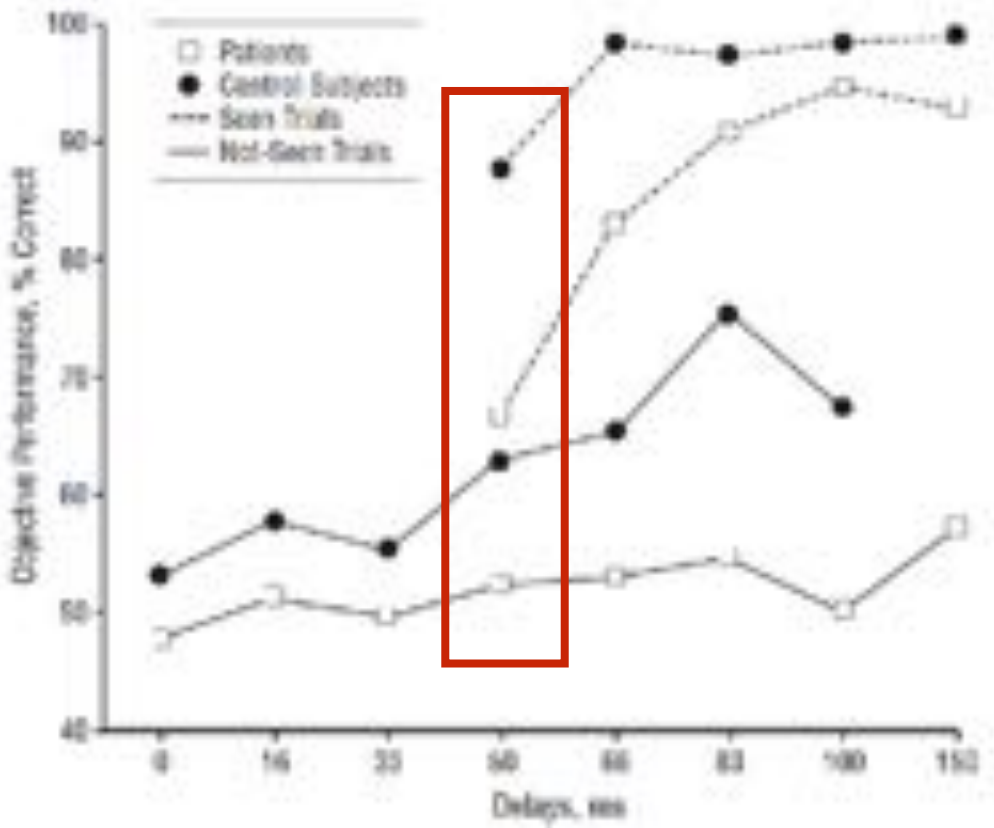
Source memory

Controls: R > K

Patients: K > R

Danion et al *Arch Gen Psychiat* 1999

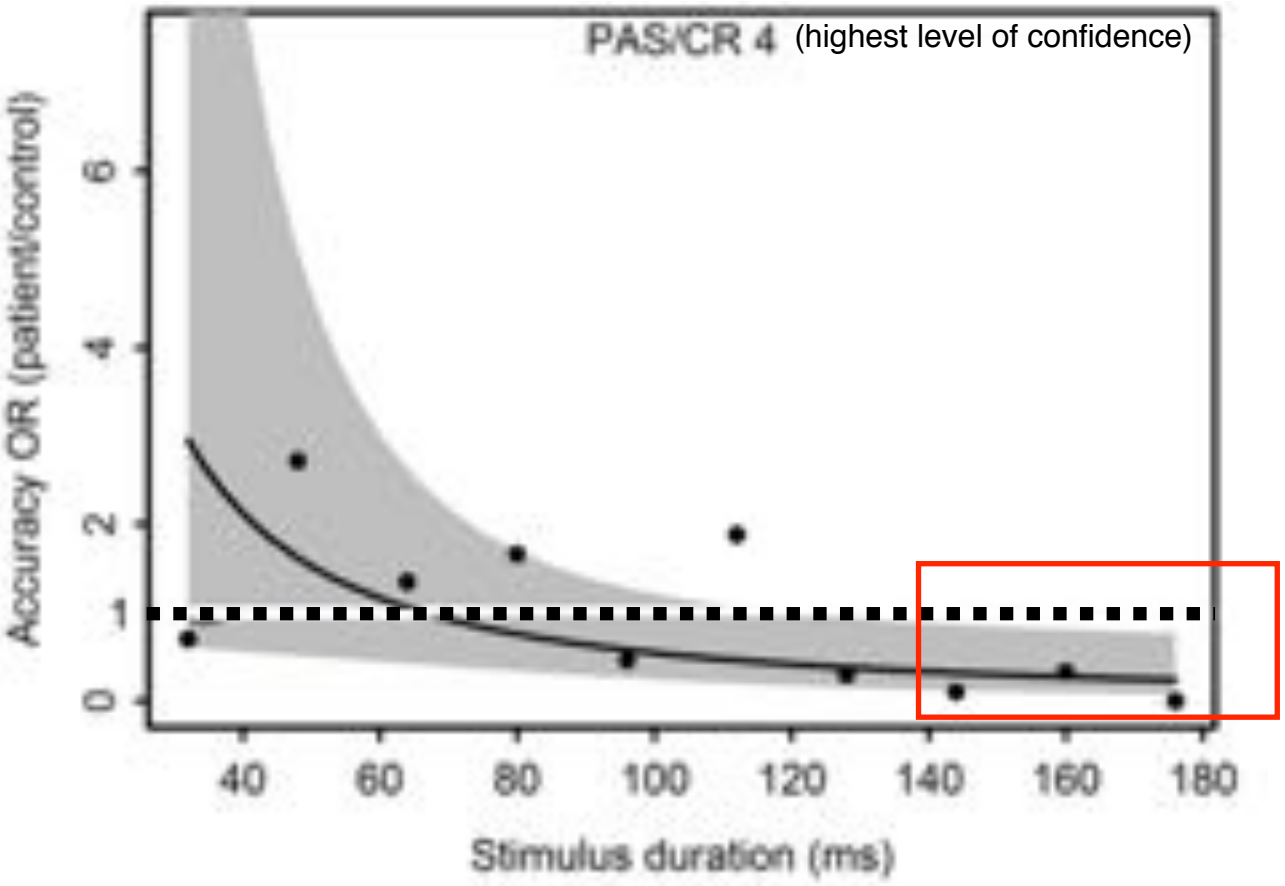
Correct identification of subliminal stimuli is possible, but is better when they are seen



Patients gain much less advantage from briefly seen stimuli

Del Cul et al *Arch Gen Psychiat* 2006

Patients in a first episode of paranoid schizophrenia are not impaired on first-order detection of stimuli



but show reduced metacognitive accuracy for the most visible stimuli

Bliksted et al *Cog Neuropsychiat* 2016

Implicit & explicit metacognition

What is implicit metacognition?

Control processes that use representations of properties of cognitive processes (metacognitive representations)

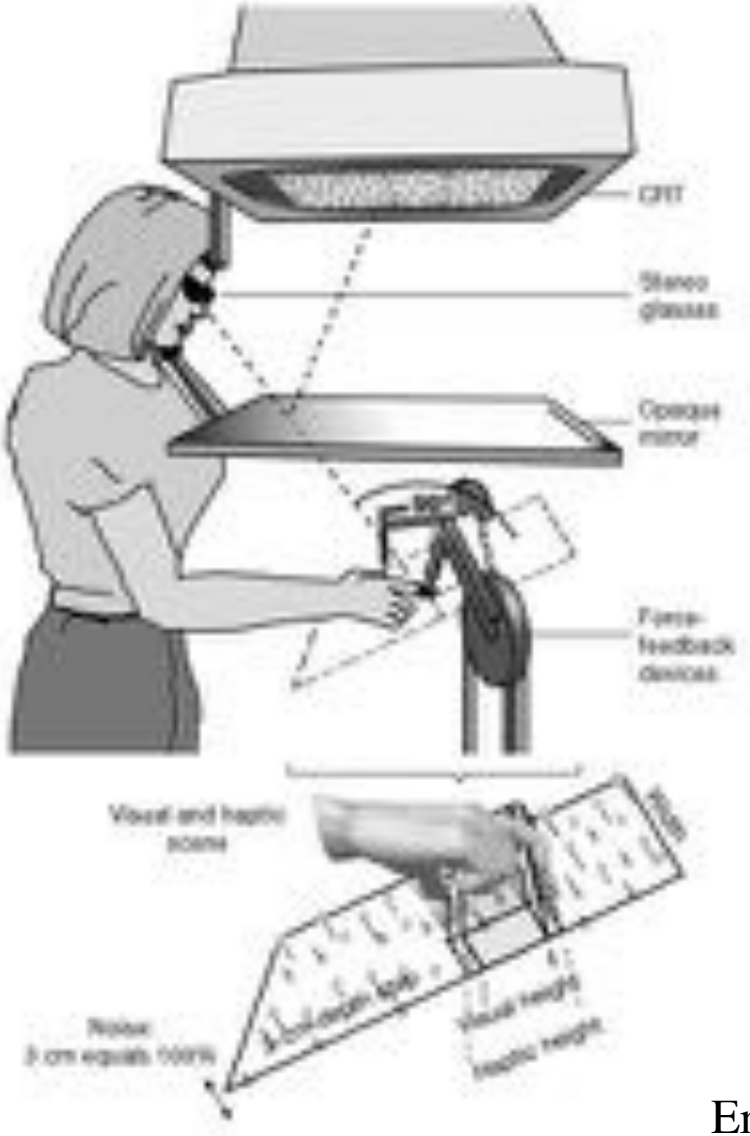
These representations need not be conscious

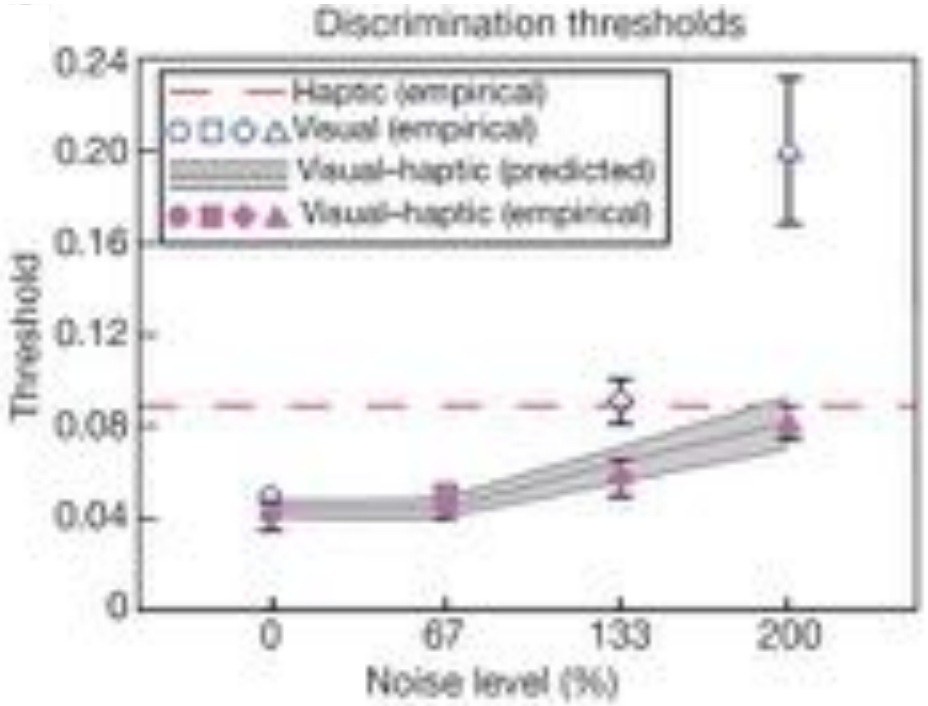
Assuming the brain is a hierarchical Bayesian control system

then representations of the properties of cognitive processes are found even at the lowest levels of the hierarchy (e.g. precision of signals)

Explicit, conscious, metacognition is the tip of an iceberg

Information from vision & touch is combined optimally on the basis of the relative precision of the signals

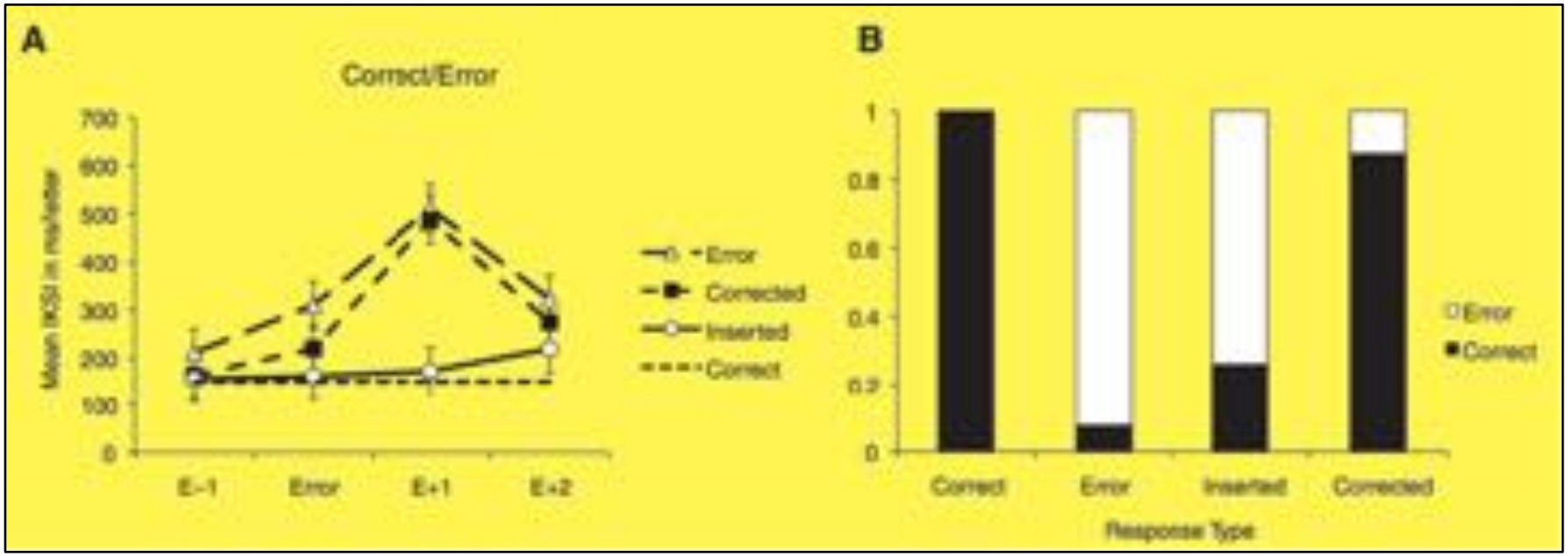




Ernst & Banks, *Nature* 2002; Alais & Burr *Curr Biol* 2004

Divergence of implicit & explicit metacognition

Correction of real & fake errors by expert typists

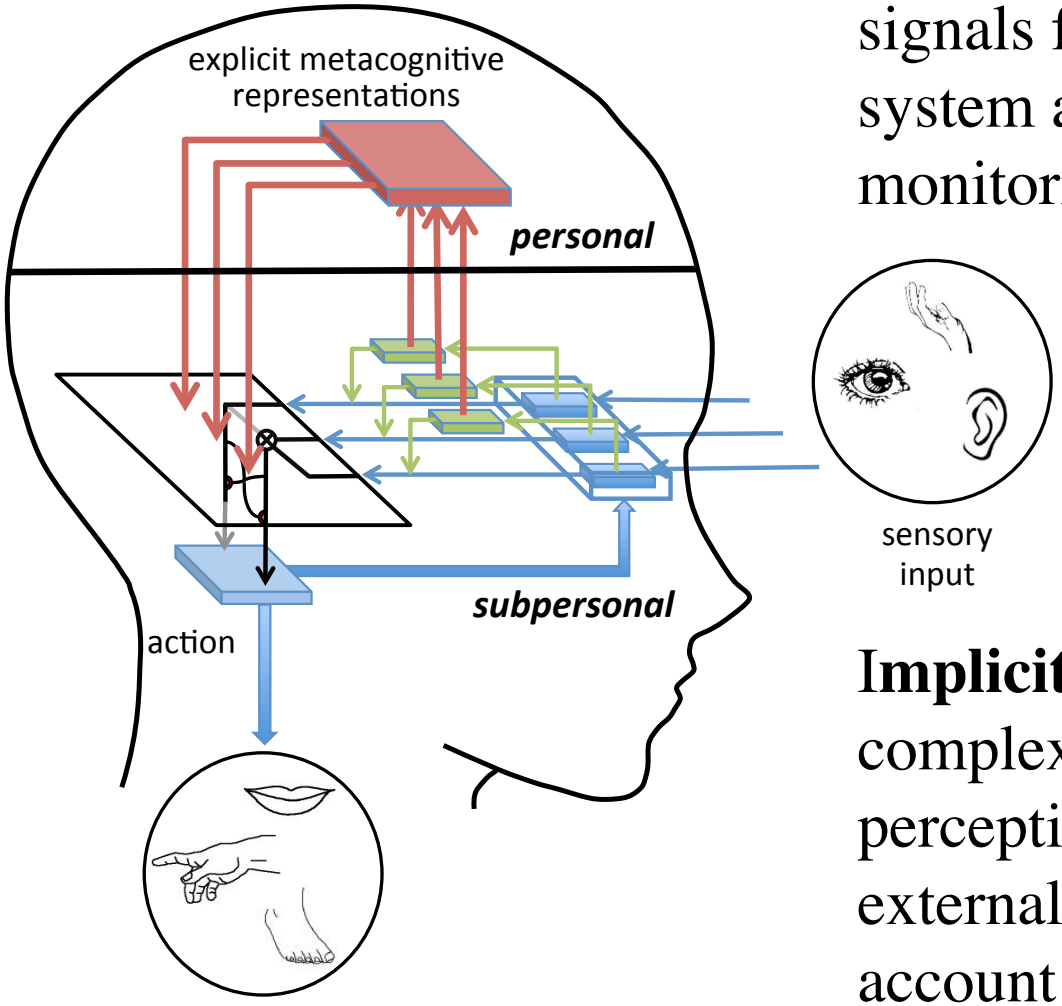


implicit metacognition
affected by real errors

explicit metacognition
affected by fake errors

Logan & Crump *Science* 2010

Implicit & explicit metacognition



Explicit level (personal): Some signals from the sub personal system are available for explicit monitoring and control

Implicit level (subpersonal): complex, automatic 'action-perception' loops interpret external stimuli & also take into account metacognitive properties like precision

Shea et al *TiCS* 2014

Properties of explicit metacognition

we have no direct conscious access
to any of the processes going on in our brain

Nisbett & Wilson *Psychol Rev* 1977

We make inferences about them from the signals
that emerge from these processes

These inferences can be wrong

Here are some metacognitive signals that are misinterpreted

Perceptual fluency: Pictures associated with perceptual fluency are preferred

Kunst-Wilson & Zajonc, Science 1980; Forster et al, Emotion 2012

Action selection fluency: determines sense of control; 'the feeling of doing'

Chambon & Haggard Cognit 2012

Perceptual fluency
is a marker of familiarity

we perceive things more fluently
if we have seen them before

With brief exposures people don't remember which items they have seen before, but they prefer them

Kunst-Wilson & Zajonc, *Science* 1980

Perceptual fluency is interpreted
as a marker of liking,
but not of familiarity

Action selection fluency and the sense of agency

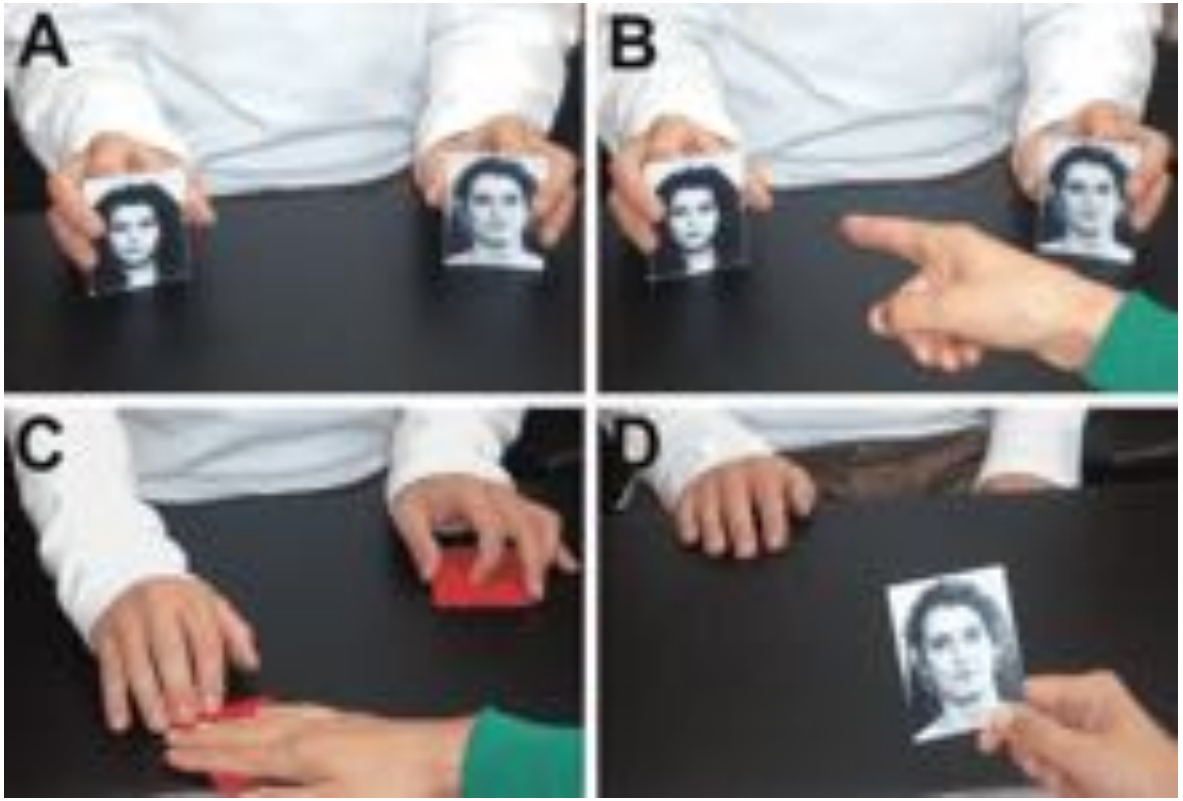
Increased action fluency can create a illusory sense of being in control (i.e causing an effect)

Priming an incongruent action increases action selection fluency and the sense of being in control while impairing performance

Chambon & Haggard *Cognition* 2012

Introspection about our decisions is fragile
But we still explain our choices

Which face is more attractive?



choose

explain choice

On 20% of trials the face was switched between choosing & explaining
74% of these deceptions were not detected

Johansson et al *Science* 2005

Although our ability to introspect is very limited we like to *reflect* upon our actions & experiences & to *discuss* these reflections with others

Through these discussions we develop explicit accounts of the world & ourselves

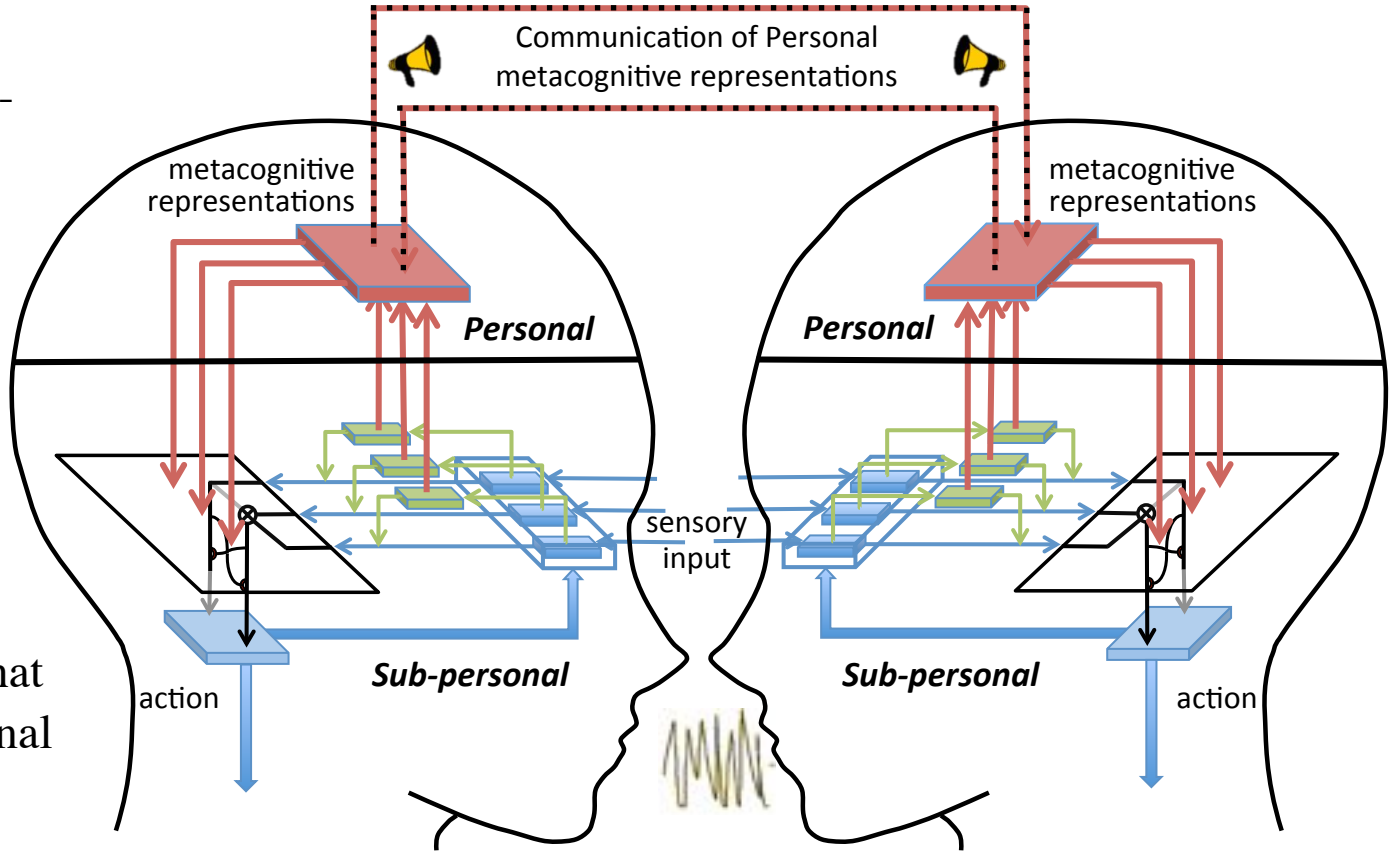
Properties of explicit metacognition

We can discuss explicit
metacognitive feelings with others
& reach a consensus
about how they should be interpreted

Explicit metacognition enables a two-way process

signals arising from sub-personal cognitive processes are converted into representations that can be communicated

communications are converted into signals that can modulate sub-personal cognitive processes



Shea et al *TiCS* 2014

Our interpretation of explicit metacognitive signals can be rapidly altered by gossip and instructions

The effects trickle down to the implicit level

Belief in free will can be weakened by authoritative statements such as

'Most rational people now recognise that free will is an illusion' *(F Crick, 1994)*

Exposure to such statements

increases antisocial tendencies (cheating)

Vohs & Schooler *Psych Sci* 2008

reduces helping & increases aggression

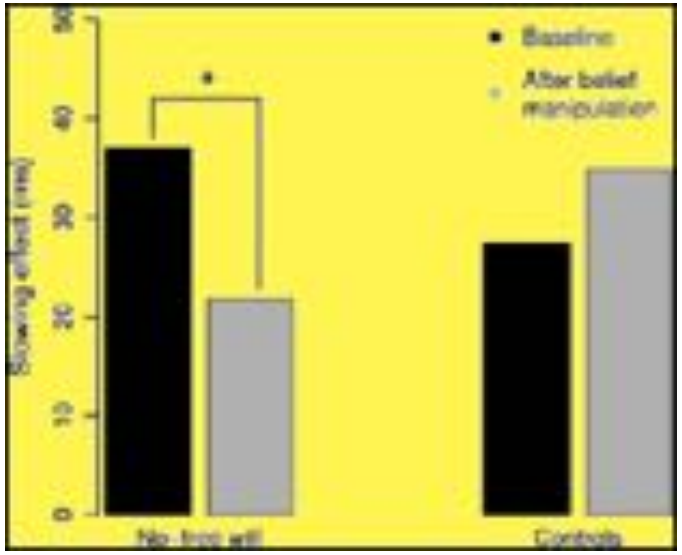
Baumeister et al *Pers Soc Psychol Bull* 2009

reduces self-control

Rigoni et al *Conscious Cogn* 2012

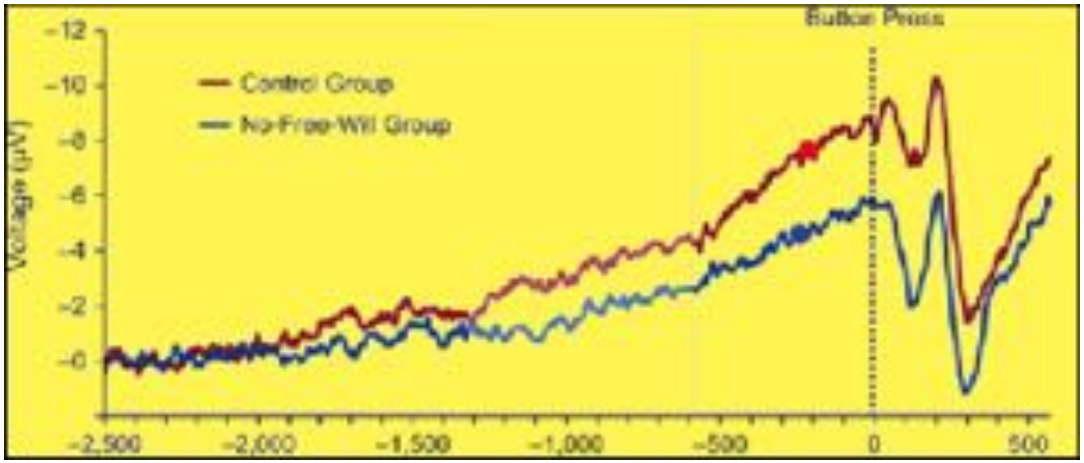
Weakening belief in free will can modify the function of sub-personal cognition & associated brain function

reduction in post-error slowing



Rigoni et al. *Cognition* 2013

reduction in the amplitude of the readiness potential

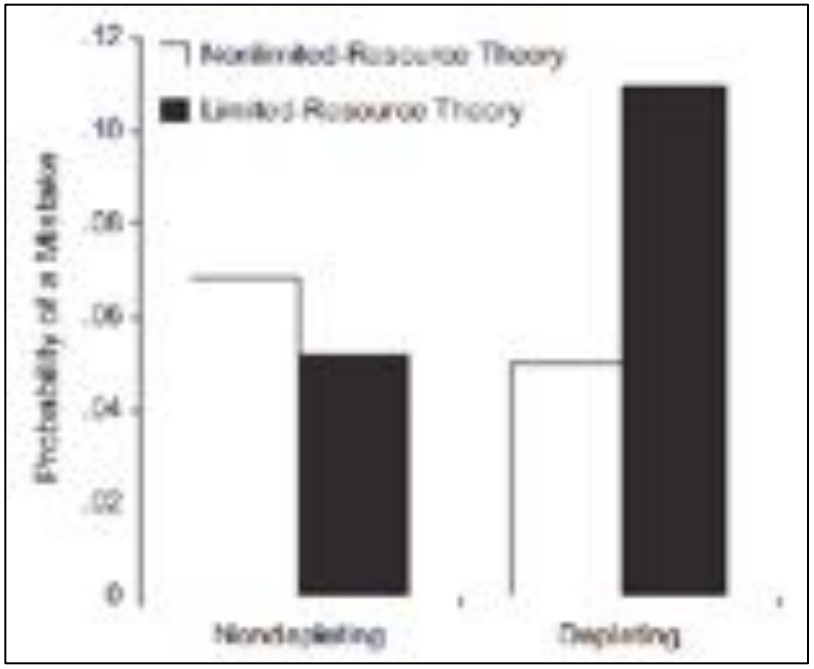


Rigoni et al. *Psychol Sci* 2011

Instructions can alter the way we interpret the sense of mental effort (e.g. Ego depletion)

Limited resource: “Working on a strenuous mental task can make you feel tired such that you need a break before accomplishing a new task”

Non-limited resource: “Sometimes, working on a strenuous mental task can make you feel energised for further challenging activities”



an inaccurate consensus can be created

Job et al, *Psychol Sci*, 2010

Explicit metacognition involves reflecting on our experiences and describing these to others

Our experiences are altered by discussions with others

Explicit Metacognition & wine tasting

If I give someone a wine and ask what do you think of that [] I am asking what do you think of it? Not, how is it for you? But, can you tell me more about it?

Does it taste the same as it did? Yes. But the way I experienced that taste is different because someone has directed my attention to it a different way.

Smith *J Goode Wine Blog* 2015

Psychosis & Explicit Metacognition

It is striking that both aspects of explicit metacognition are impaired during an episode of psychosis

patients lack insight & have difficulty in describing their experiences to others

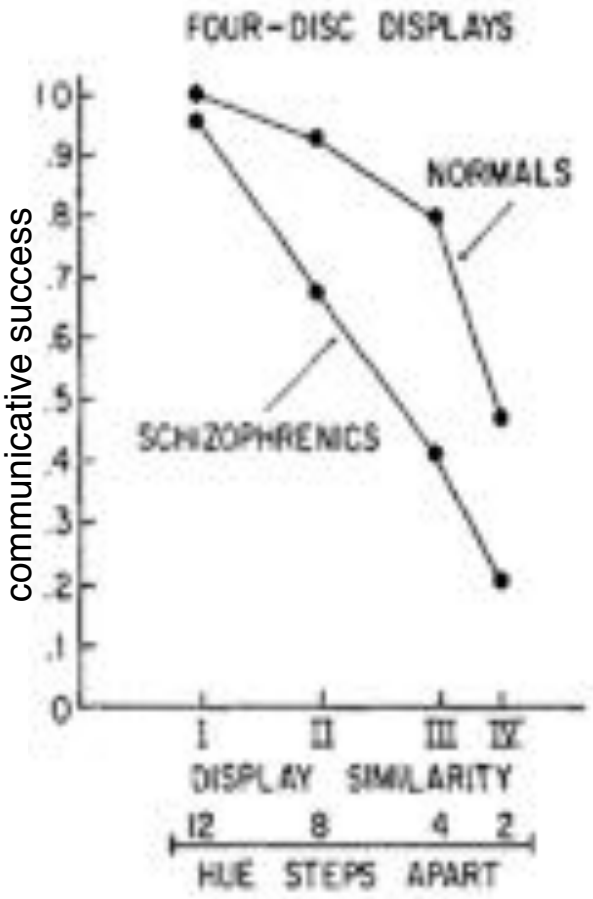
Their beliefs & experience are not influenced by what others say

Introspection & communication

Attempts to describe one of four coloured disks so that a listener can pick it out

Control speaker: *The lightest of the greens. The others become blue like the ocean or the sea*

Schizophrenic speaker: *Clean green. The one without the cream. Don't see this colour on planes, it looks like moss, boss.*



Cohen *Language and Cognition in Schizophrenia* 1976

Cohen et al *J Abn Psychol* 1974

Explicit metacognition
has a key role in generating consensus

how* we *interpret our feelings & sensations

Explicit metacognition has a critical role in creating advantages for interacting minds

Its reportability *allows minds to share experiences*

The malleability & fallibility *of the interpretation of metacognitive signals enables the top-down effects of culture on brain & behaviour*

Experiences of agency & responsibility *create social cohesion & cumulative culture*

consensus can be more important than accuracy

Psychosis & Explicit Metacognition

Delusions are not defined by *bizarreness*
but by lack of *consensus*

"A false belief [ ] that is firmly sustained despite what almost everyone else believes"

"The belief is not one ordinarily accepted by other members of the person's culture or subculture"

DSM-5 2013 p. 819

In some circumstances lack of consensus can
lead to greater accuracy

consensus vs accuracy

People can pick out which are the untrustworthy faces

But not which are the criminals

There is strong consensus about trustworthiness, but poor accuracy

Rule et al *J Pers Soc Psychol* 2013

consensus vs accuracy

Most studies of emotion recognition use posed faces
This captures *consensus* rather than *accuracy*

Mclellan et al *Cognit Emot* 2010

There is a *deficit* in recognising posed emotions associated with schizophrenia

For genuine expressions of emotion, the paranoid-schizophrenia group was *more accurate* than controls

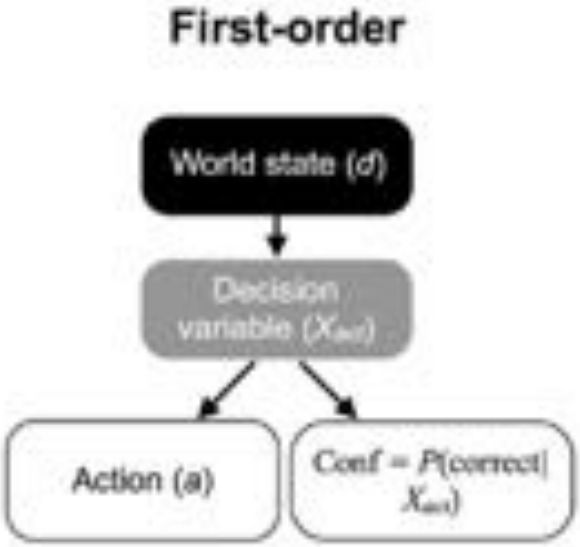
Davis & Gibson, *J Abnorm Psychol* 2000

Explicit metacognition

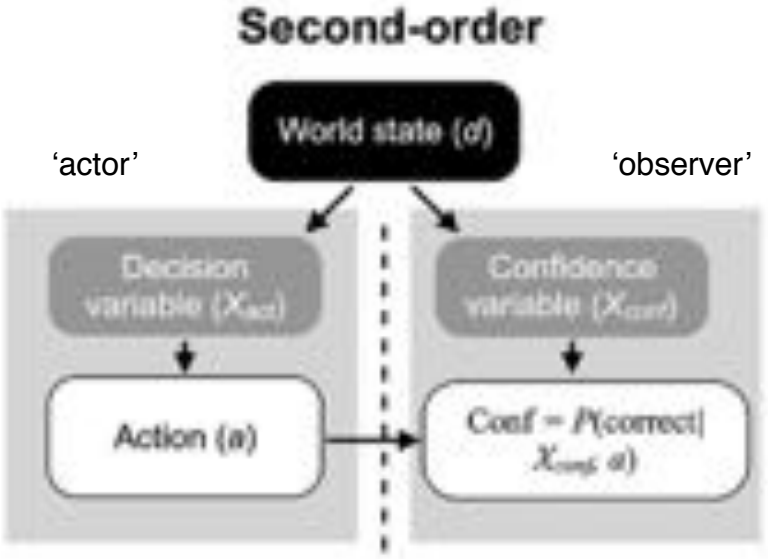
How does explicit thinking about thinking achieve such an important social role?

Social function of explicit metacognition

clues from a computational account



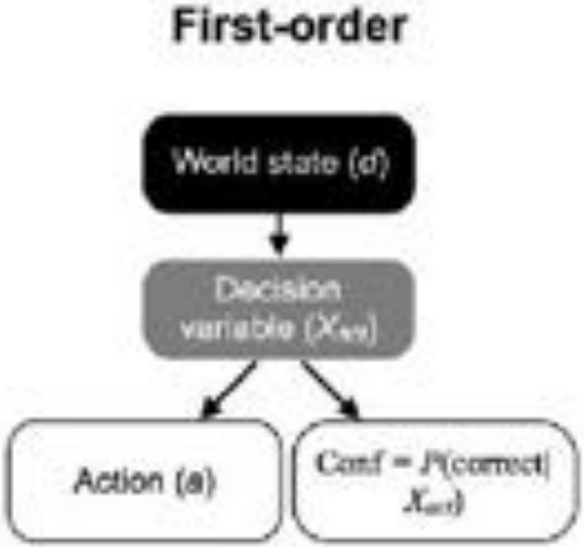
The world state generates a decision variable Xact that supports both actions and confidence.



An 'observer' system derives confidence from the world state & the decision system state

Fleming & Daw *Psych Rev* 2017

Confidence in decisions is a metacognitive variable



Fleming & Daw *Psych Rev* 2017

The same information is used to make the decision and to rate confidence

p(A): probability A is correct
p(B): probability B is correct

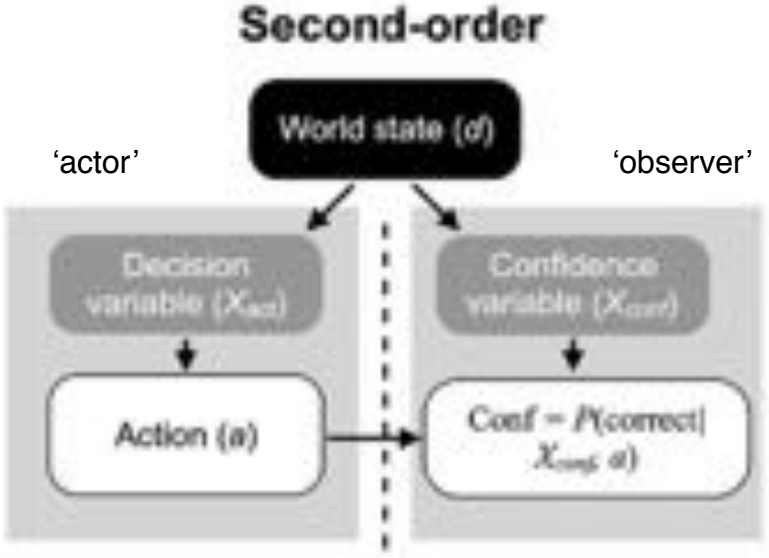
Decision: if p(A)>p(B), choose A
Confidence ∝ p(A)-p(B)

But confidence accuracy can be independent of first-order decision accuracy

e.g. prefrontal damage impairs confidence accuracy, but not decision accuracy

Fleming et al *Brain* 2014

A second-order computation of metacognition can be applied to others as well as the self



"We [] describe a second-order model of confidence in another individual's performance to provide the intuition for the within-subject case, and to demonstrate the symmetry between evaluating one's own actions and those of another actor"

Fleming & Daw *Psych Rev* 2017

The 'observer' in this model has no direct access to the state of the world or the state of decision-maker

This corresponds to the lack of direct access of the implicit, *sub-personal-level system to the* explicit *personal level system*

The positive symptoms of schizophrenia reflect failings of explicit metacognition about hidden states of the self and the other

self	other
grandiose delusions	*ideas of reference*
I have super-powers	people are watching me
delusions of control	*delusions of reference*
actions are imposed on me	people are communicating with me
passivity experiences	*delusions of assistance*
emotions are imposed on me	people are trying to help me
thought insertion	*delusions of persecution*
these are not my thoughts	people are trying to harm me

Implicit metacognition
a first-order process

Explicit metacognition
a second-order process

The second-order account of explicit metacognition provides a computational framework for exploring the positive symptoms of schizophrenia

Aarhus
Denmark

Queen Square
Bloomsbury

Senate House
Bloomsbury


Nick Shea

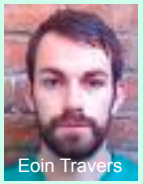

Dan Bang


Steve Fleming


Barry CSmith


Uri Hertz


Vibeke Bliksted


Eoin Travers

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