SYNERGY | LA, USA | October 2012

Pain.

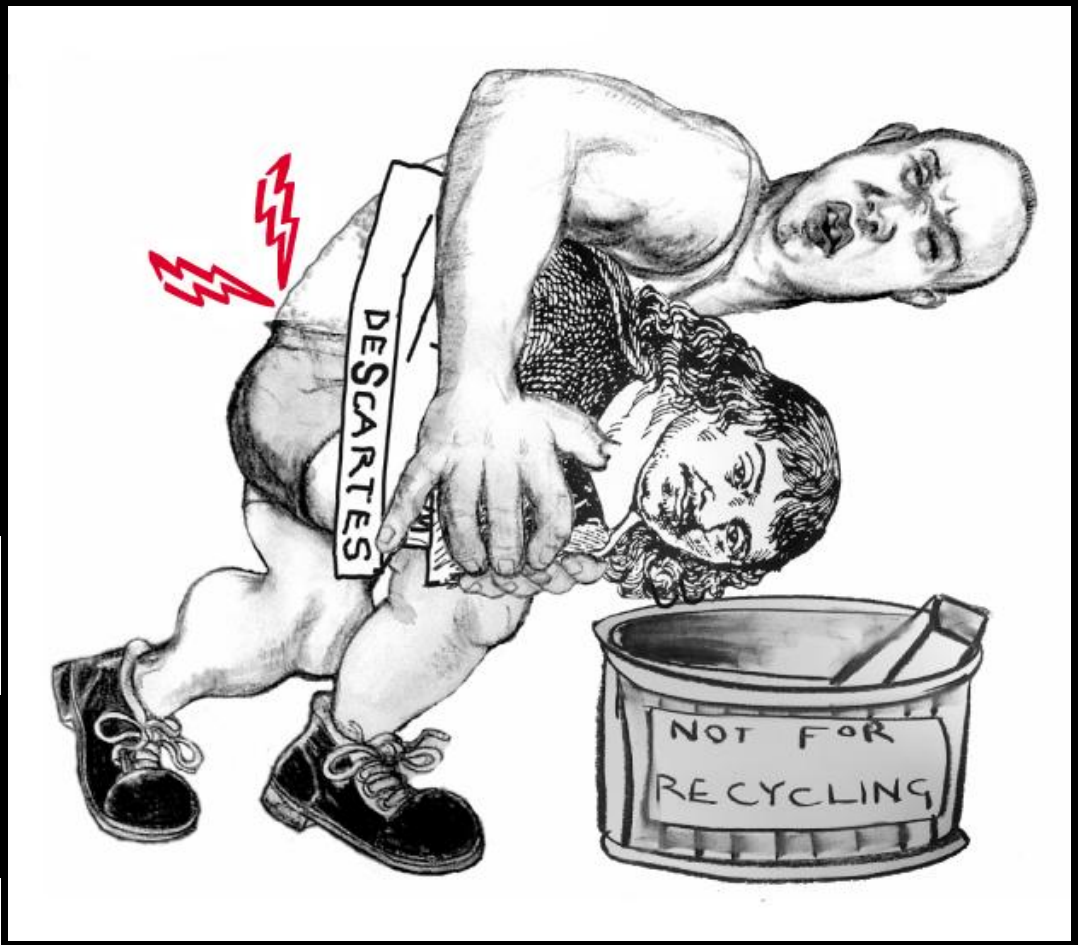
Lorimer Moseley

Professor of Clinical Neurosciences & Chair in Physiotherapy
University of South Australia, Adelaide, Australia

Senior Research Fellow
Neuroscience Research Australia, Sydney, Australia


Penfolds
Grange

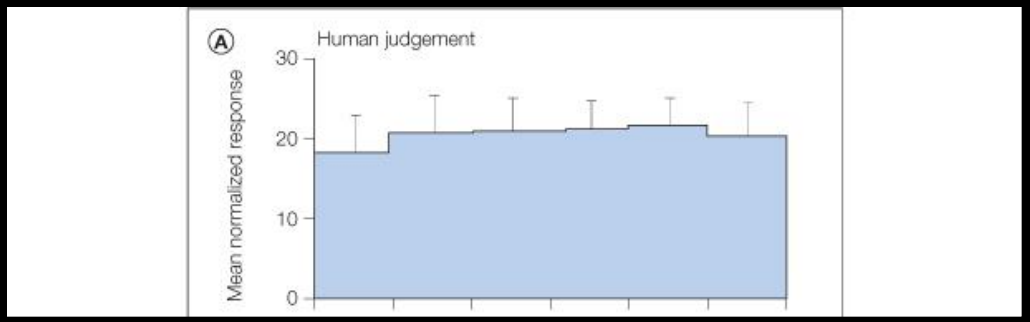
Out with the old….



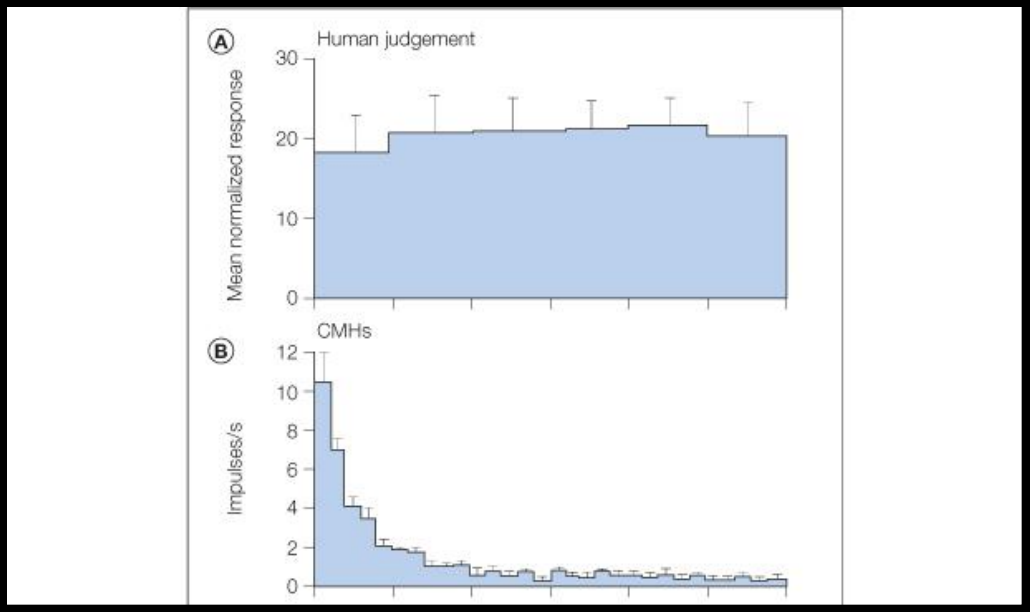
1654

Nociception & pain.

Hold 53˚ C on skin for 30 sec

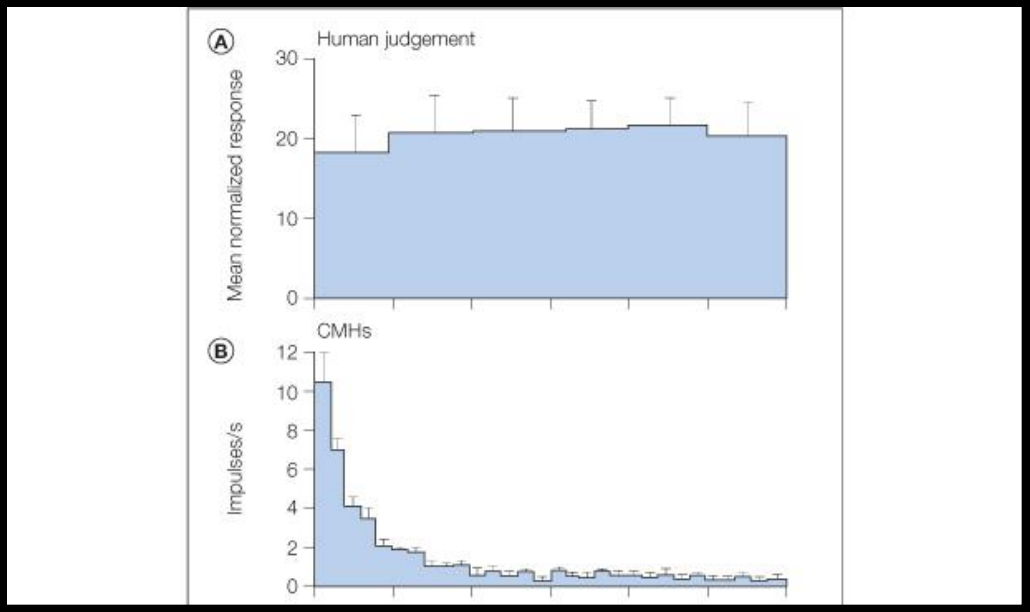


Hold 53˚ C on skin for 30 sec

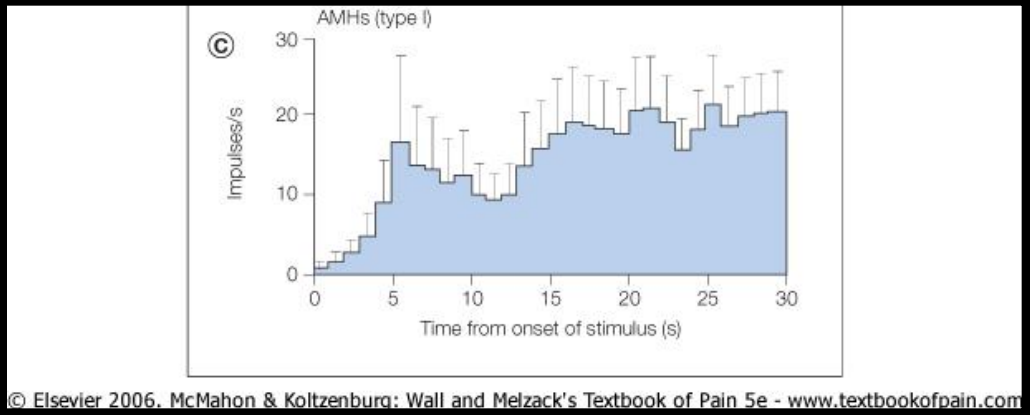


Record activity in C fibres

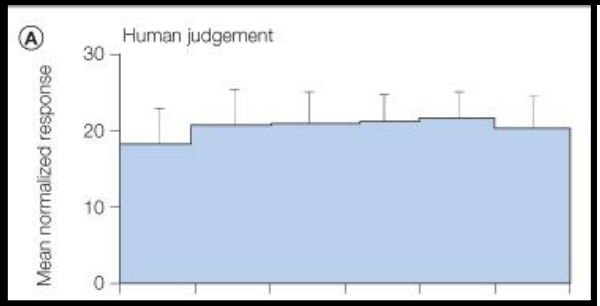
Hold 53˚ C on skin for 30 sec

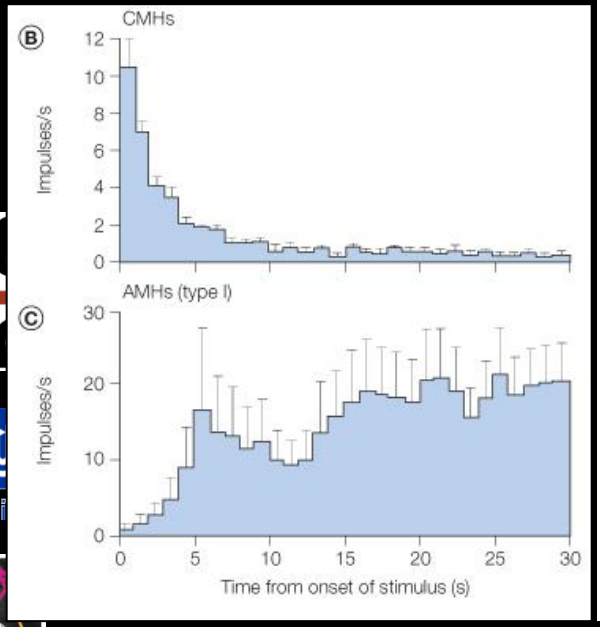


Record activity in C fibres and A™ fibres

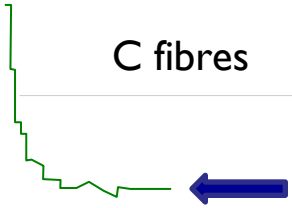


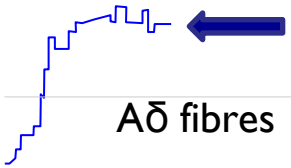
Is nociception sufficient or necessary for pain?





If so, we should see no change in pain without change in nociception.

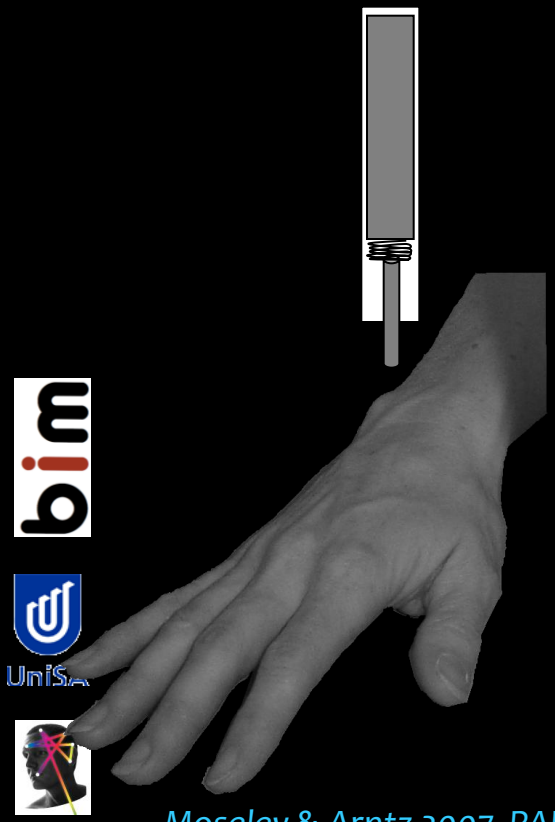


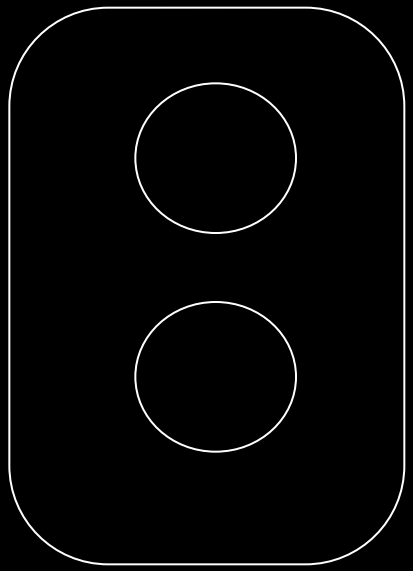


And no change in nociception without a change in pain.

Manipulated meaning of nociceptive stimulus

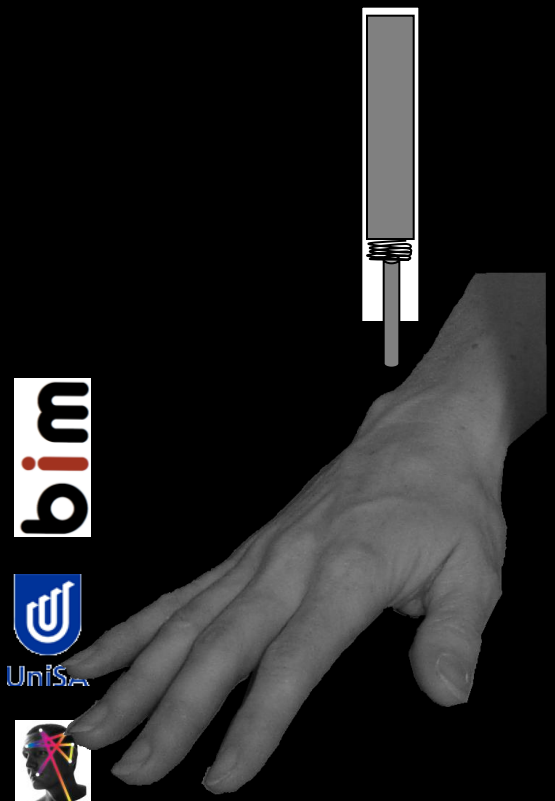
Very cold (-20°C) stimulus associated with a red or a blue light

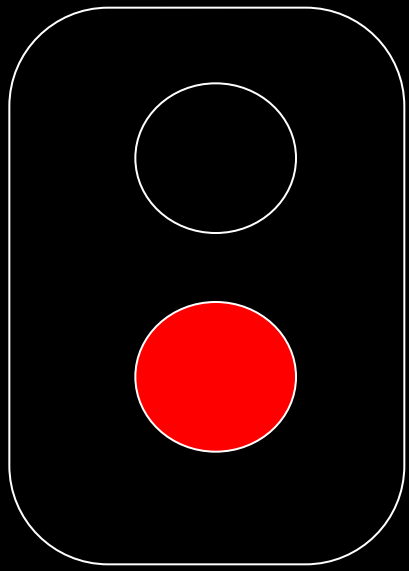




Moseley & Arntz 2007 PAIN

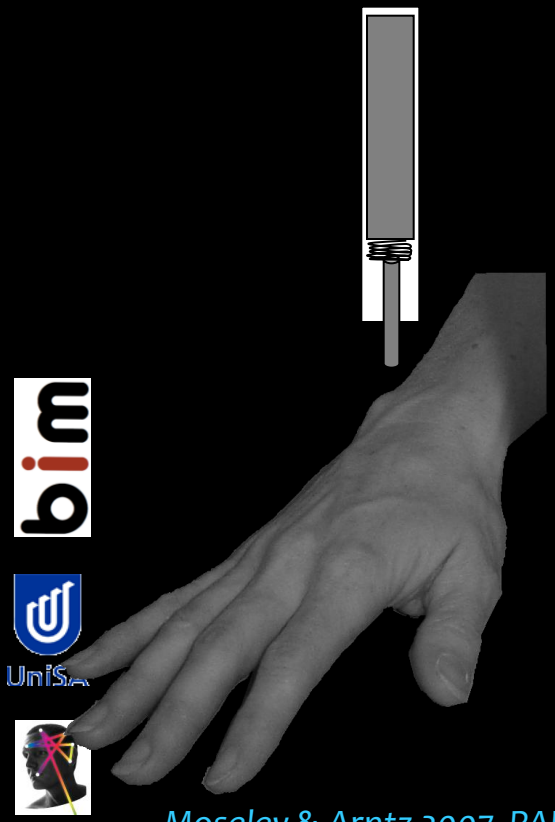
Manipulated meaning of nociceptive stimulus - HOT

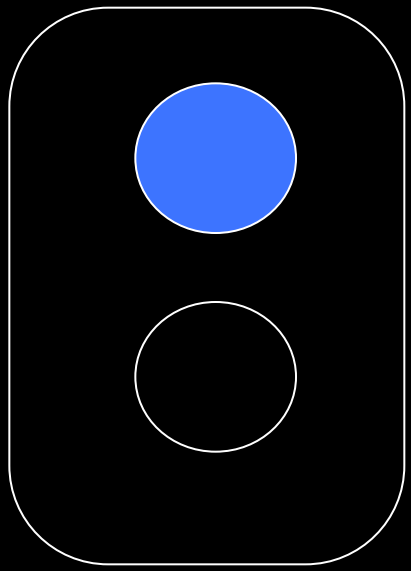




Moseley & Arntz 2007 PAIN

Manipulated meaning of nociceptive stimulus - COLD





Moseley & Arntz 2007 PAIN

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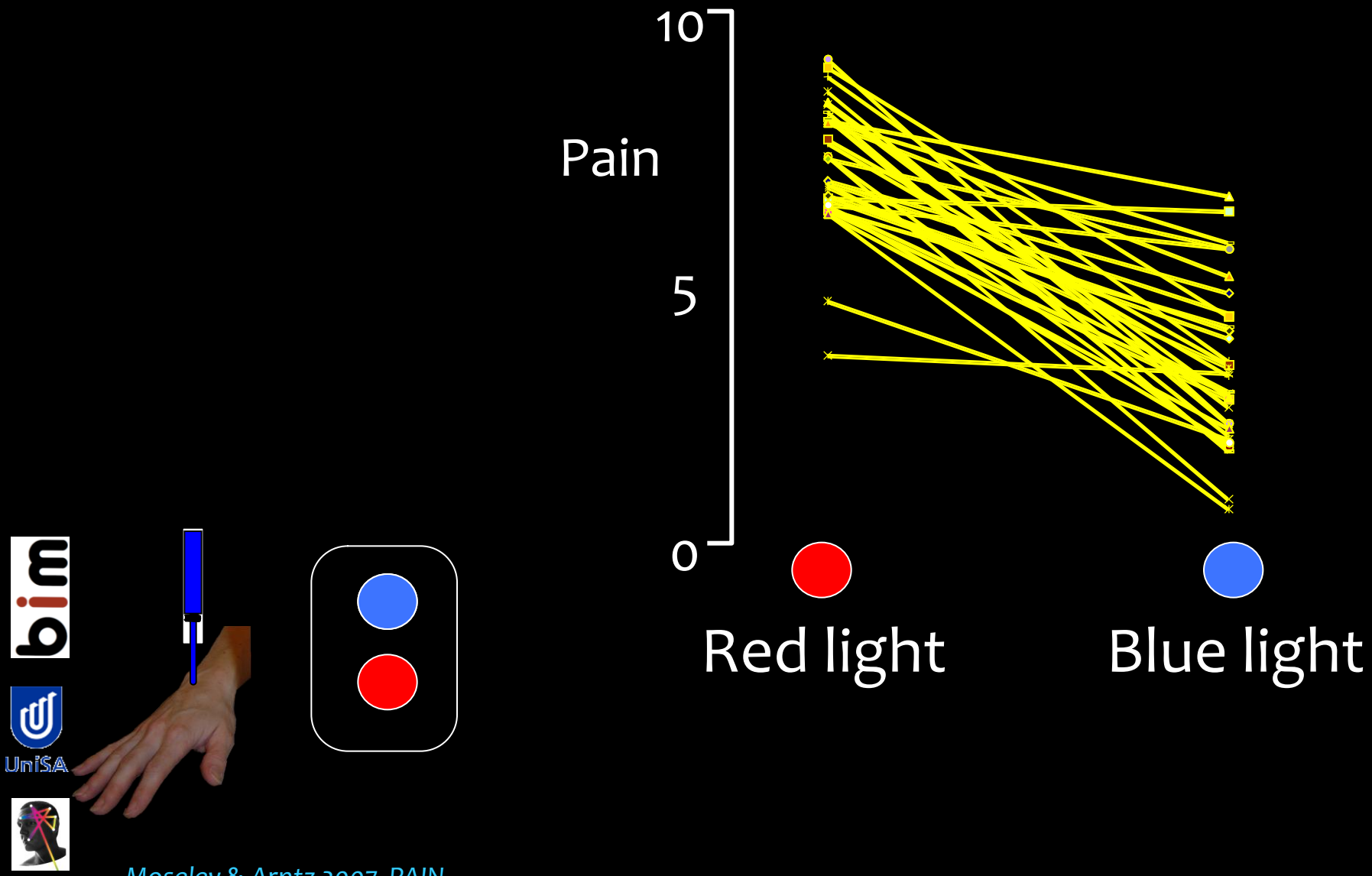
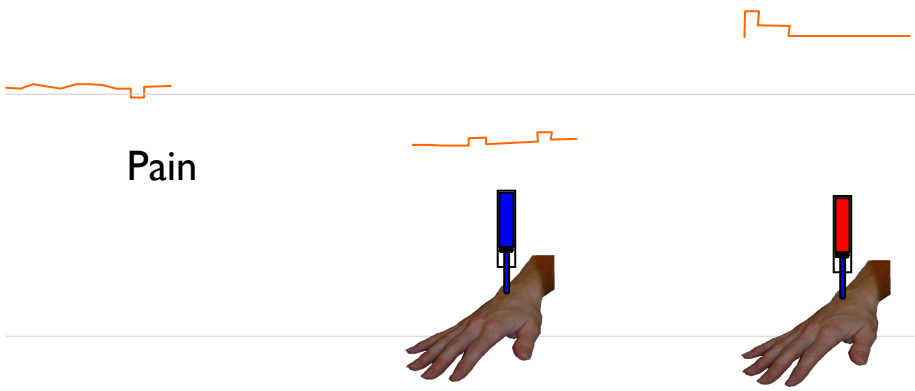


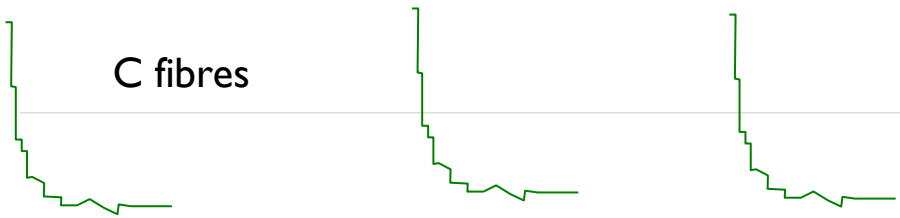
Moseley & Arntz 2007 PAIN

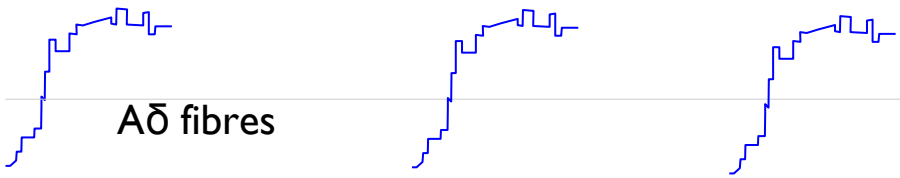
Visual cue
= ‘safe’

Visual cue
= ‘danger’



This is a change in pain without a change in nociception.





Beliefs, knowledge & logic can also be non-specific

e.g. blue placebo pills sedate, red stimulate

Blackwell et al 1972 Lancet 1; 1279-82

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e.g. blue placebo pills sedate, red stimulate

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Except Italian men, in whom the opposite is true

Luchelli et al 1978 Euro J Clin Pharm 13; 153-5

Beliefs, knowledge & logic can also be non-specific

e.g. blue placebo pills sedate, red stimulate

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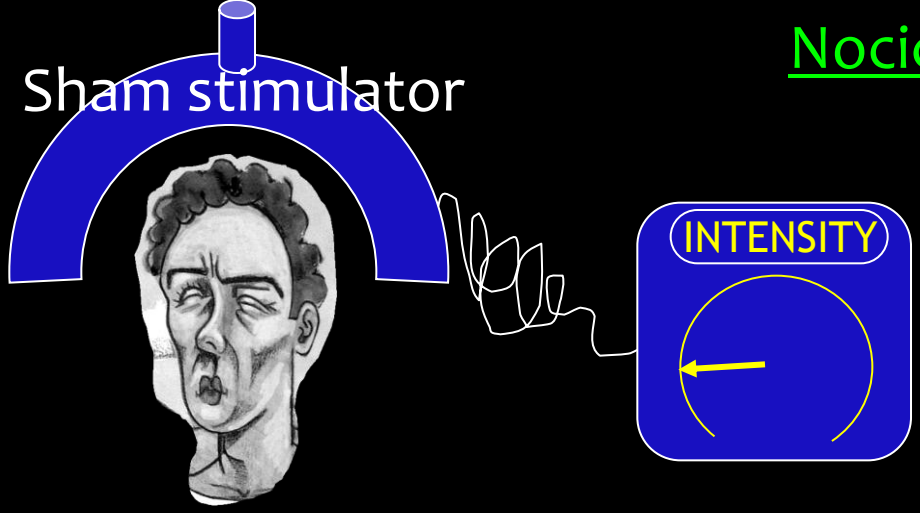
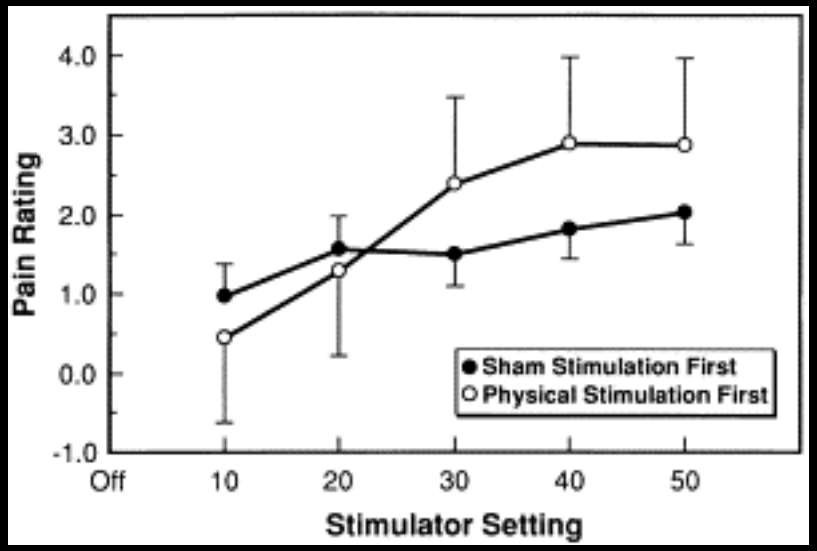
Why might this be the case?

Nociception is not necessary for pain

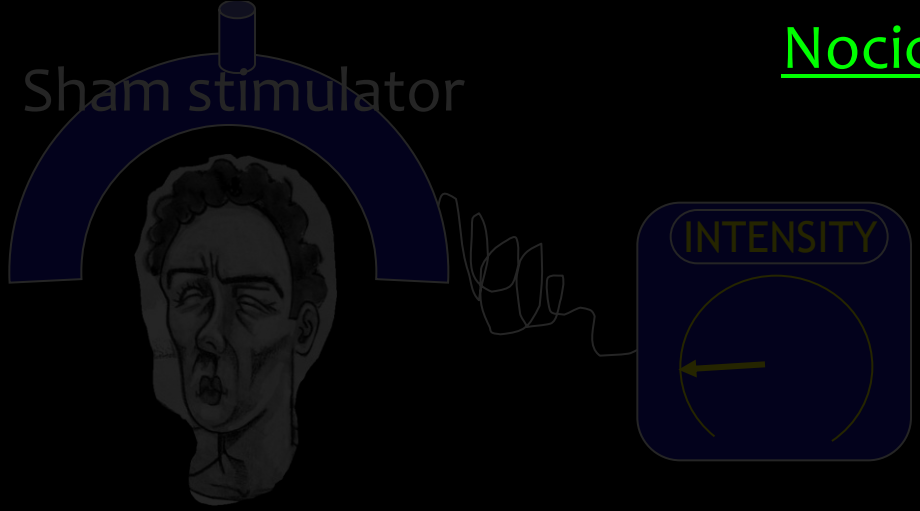


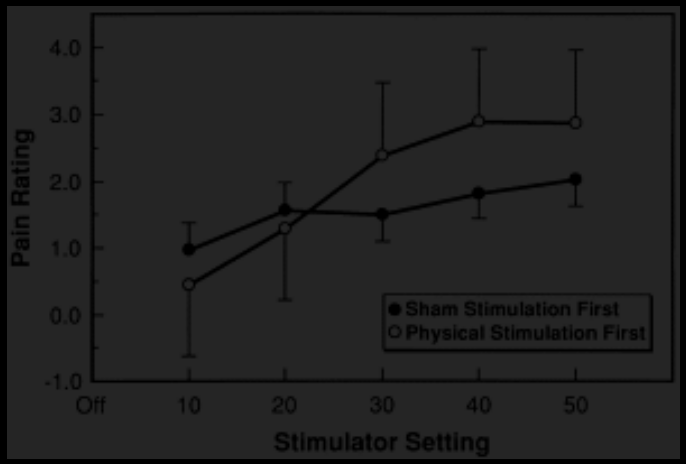
Bayer et al PAIN 74; 327-31 (1998)

"Normal" volunteers



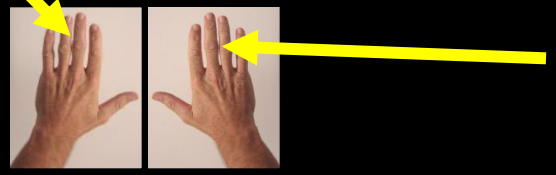
Nociception is not necessary for pain





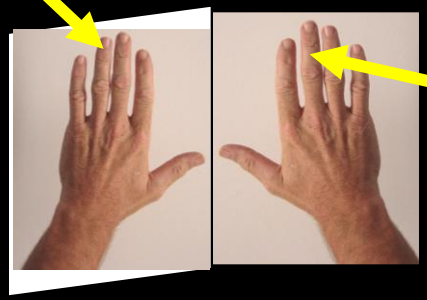
Patients with CRPS

Pain



Touch

Visual input of a tactile stimulus



Tactile stimulus

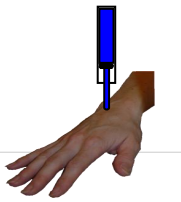
Acerra & Moseley 2005 Neurology 65: 751-3

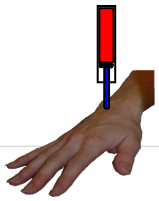
Visual cue = 'safe'

Visual cue = 'danger'

Credible evidence of danger

Pain





This is pain without nociception.

C fibres

Aδ fibres

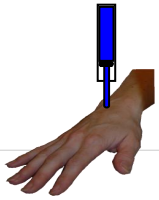
Visual cue = ‘safe’

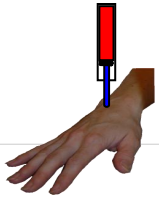
Visual cue = ‘danger’

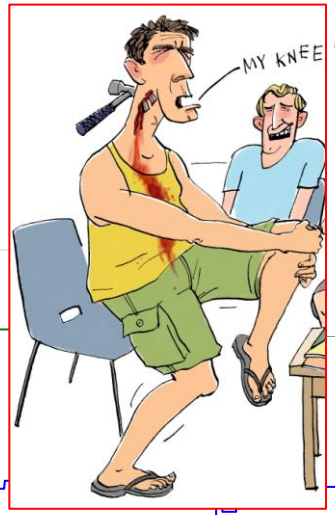
Credible evidence of danger

Pain-free trauma

Pain







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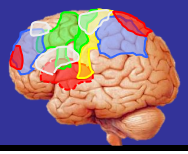
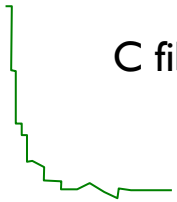
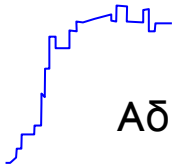


Experimental studies…

Pain



C fibres

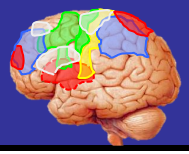


Aδ fibres

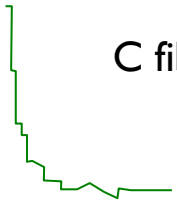
Are the participants normal?

Is the stimulus normal?

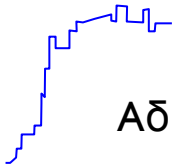
Is *anything* normal?



Pain

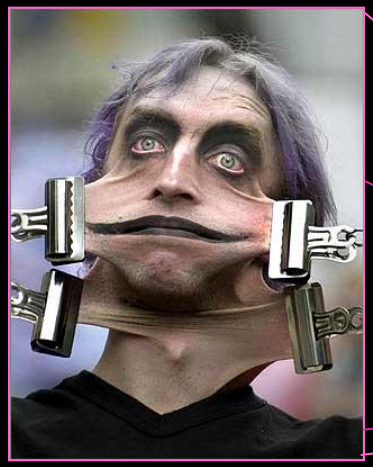


C fibres

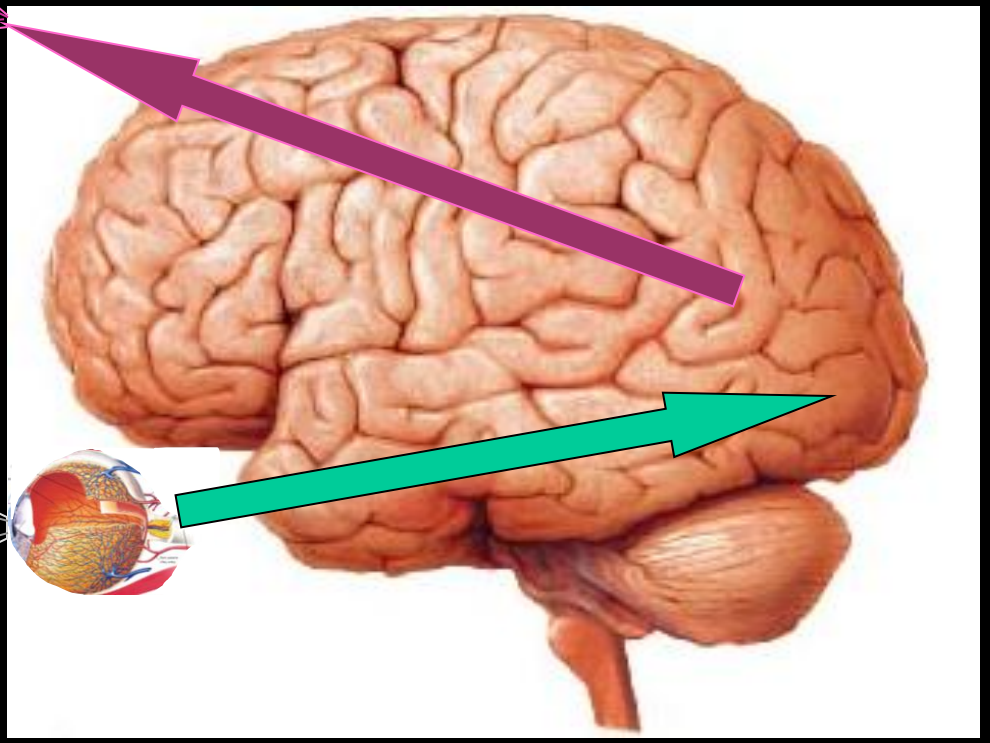


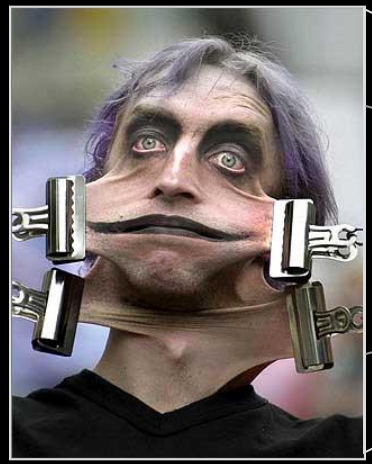
Aδ fibres

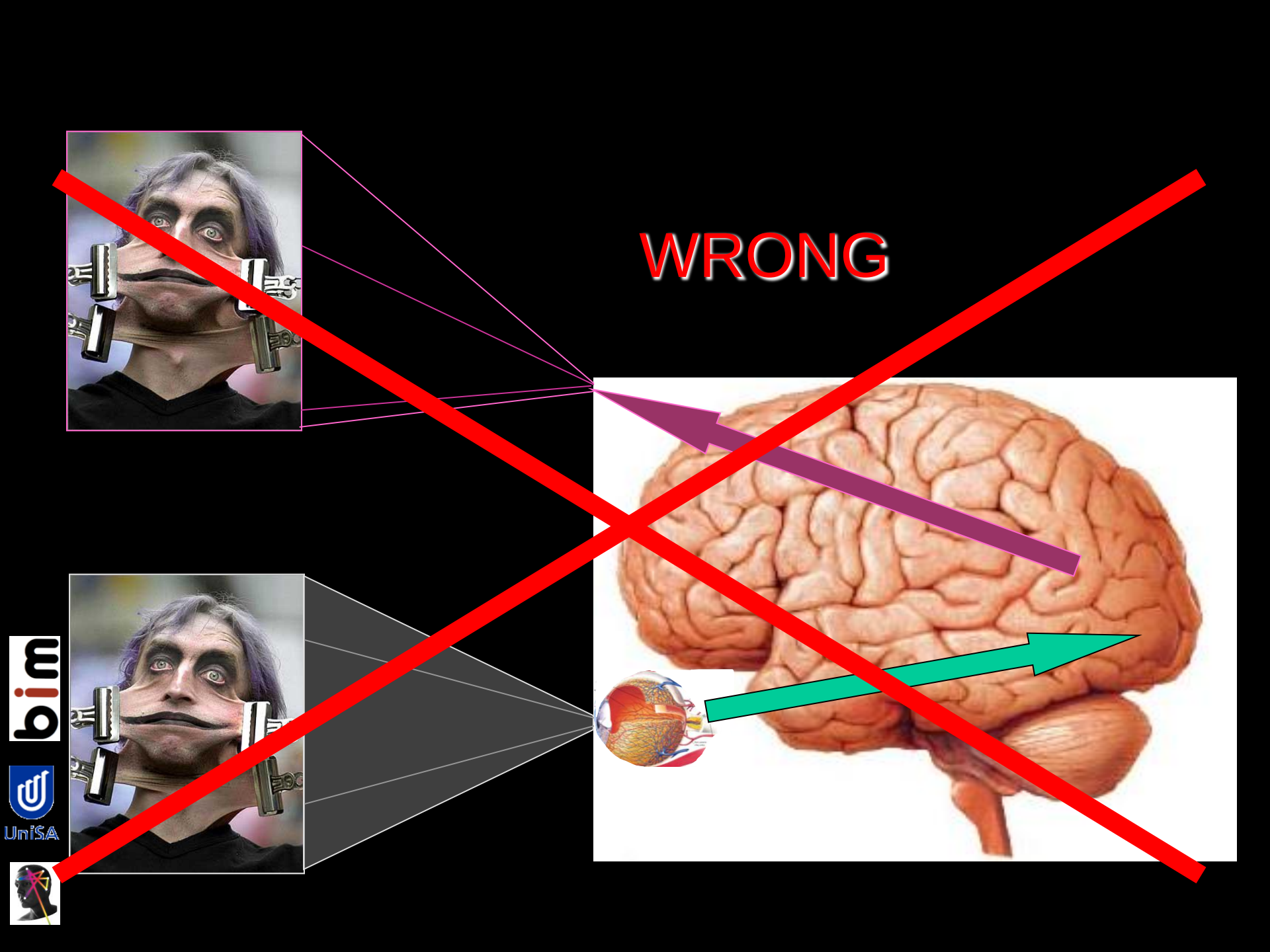
Ed Miracle, c 1970

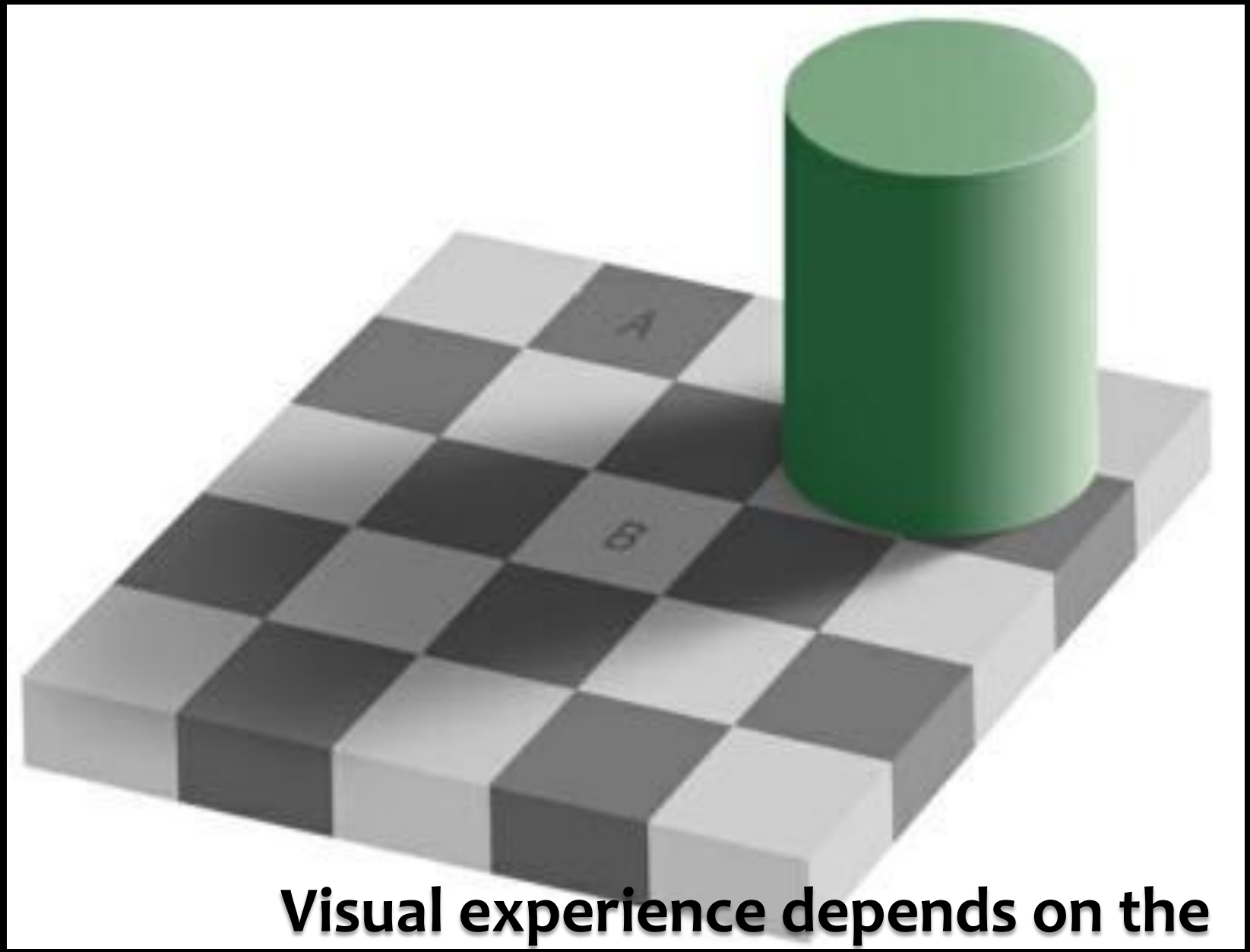


Vision research – RIGHT?

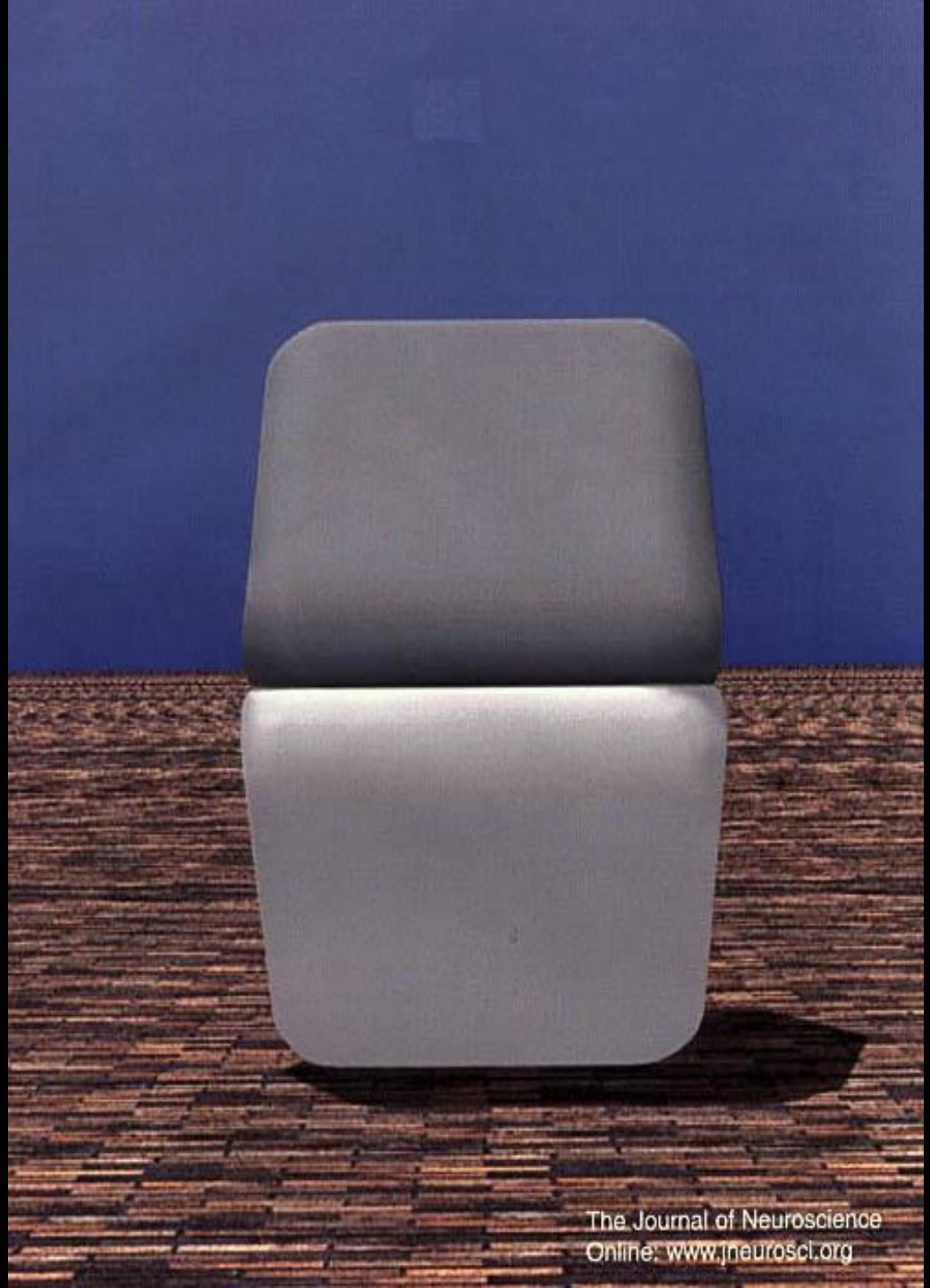





WRONG

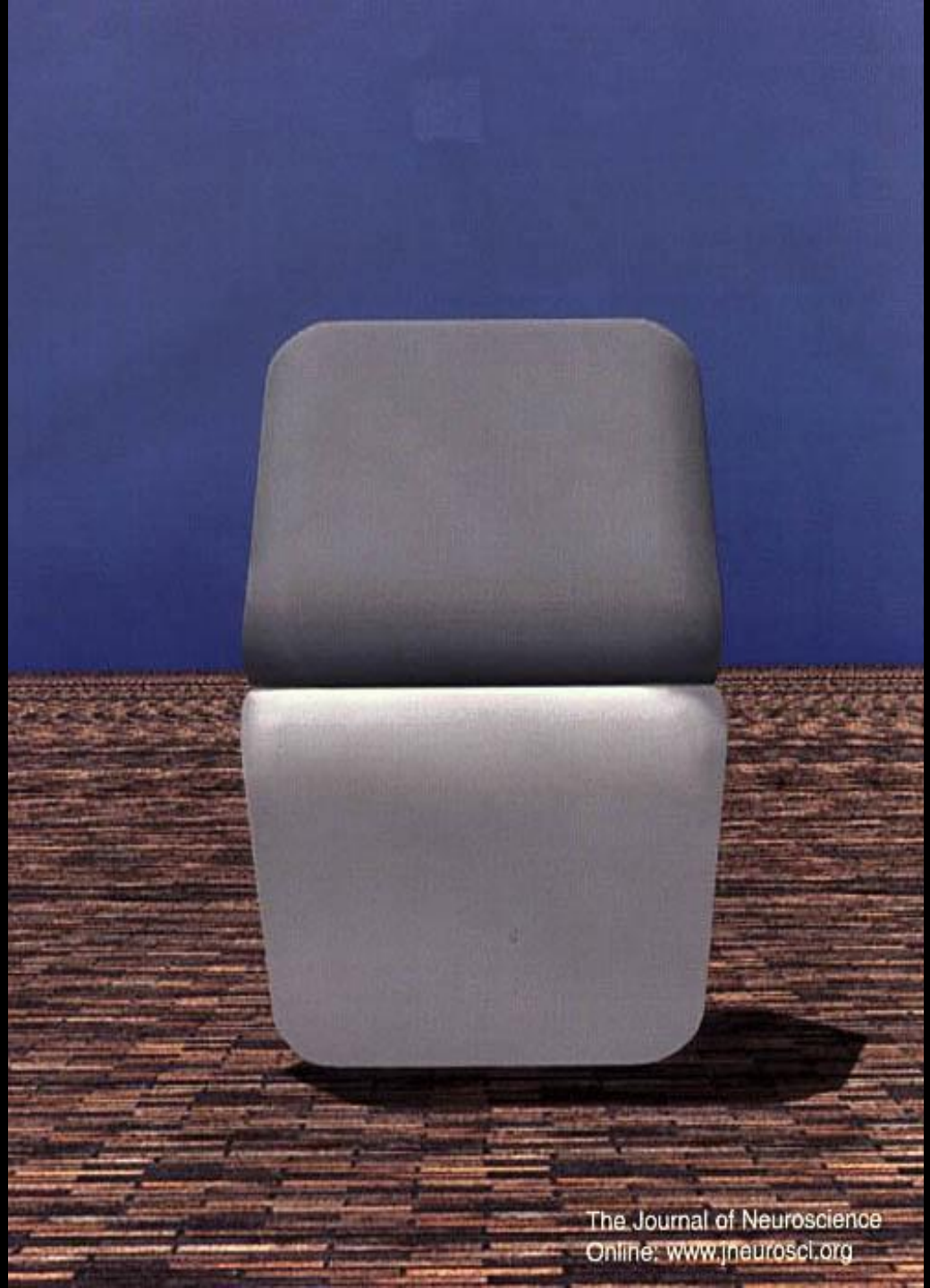


Visual experience depends on the *evaluation* of sensory input


The Journal of Neuroscience
Online: www.jneurosci.org


bim


UniSA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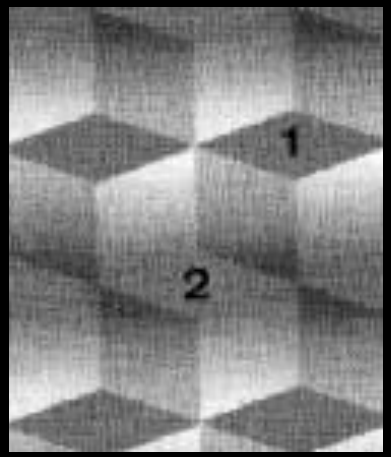
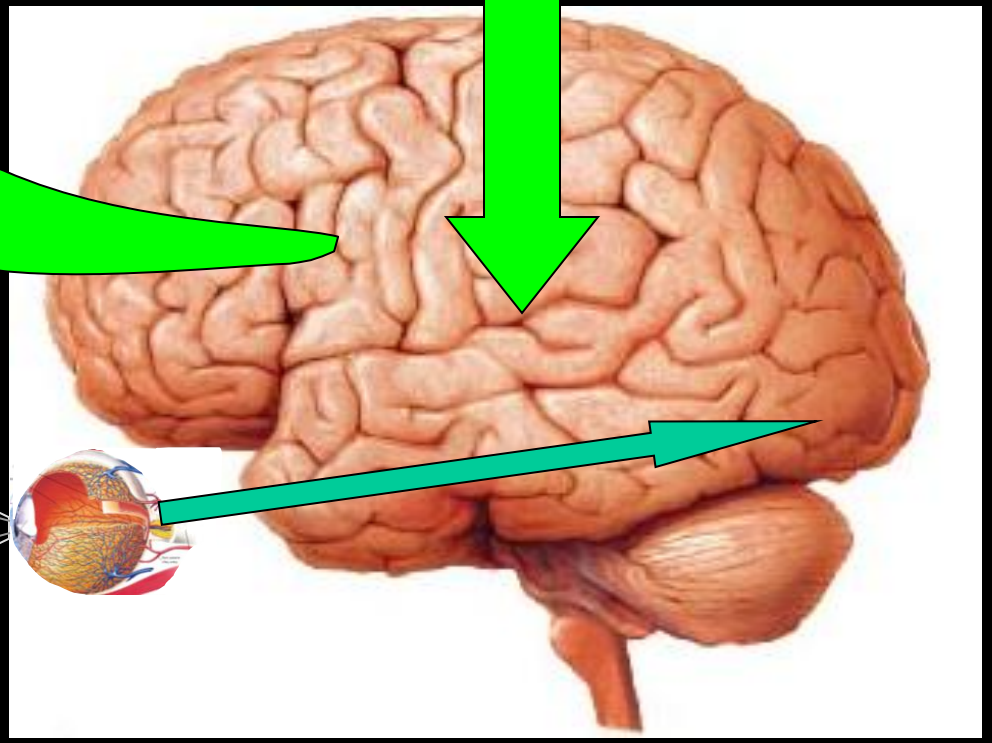
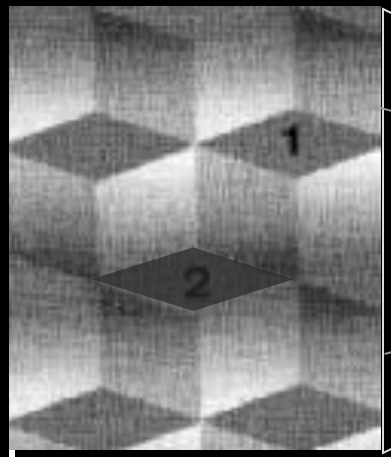


Complex reasoning mechanisms based on experience, context, environment…MEANING

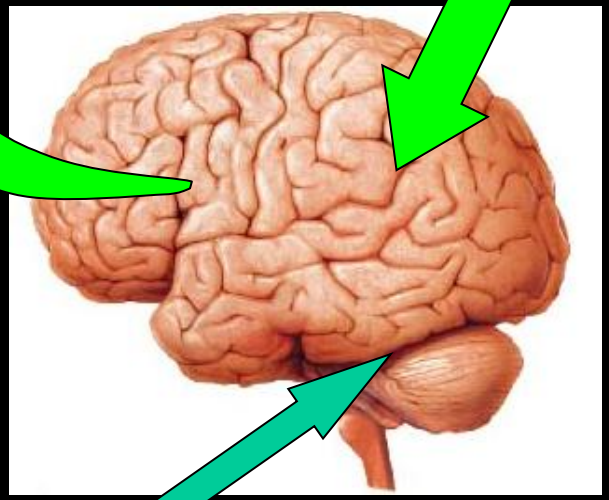


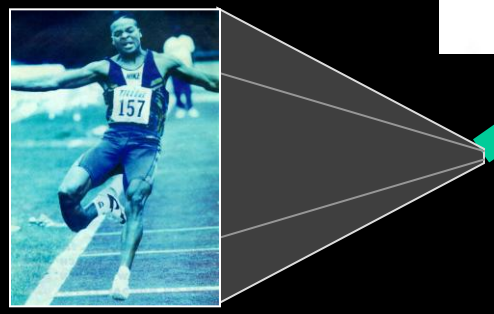


The same thing applies to pain

pain

Complex reasoning mechanisms based on experience, context, environment…MEANING





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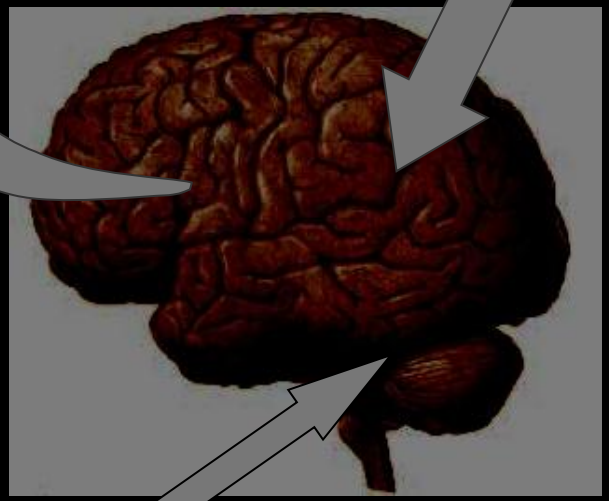
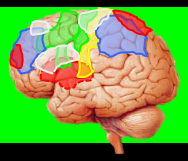
Complex reasoning mechanisms based on experience, context, environment…MEANING



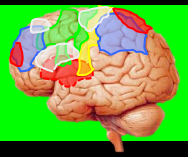
“How dangerous is this really?”



Nociception & pain.

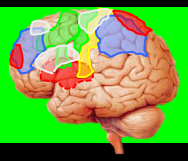
Nociception is activity in high threshold primary fibres (C and Aδ) & their projections.

Pain is an emergent conscious experience that serves to evoke a behavioural protective response.



Some nonsense terms:

Pain stimulus
Pain receptor
Pain pathway
Descending pain control



Modulators of nociception

Modulators of nociception	Where?
Sensory stimuli	Primary nociceptors in tissue
Sensitivity of primary nociceptors	In tissue (peripheral sensitisation)
Sensitivity of spinal nociceptors	In dorsal horn (central sensitisation)
Sensitivity of supraspinal networks	In brain (cortical sensitisation)
Descending modulation	In dorsal horn

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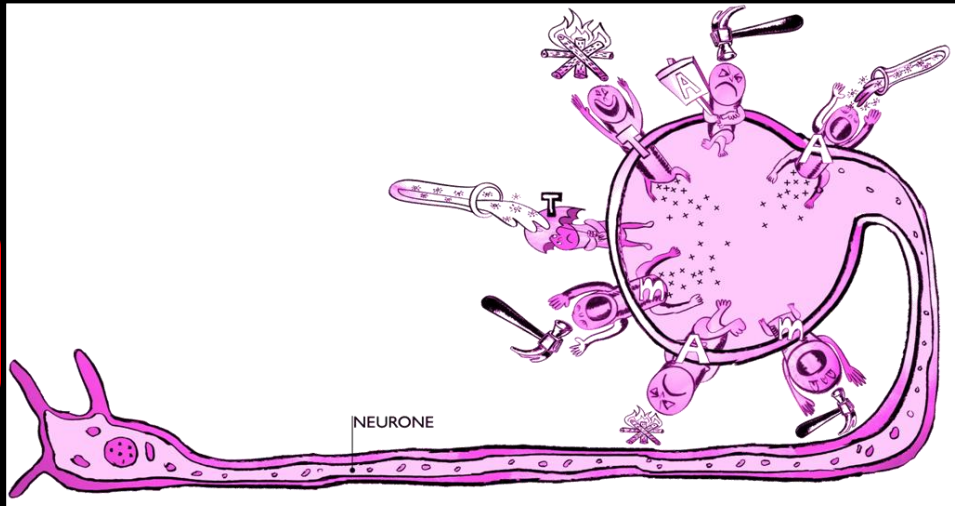

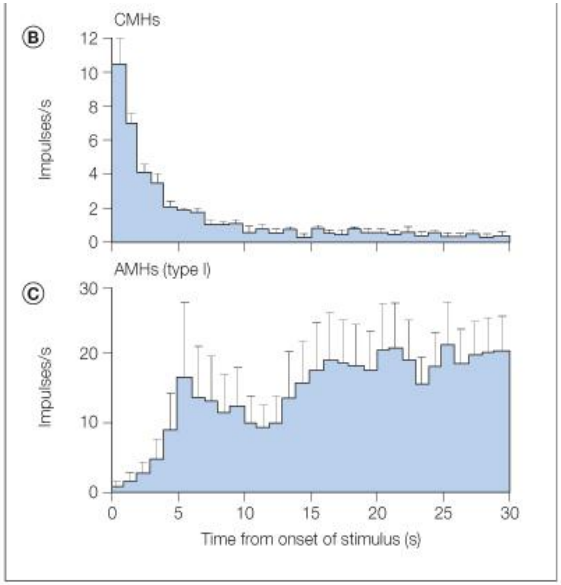

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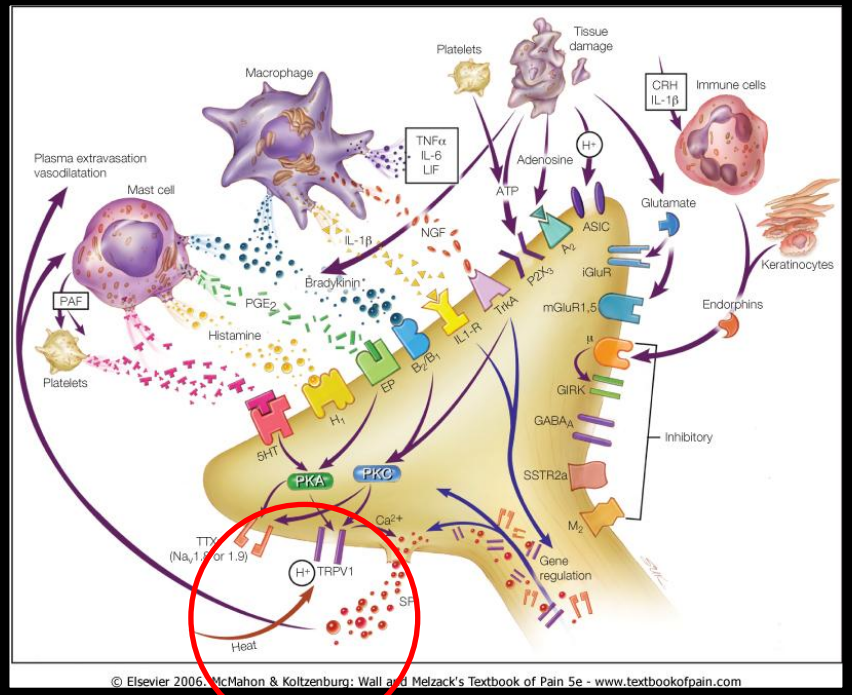
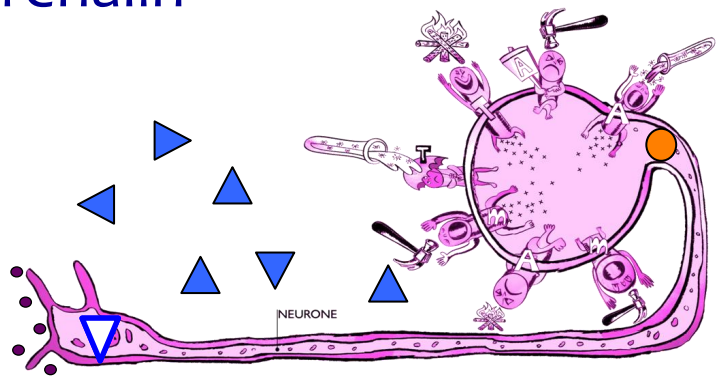


Heat sensitive
Mechanically sensitive

Nociception & pain.

Modulators of nociception	Where?
Sensory stimuli	Primary nociceptors in tissue
Sensitivity of primary nociceptors	In tissue (peripheral sensitisation)
Sensitivity of spinal nociceptors	In dorsal horn (central sensitisation)
Sensitivity of supraspinal networks	In brain (cortical sensitisation)
Descending modulation	In dorsal horn

Adrenalin



Primary nociceptor becomes adrenosensitive

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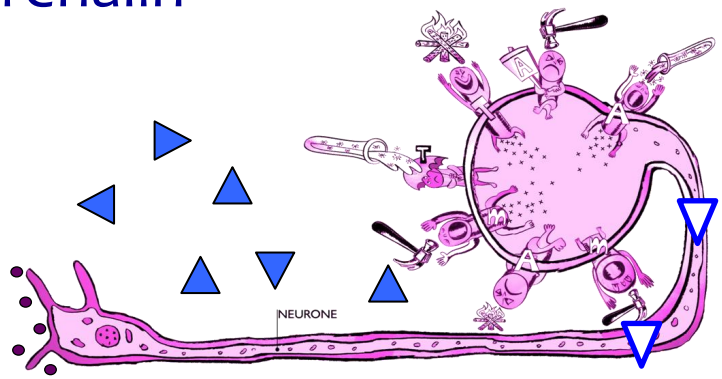
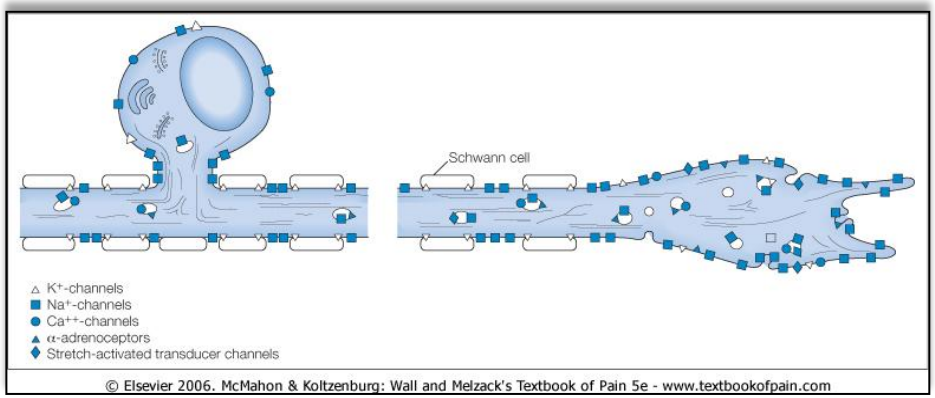
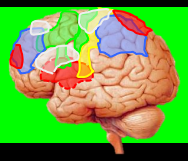


Primary nociceptor becomes adrenosensitive





Nociception & pain - targets.

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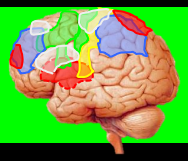
Descending modulation	In dorsal horn

Modulators of pain	Where?
Nociception	Brain
Anything relevant	Brain
Endocrine sensitivity	
(mood & meaning – context, consequences etc)	



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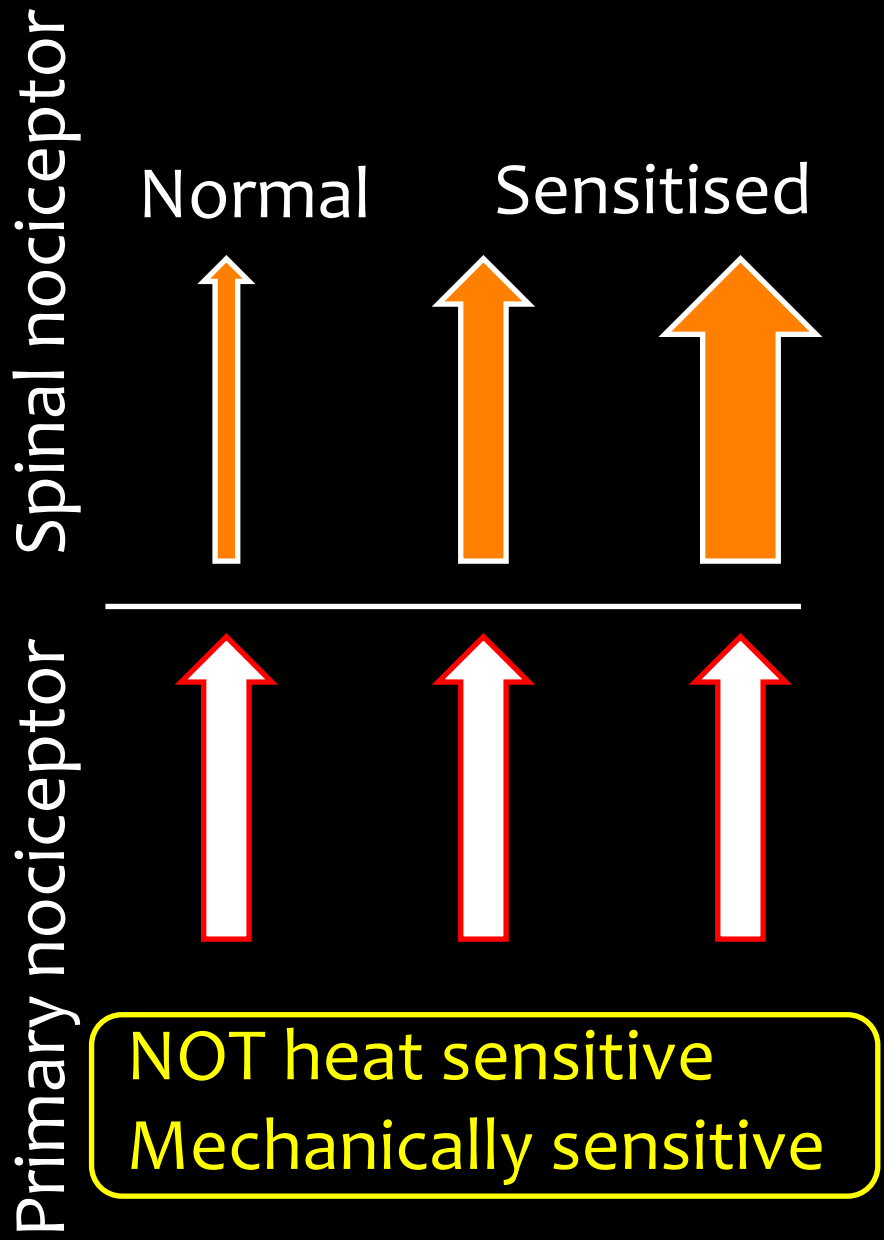

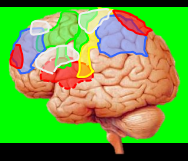

Nociception & pain.

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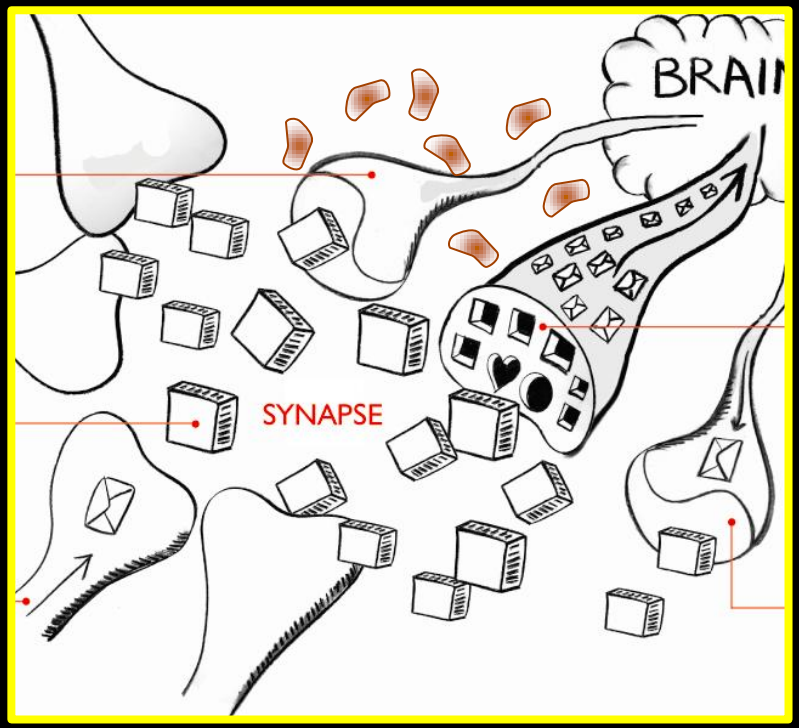
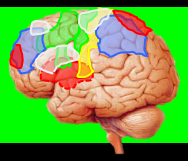
Descending modulation	In dorsal horn

Immune mediators (cytokines)





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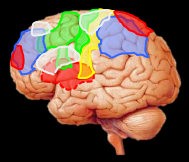
Modulators of pain	Where?
Nociception	Brain
Anything relevant to the need to protect body tissue (mood & meaning –	Brain

Immune sensitivity

Endocrine sensitivity

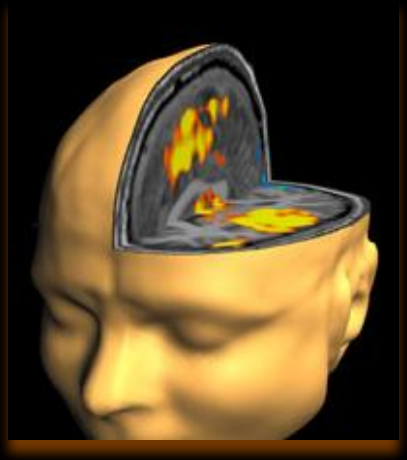


Modulators of pain:

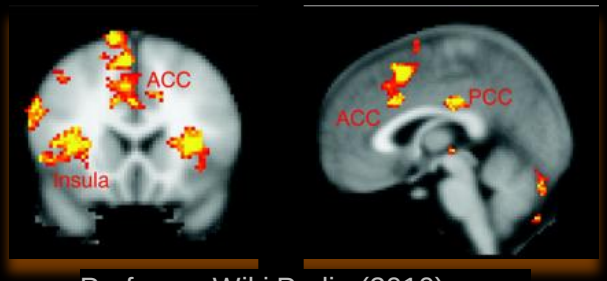
1. Nociception

2. *Anything* relevant to the need to protect body tissue (mood & meaning – context, consequences etc)

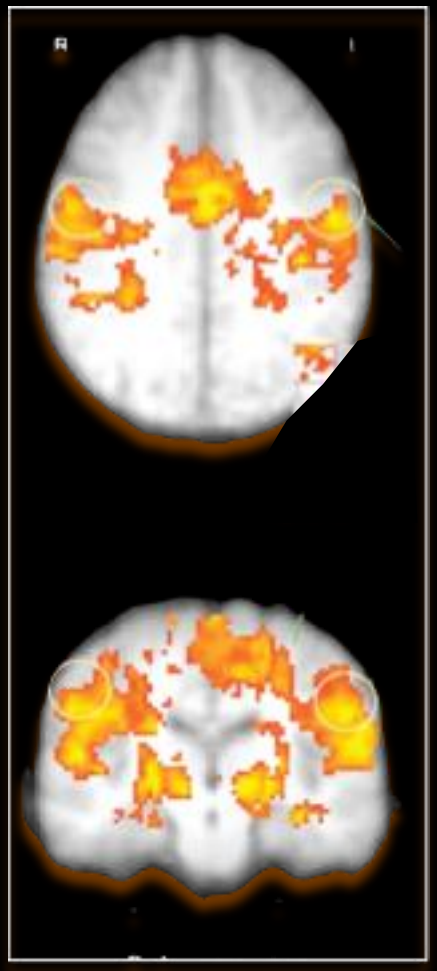
Pain emerges with activation of the pain 'neuro*tag*'



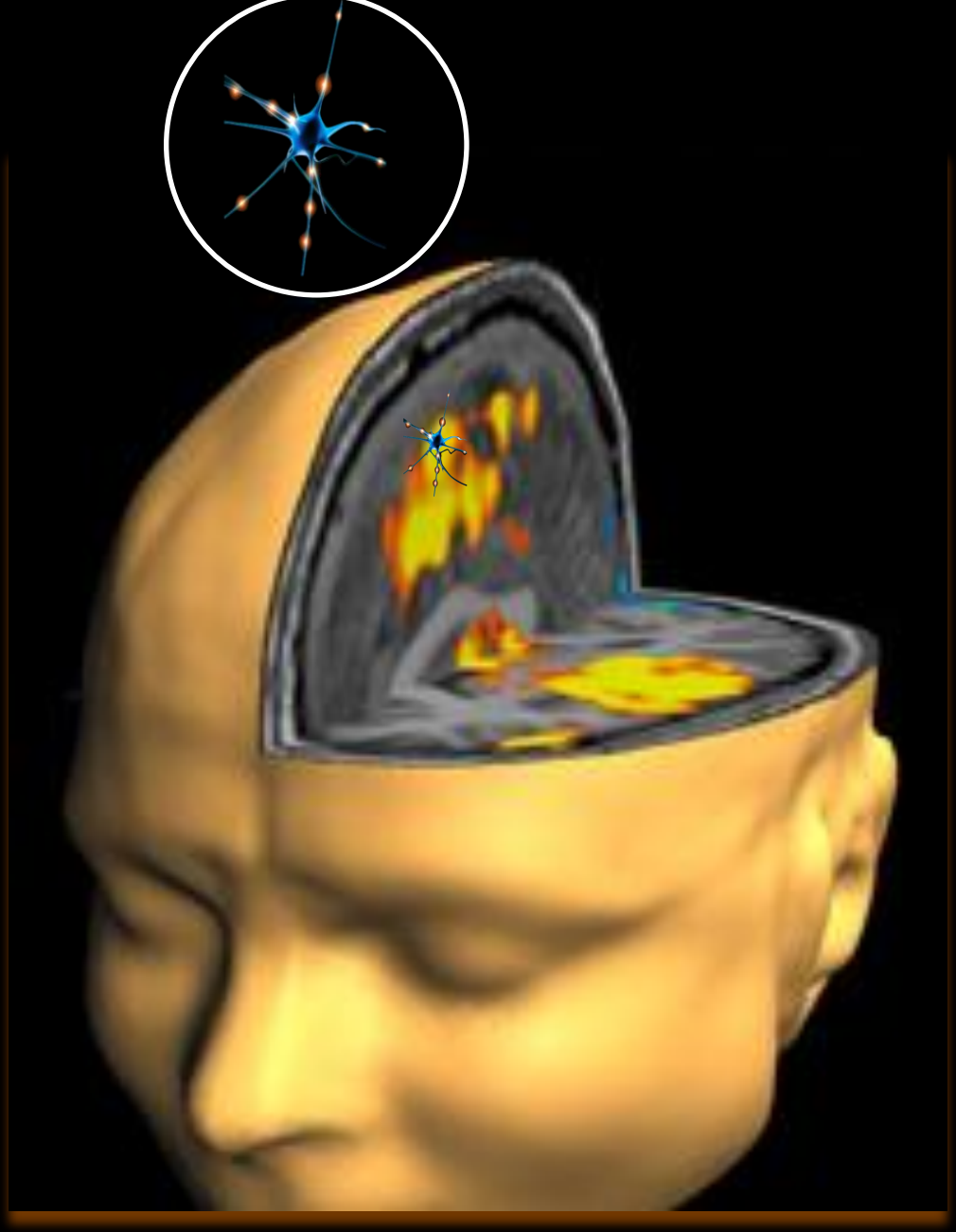
Hoffman et al (2004) *NeuroReport*

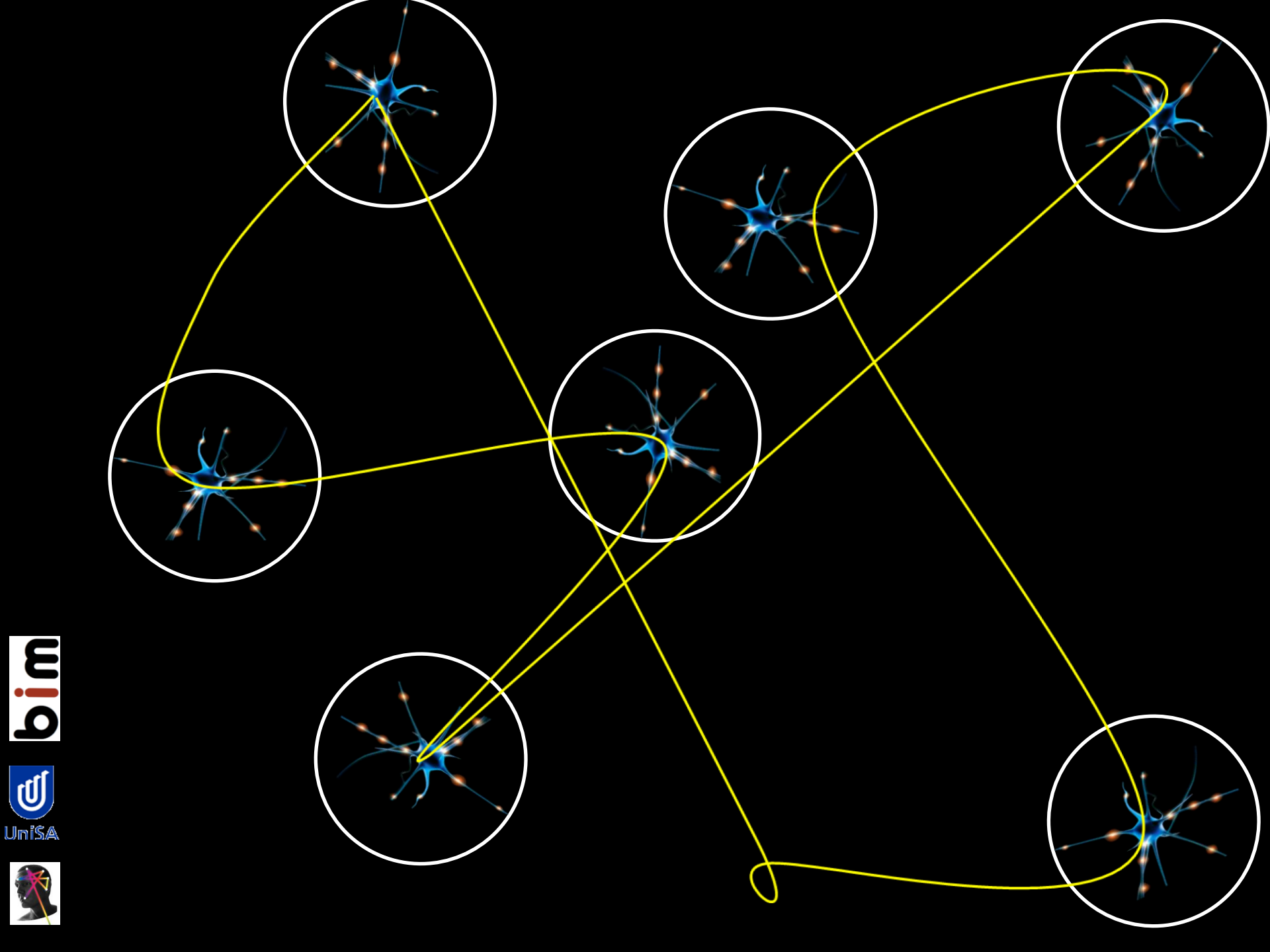


Professor Wiki Pedia (2010)



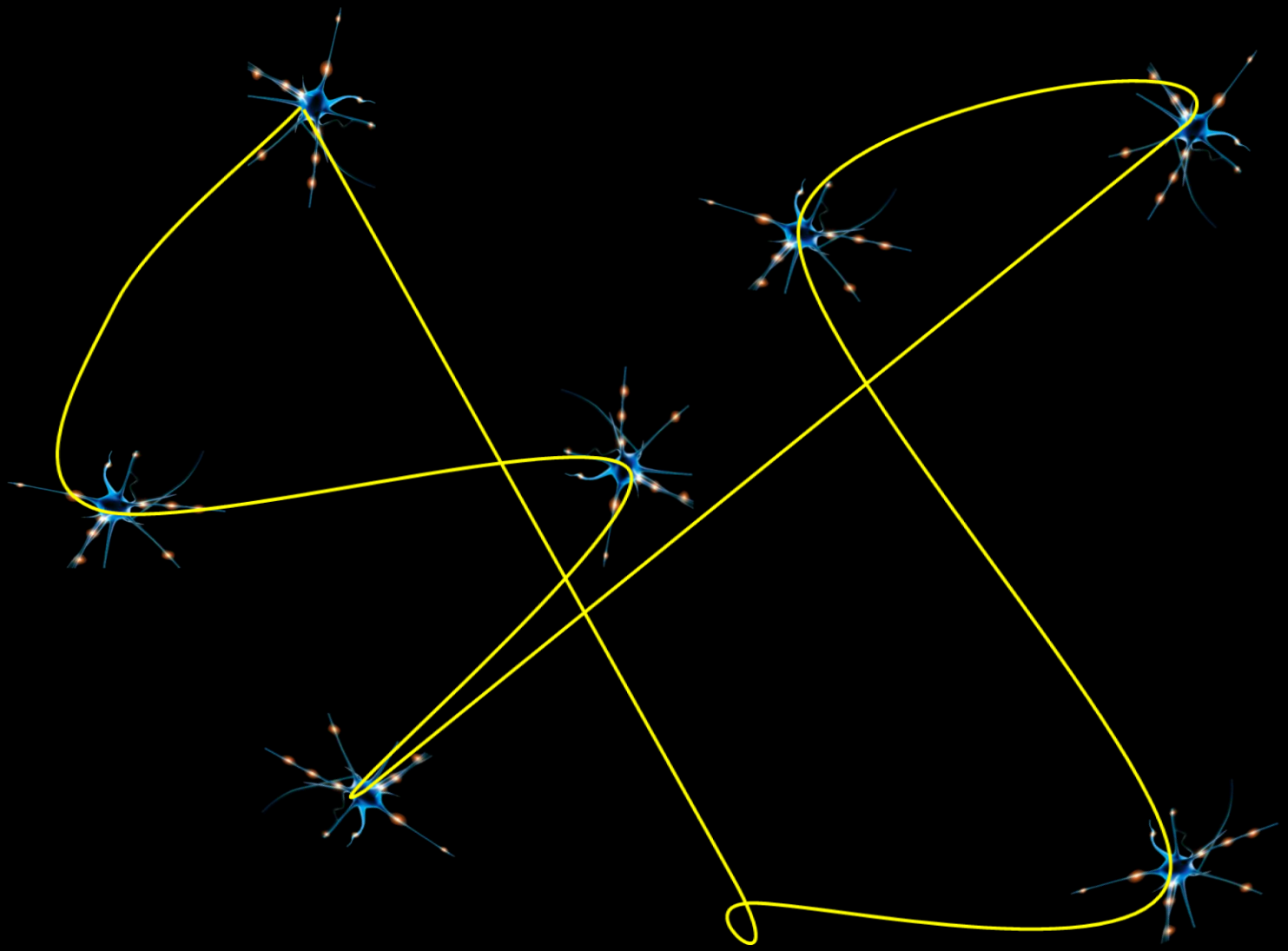
MacIver et al (2008) *Brain*





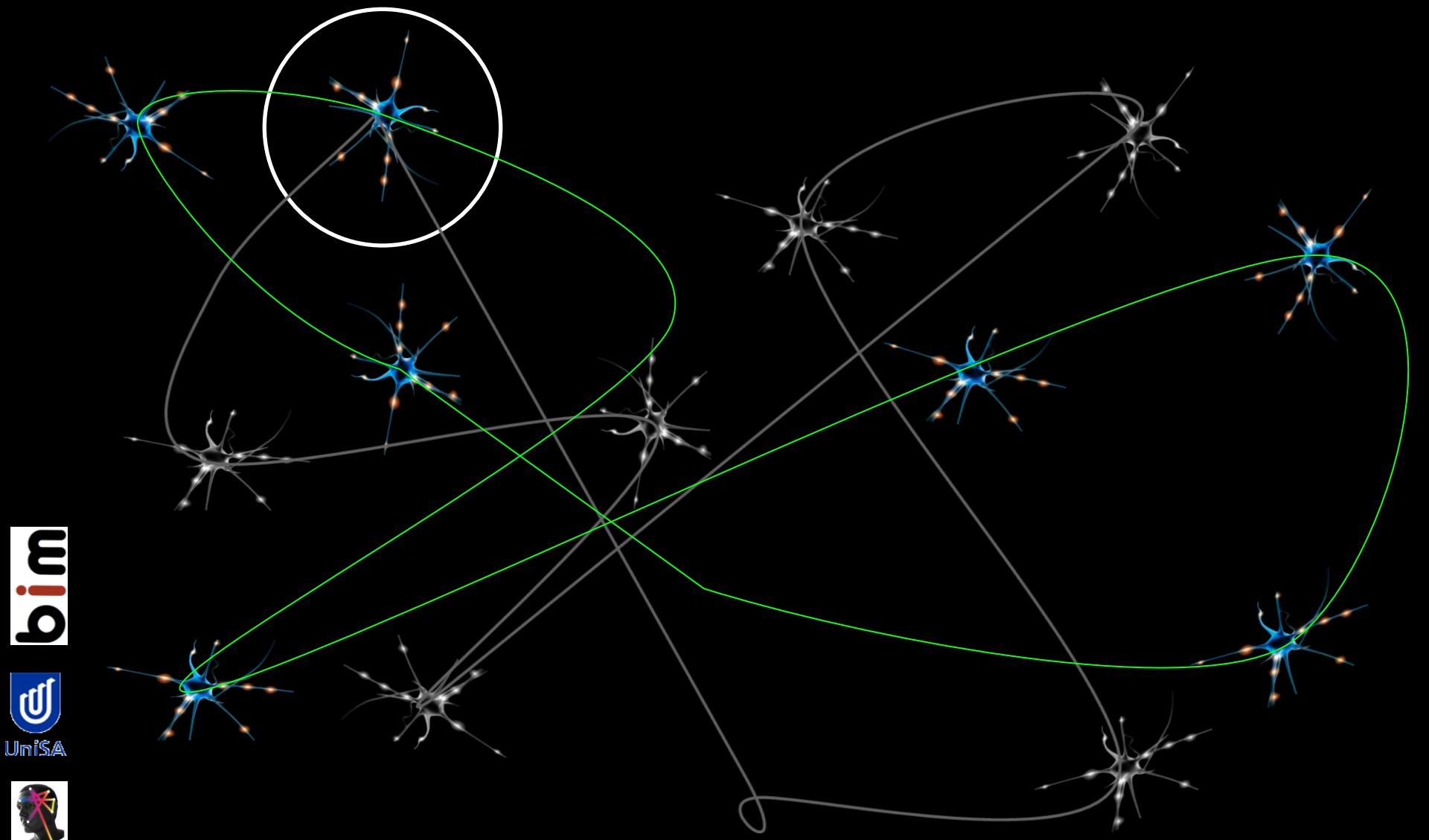
Related tags share neurones

Pelvic pain.



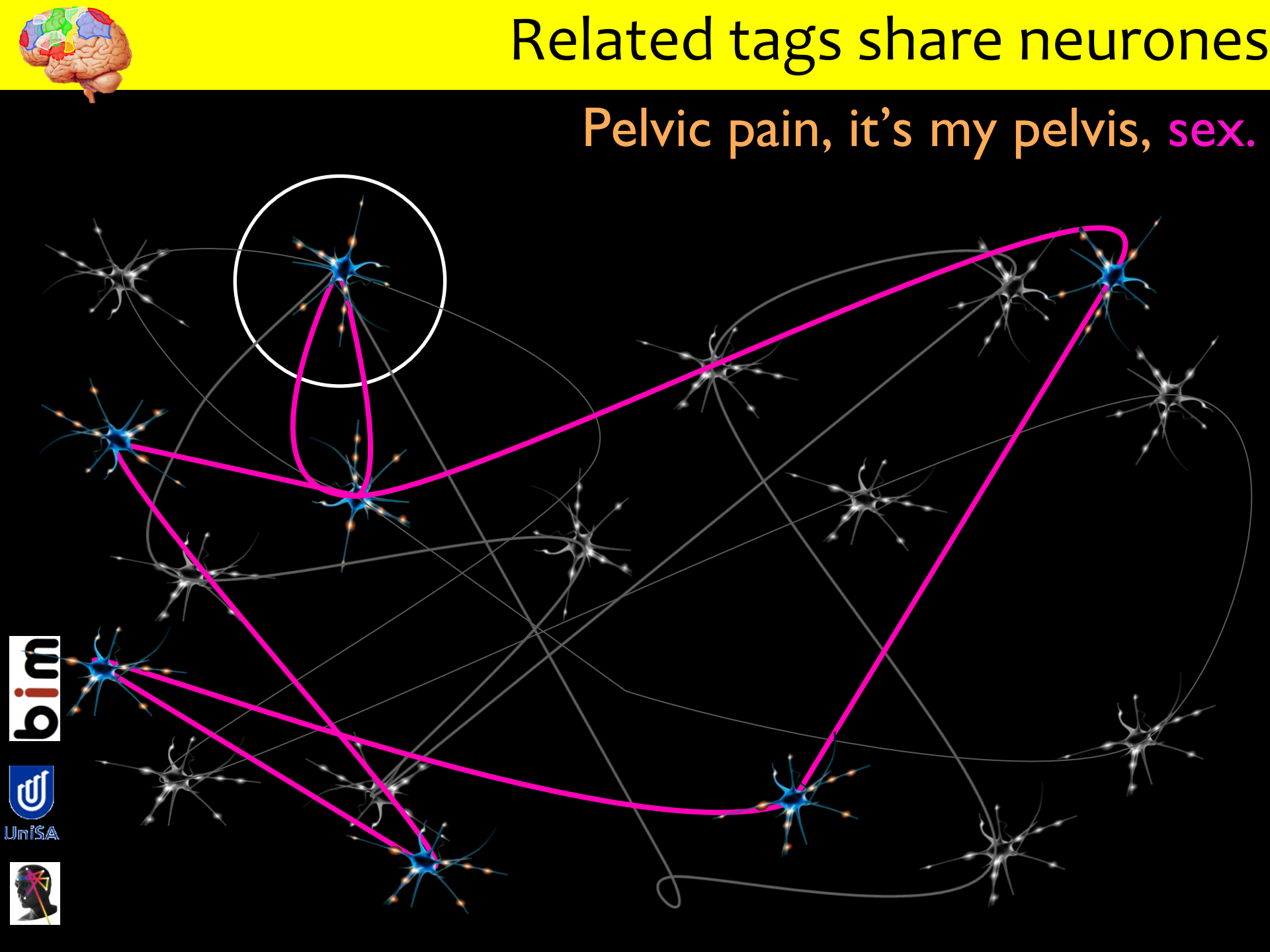
Related tags share neurones

Pelvic pain, its MY pelvis



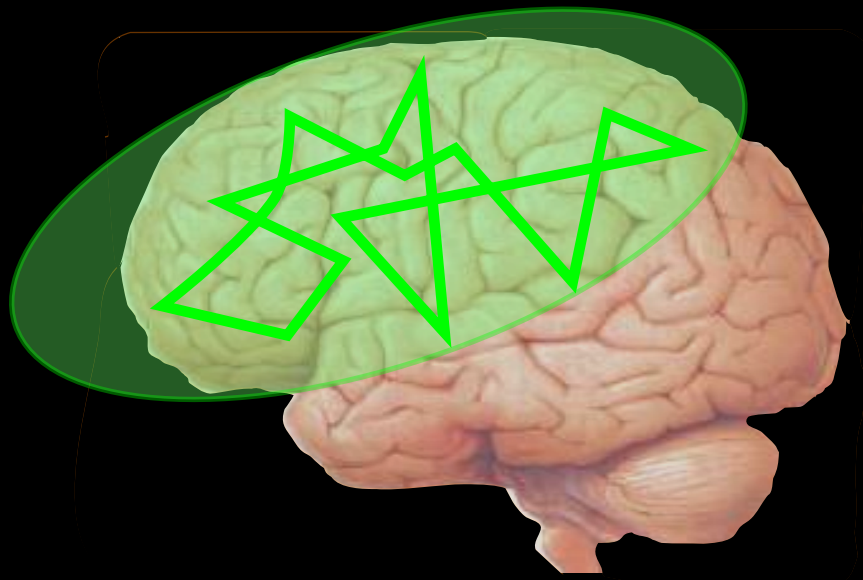
Related tags share neurones

Pelvic pain, it's my pelvis, sex.



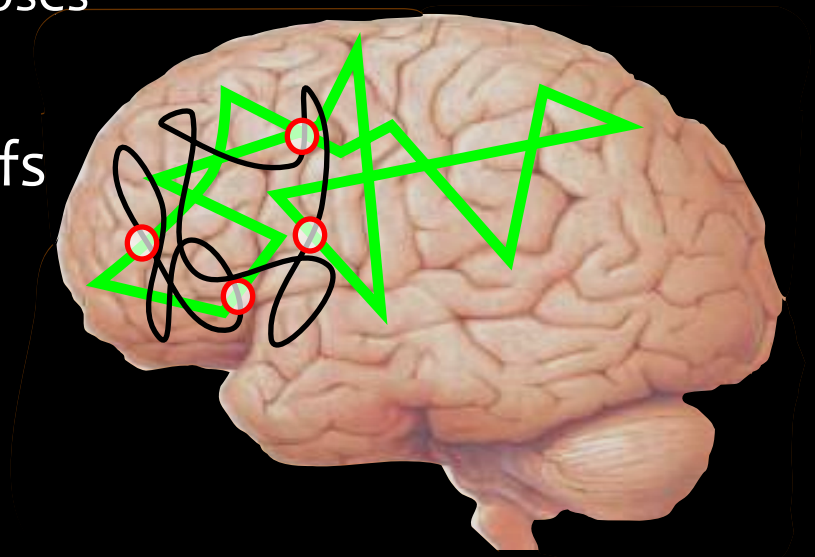
Related tags share neurones

Pelvic pain, it's my pelvis, sex, beliefs about sex



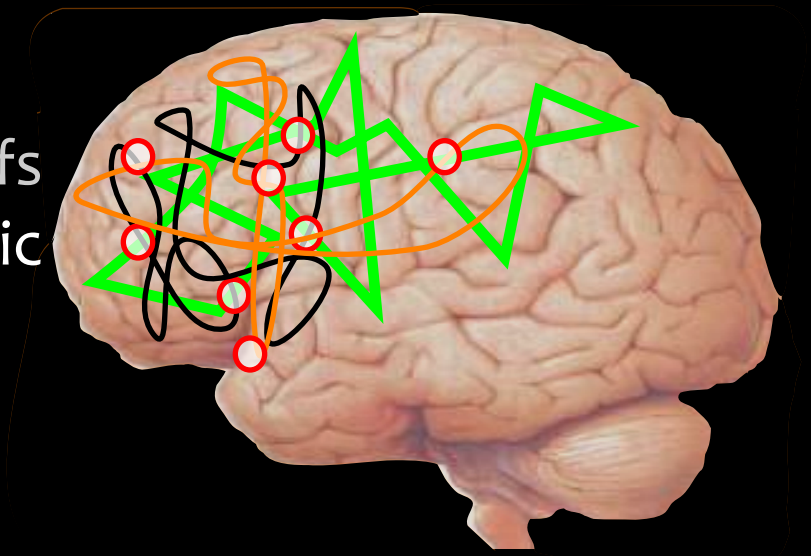
- Shared neurones/synapses

Beliefs

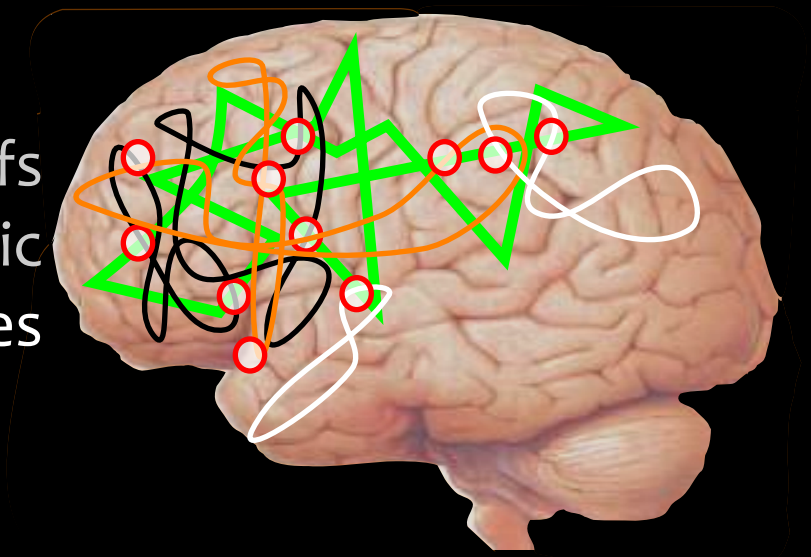


Beliefs

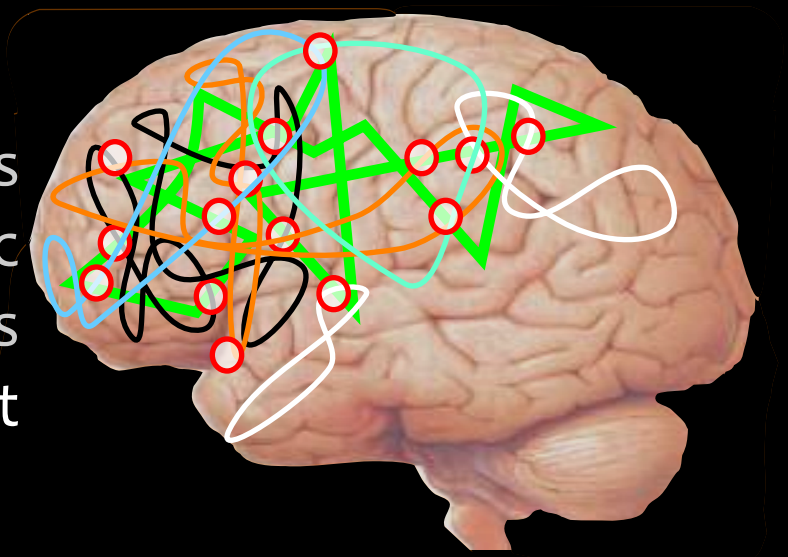
Knowledge, logic



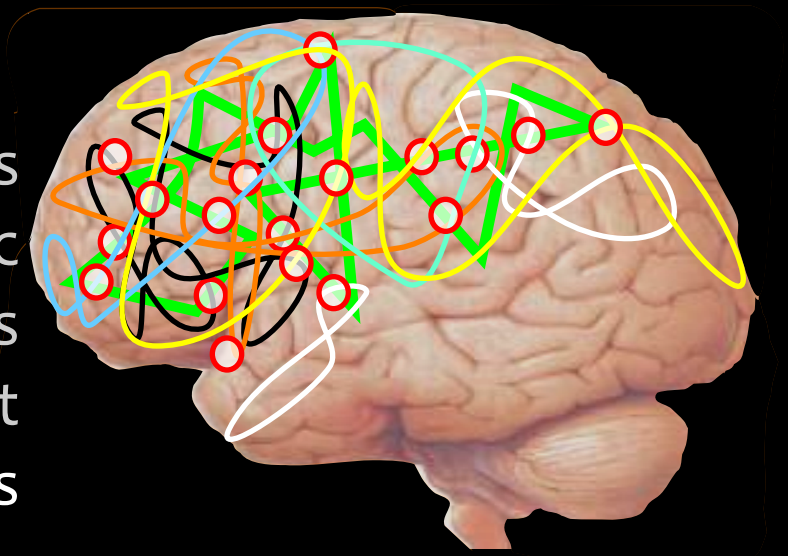
Beliefs
Knowledge, logic
Other sensory cues

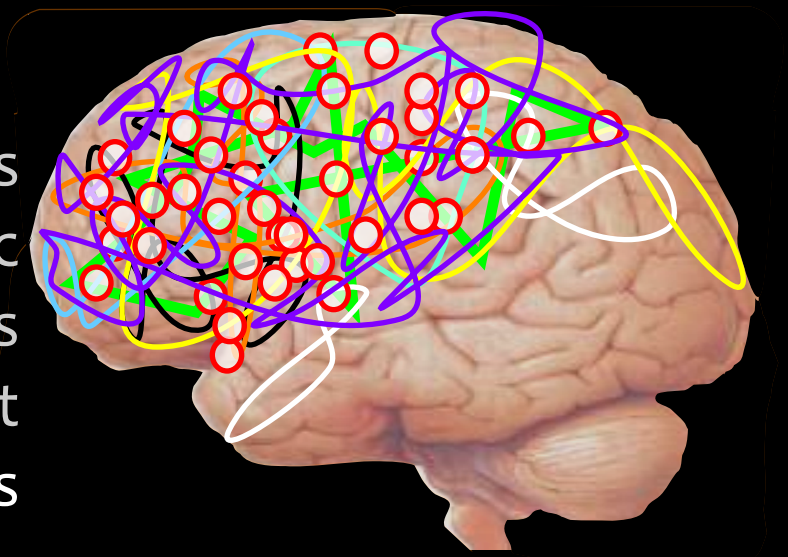


Beliefs
Knowledge, logic
Other sensory cues
Social context



Beliefs
Knowledge, logic
Other sensory cues
Social context
Anticipated consequences



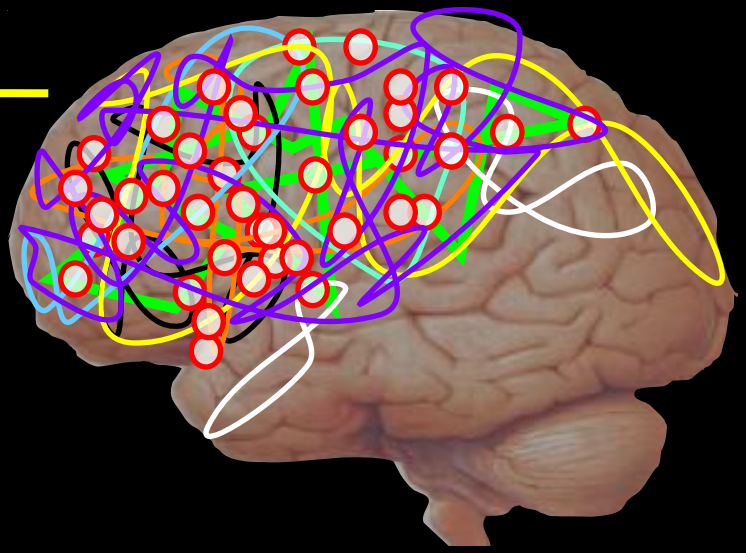


Beliefs
Knowledge, logic
Other sensory cues
Social context
Anticipated consequences

Family
media
previous history
culture
GP
work
physiotherapist
education
activity self-efficacy
access

exposure

Pain



Beliefs
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exposure

The brain corrects any ‘error’.

Beliefs
Knowledge, logic
Other sensory cues
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Anticipated consequences
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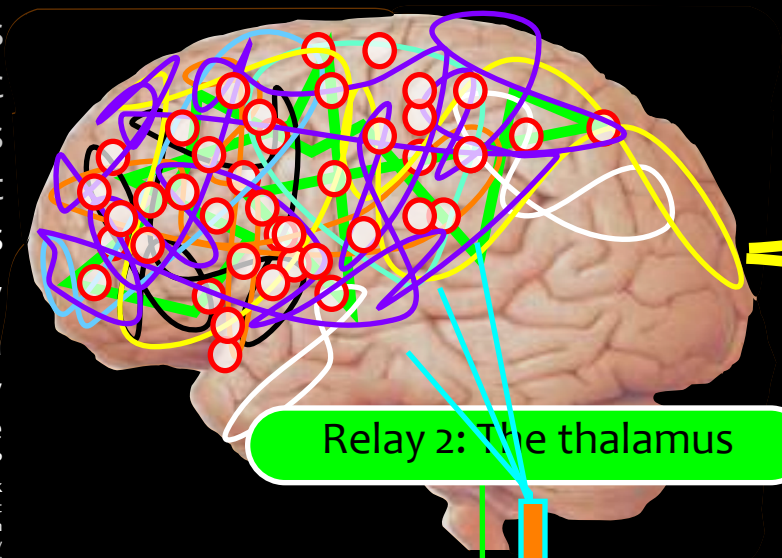

Pain

It's not that dangerous

Relay 2: The thalamus

Relay 1: The dorsal horn

Danger

Beliefs
Knowledge, logic
Other sensory cues
Social context
Anticipated consequences
Family
media
previous history
culture
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work
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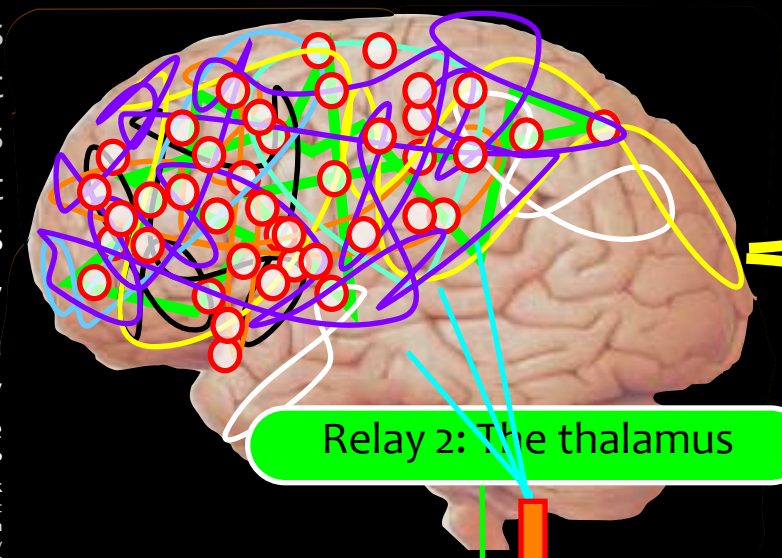


Pain

It's MORE dangerous than that!

Relay 2: The thalamus

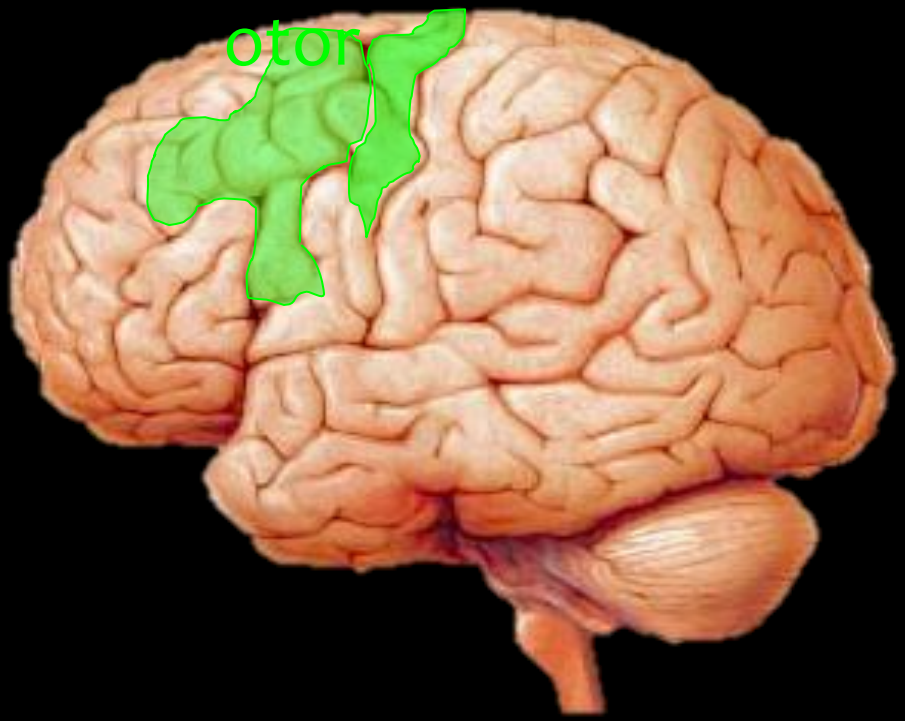
Relay 1: The dorsal horn

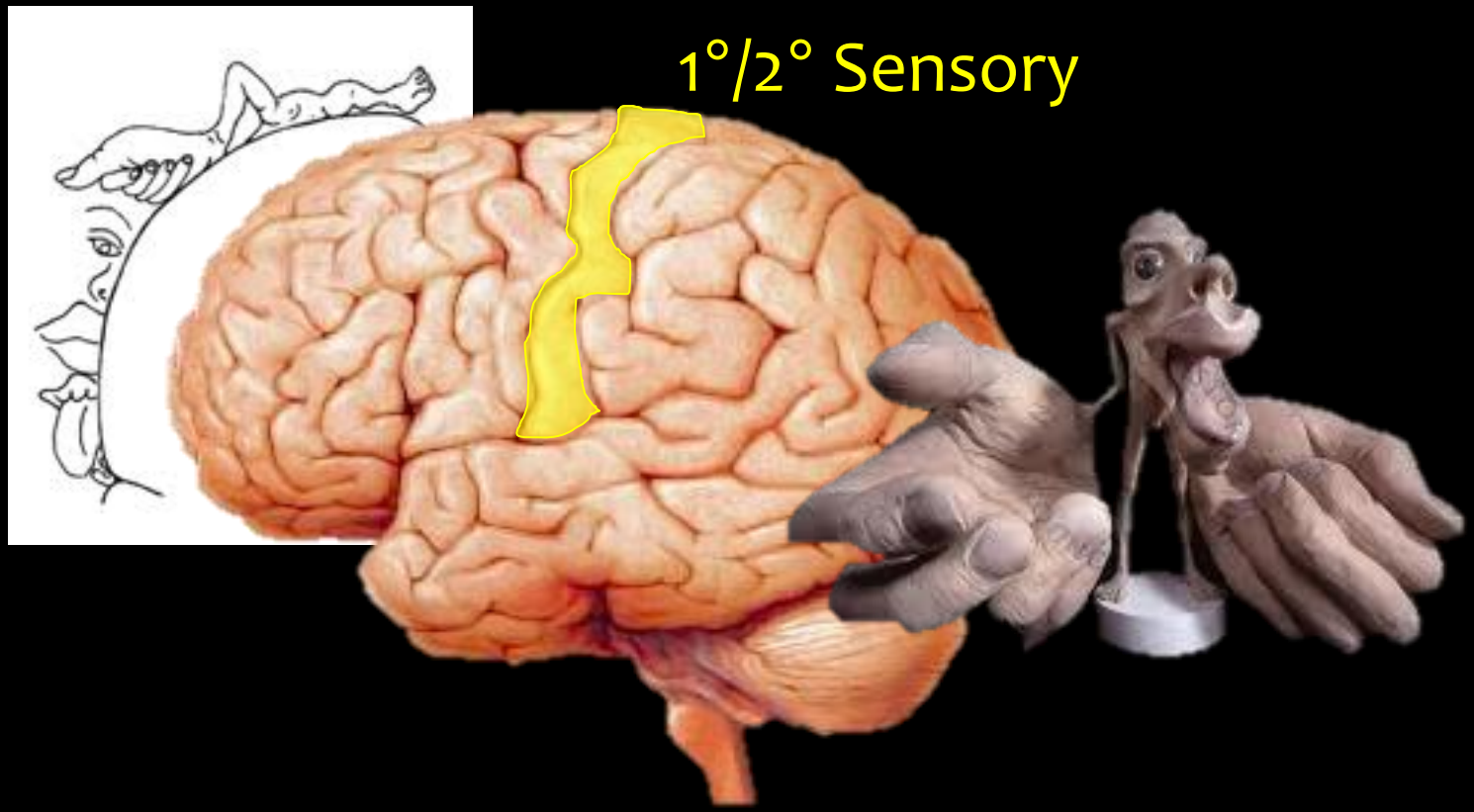
Danger

Constructing the cortical body matrix

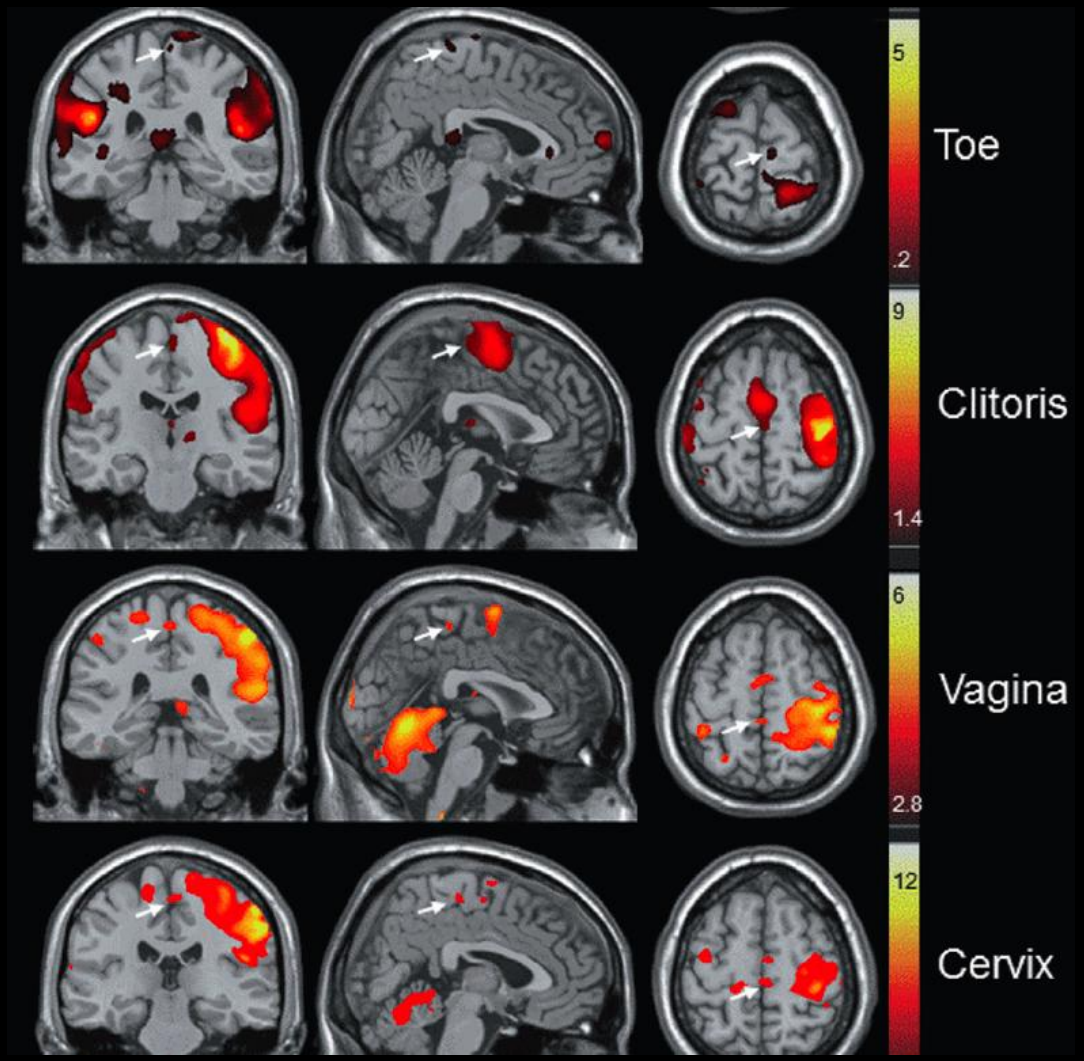
1°

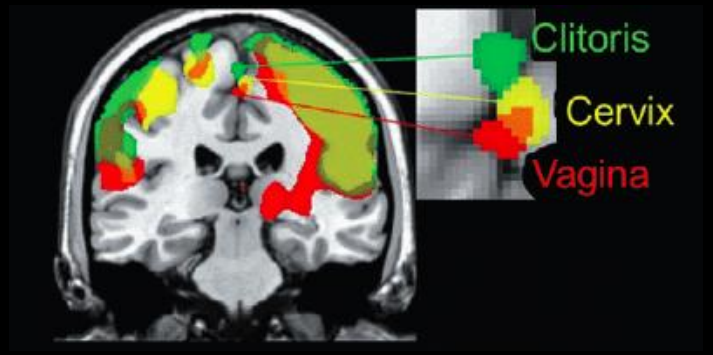
Motor/SMA/premotor




1°/2° Sensory

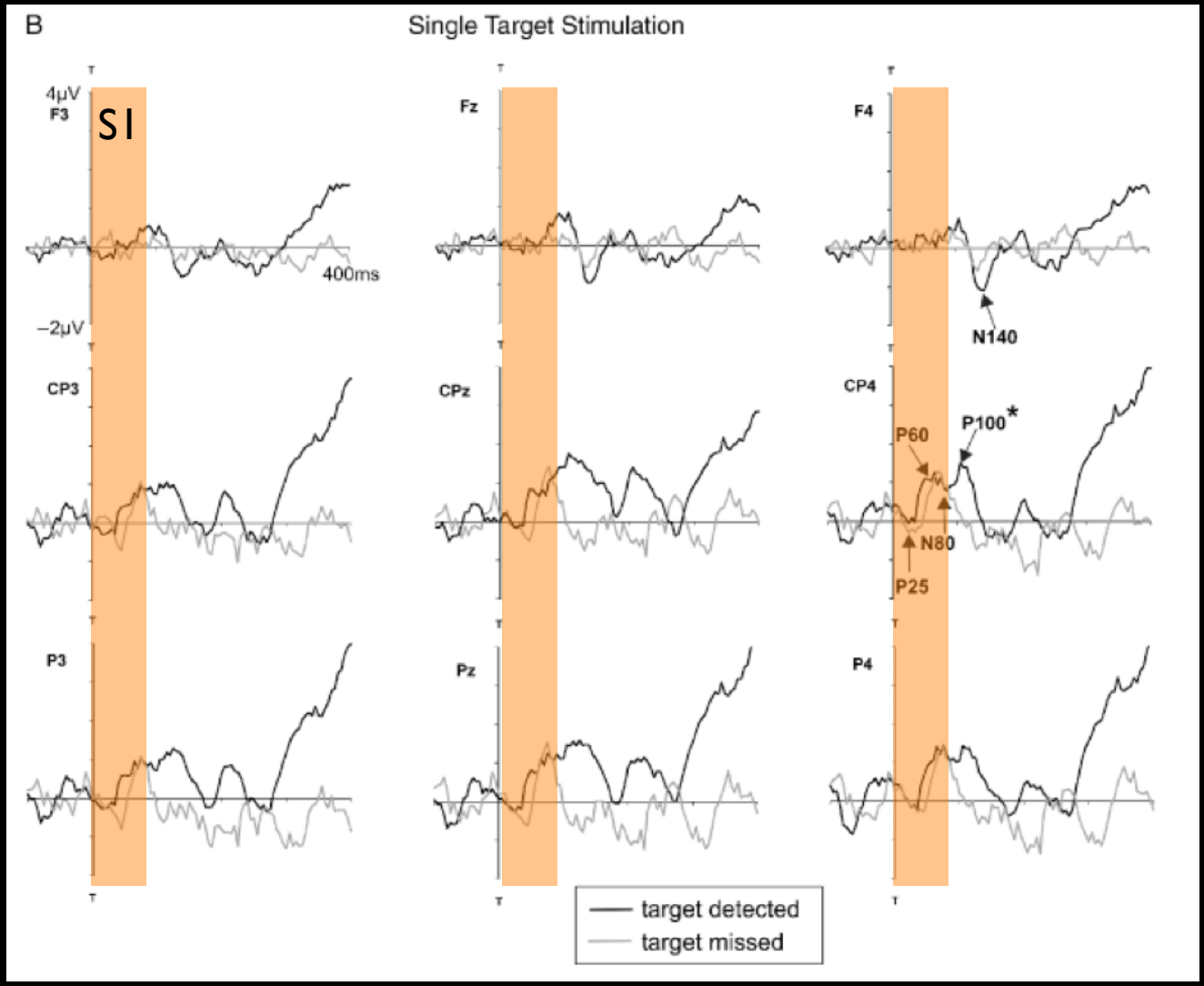
The hermunculus





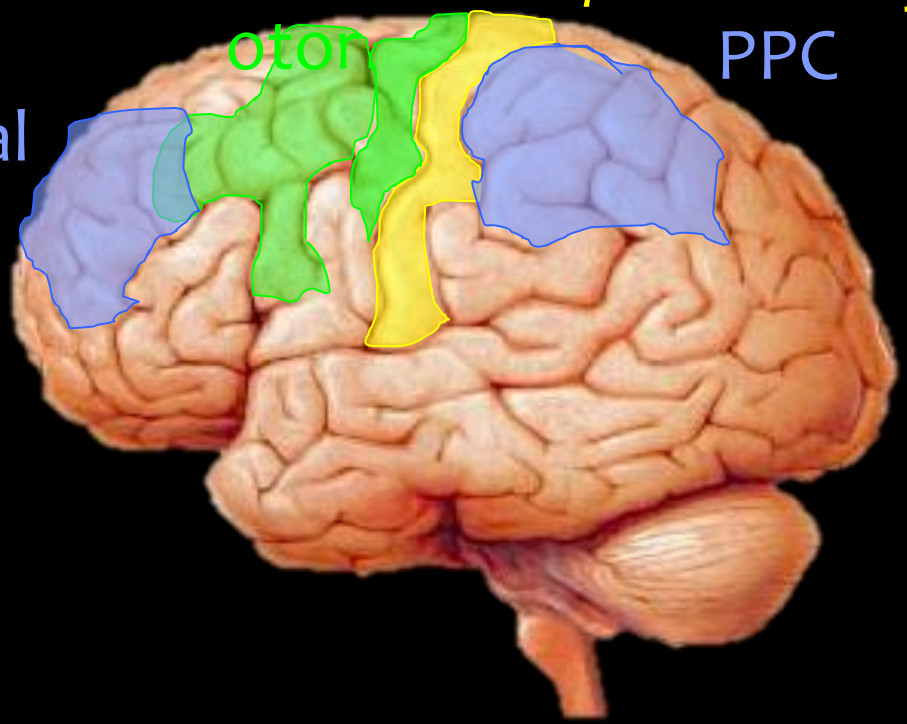
Komisaruk et al J Sex Med 2011

S1 is not the seat of perception



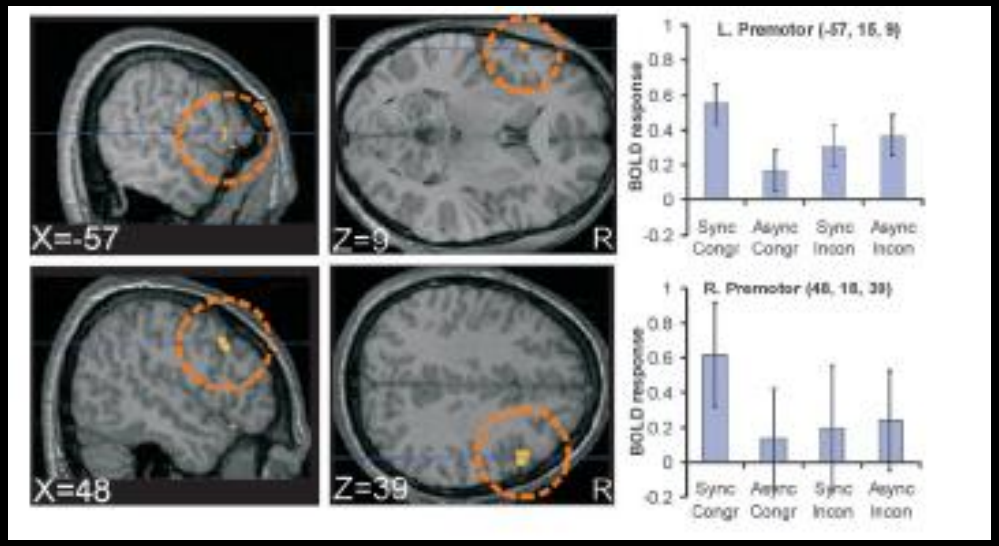
Schubert et al 2006 Psychophysiol

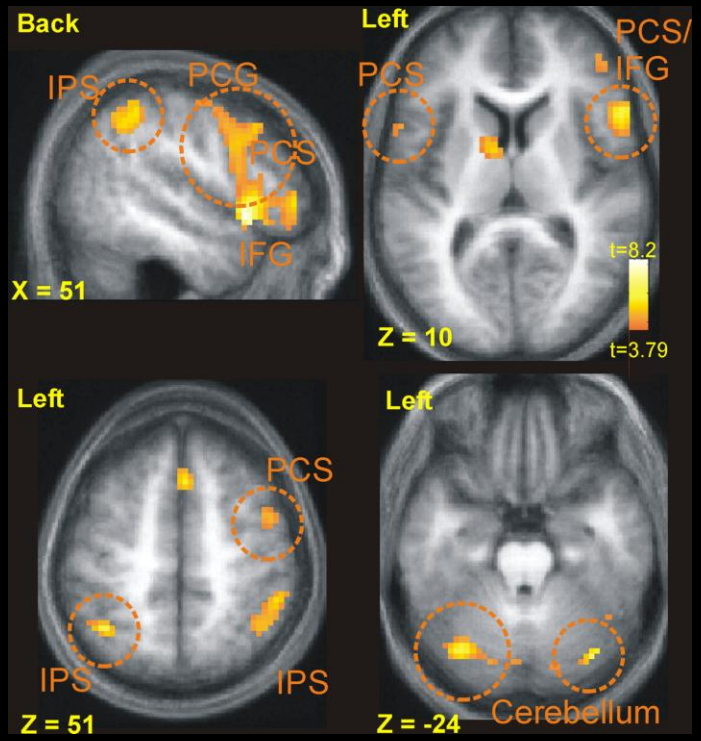
Body percept



But how do you know it is yours?

Ehrsson et al. Science 2006





Ehrsson et al. J. Neurosci. 2005

Body percept

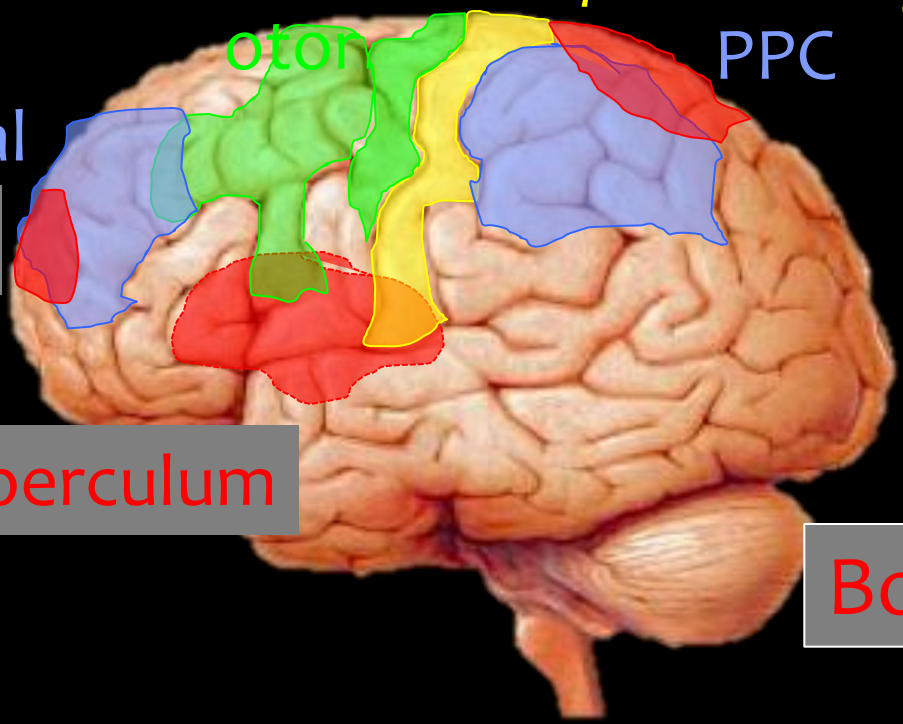
1°
Motor/SMA/premotor

1°/2° Sensory
PPC

Visual
Vestibular
Auditory

Frontal

Frontal



Insula & operculum

Body ownership

Body percept

1°
Motor/SMA/premotor

1°/2° Sensory
PPC

Visual
Vestibular
Auditory

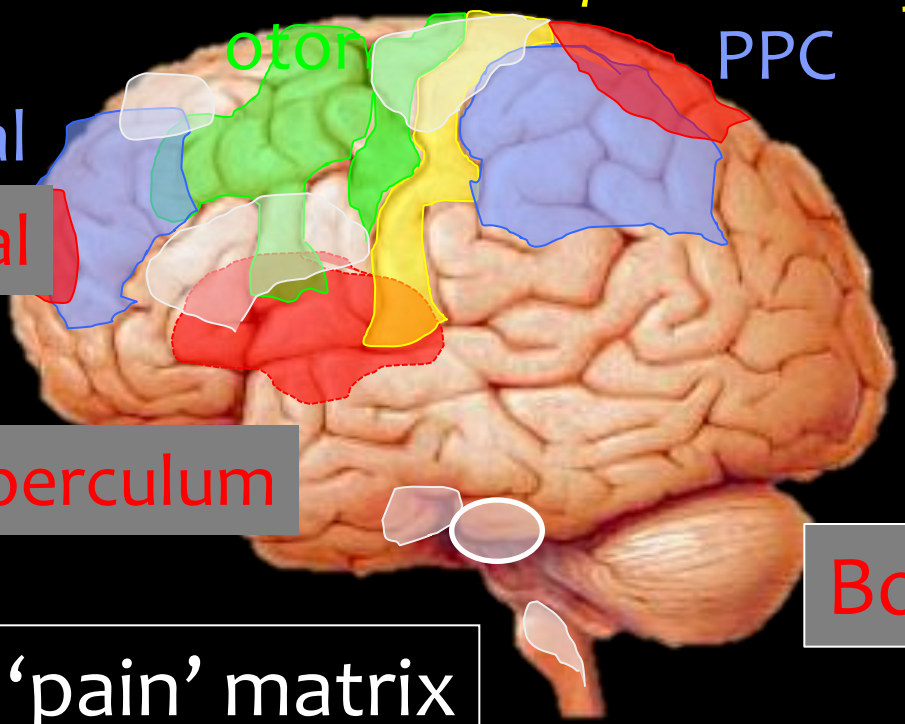
Frontal

Frontal

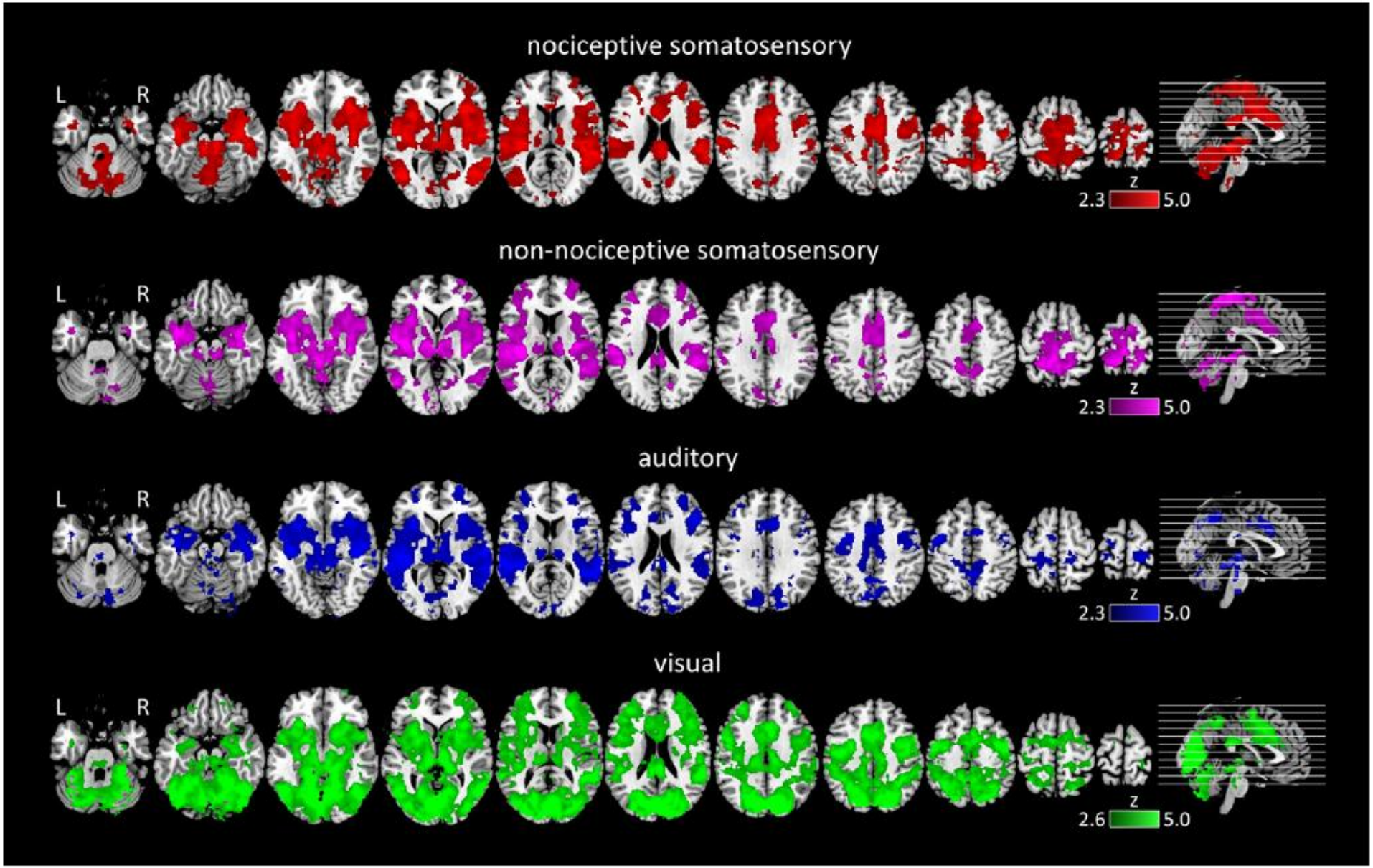
Insula & operculum

Body ownership

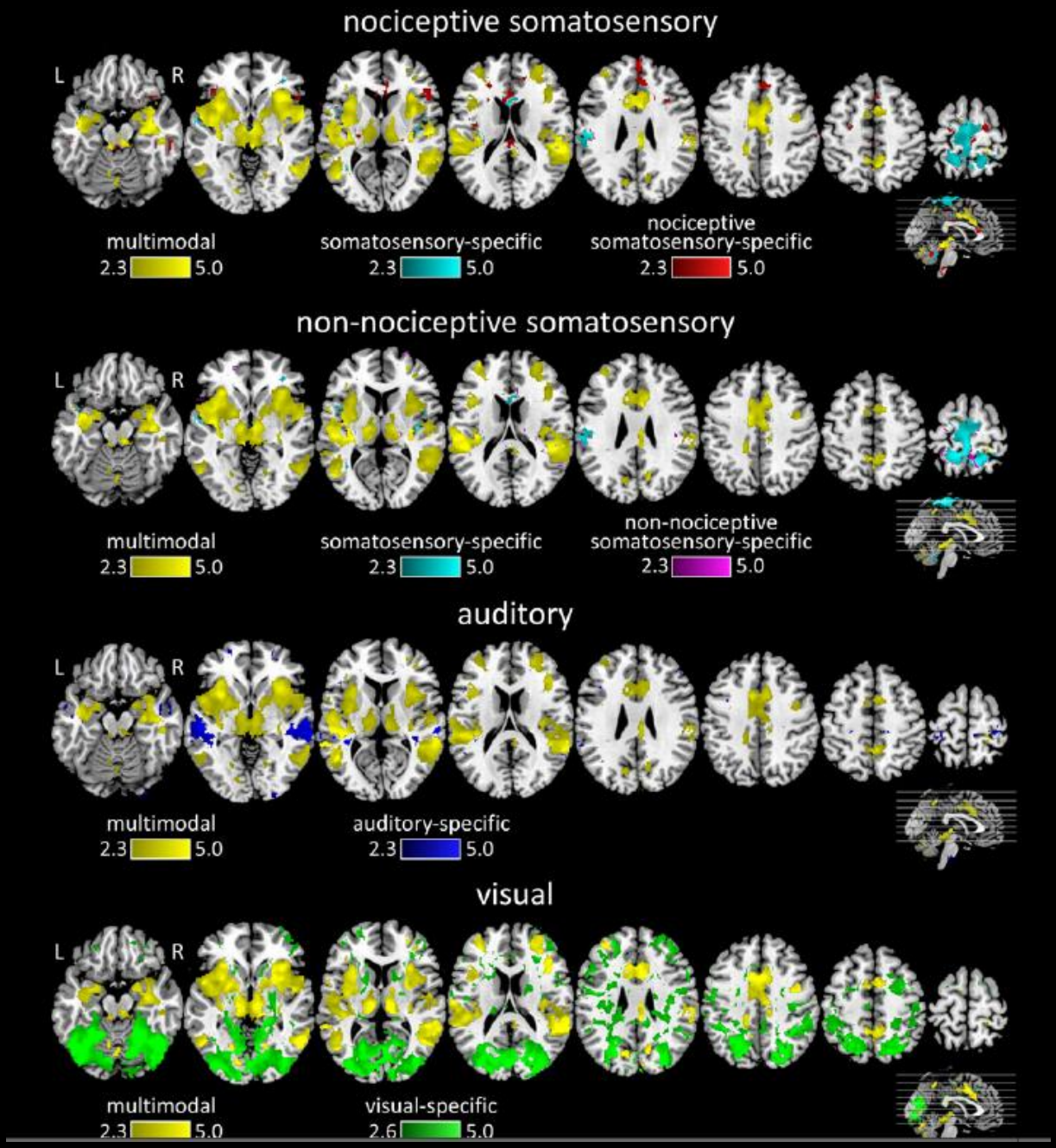
The ‘pain’ matrix



Moreaux et al 2011 Neuroimage



Moreaux et al 2011 Neuroimage



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1°/2° Sensory
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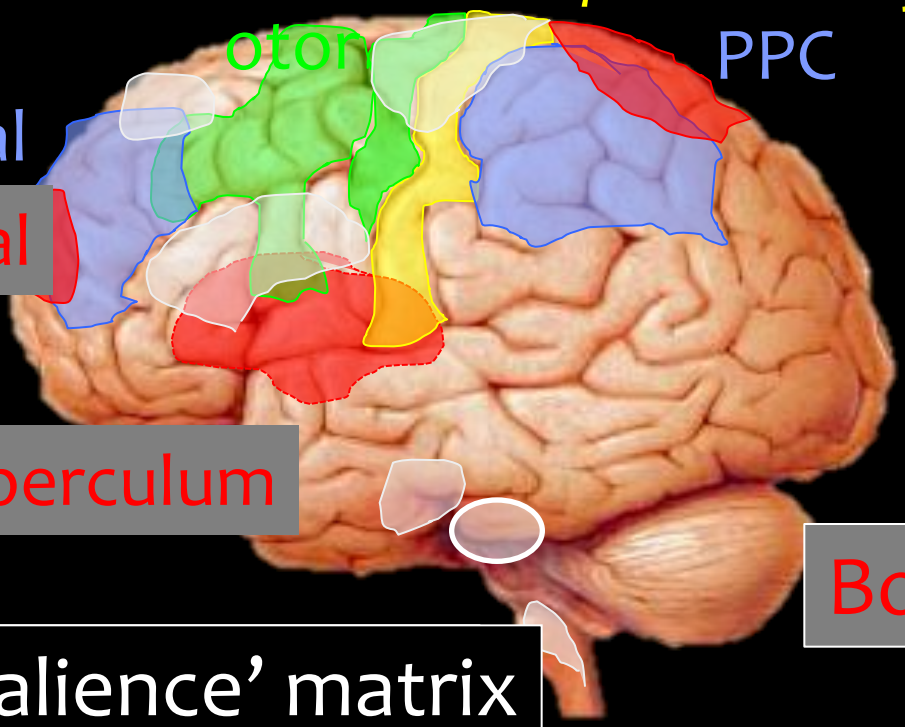
Frontal



Insula & operculum

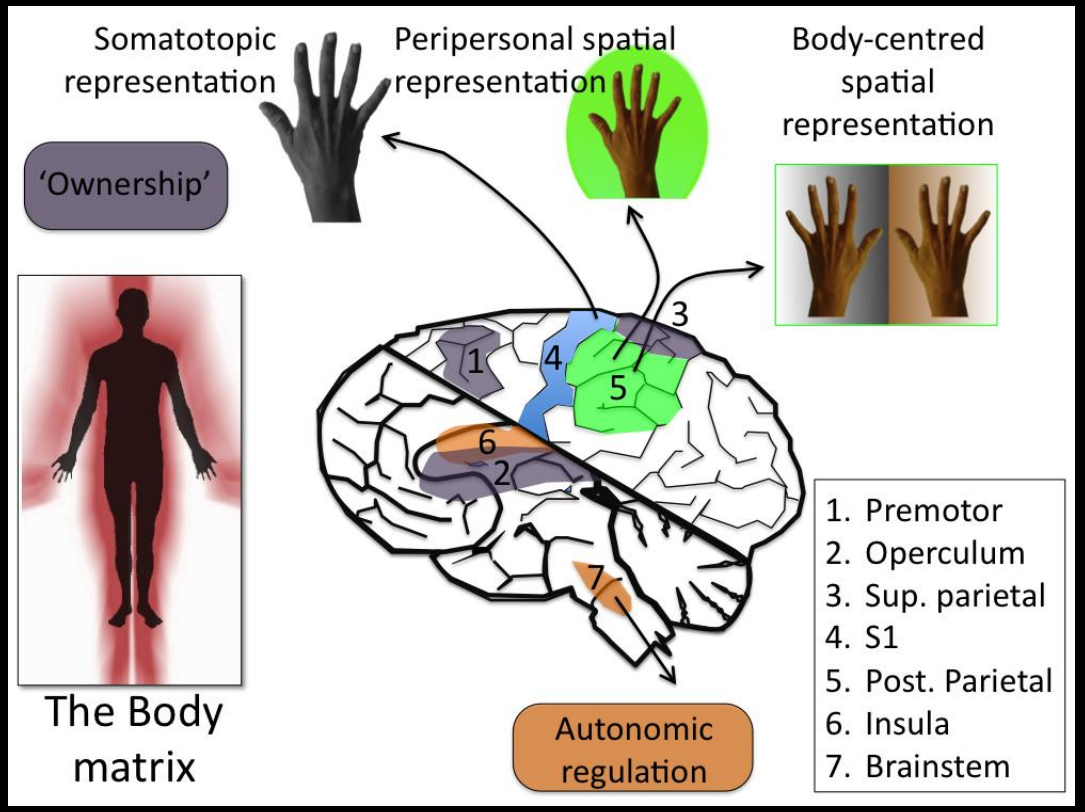
Body ownership

The ‘salience’ matrix

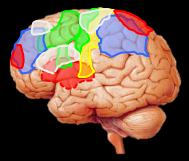
Body protection & regulation

The cortical body matrix:

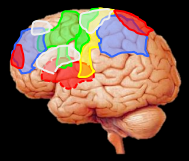
A network of neural loops that subserves the protection and regulation of the body, both physiologically and psychologically.



Moseley et al 2012 Neurosci Biobeh Reviews



Facilitation & disinhibition



Facilitation

Facilitation (= sensitisation)

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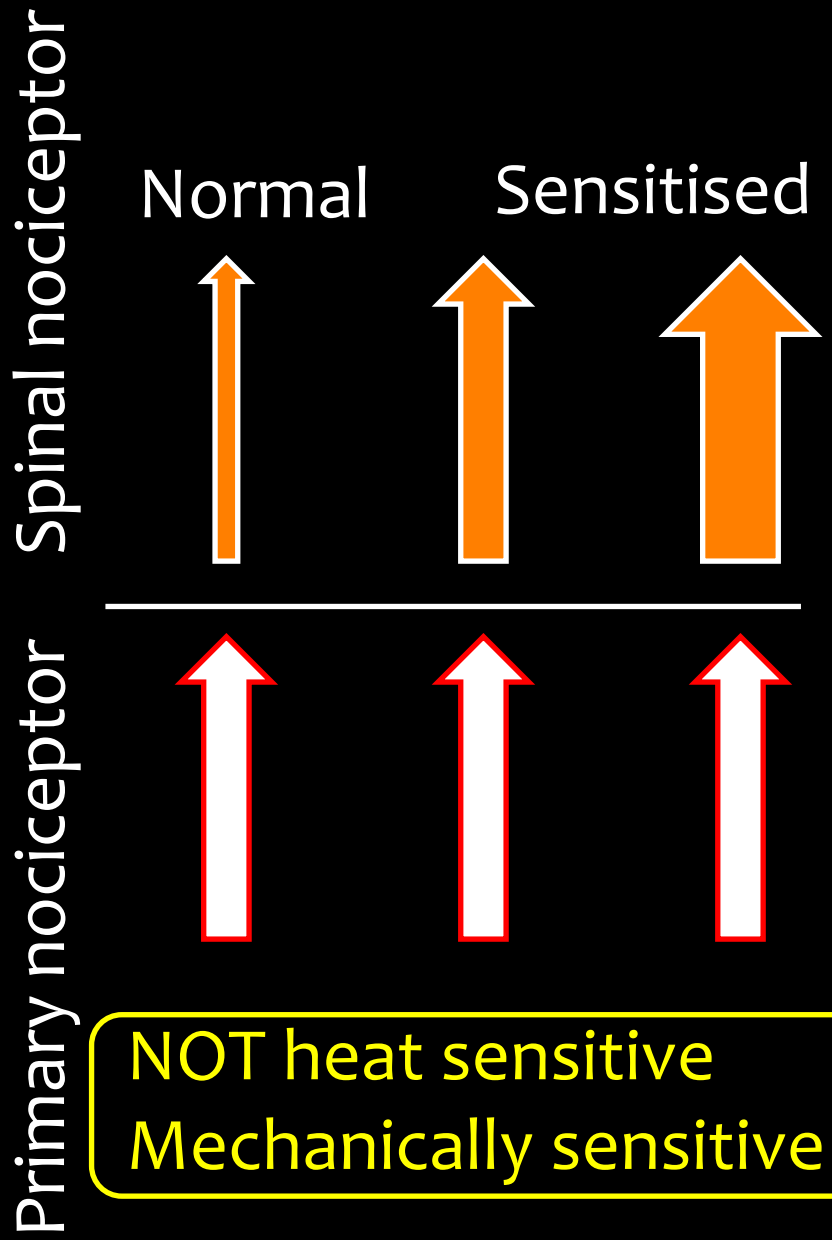
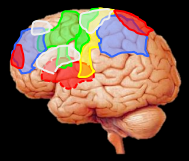
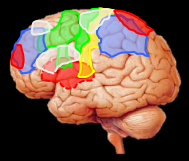


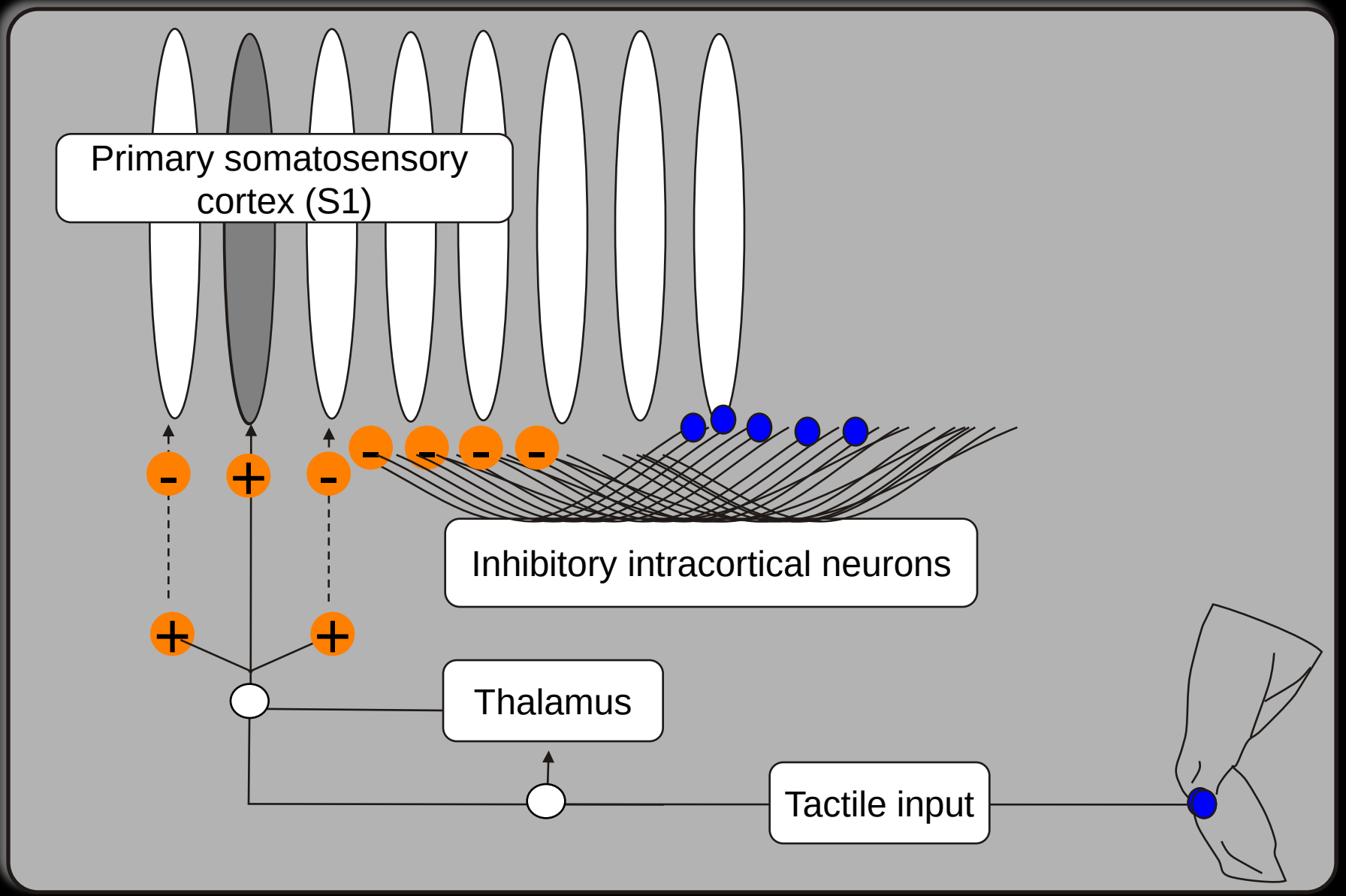


Facilitation & disinhibition

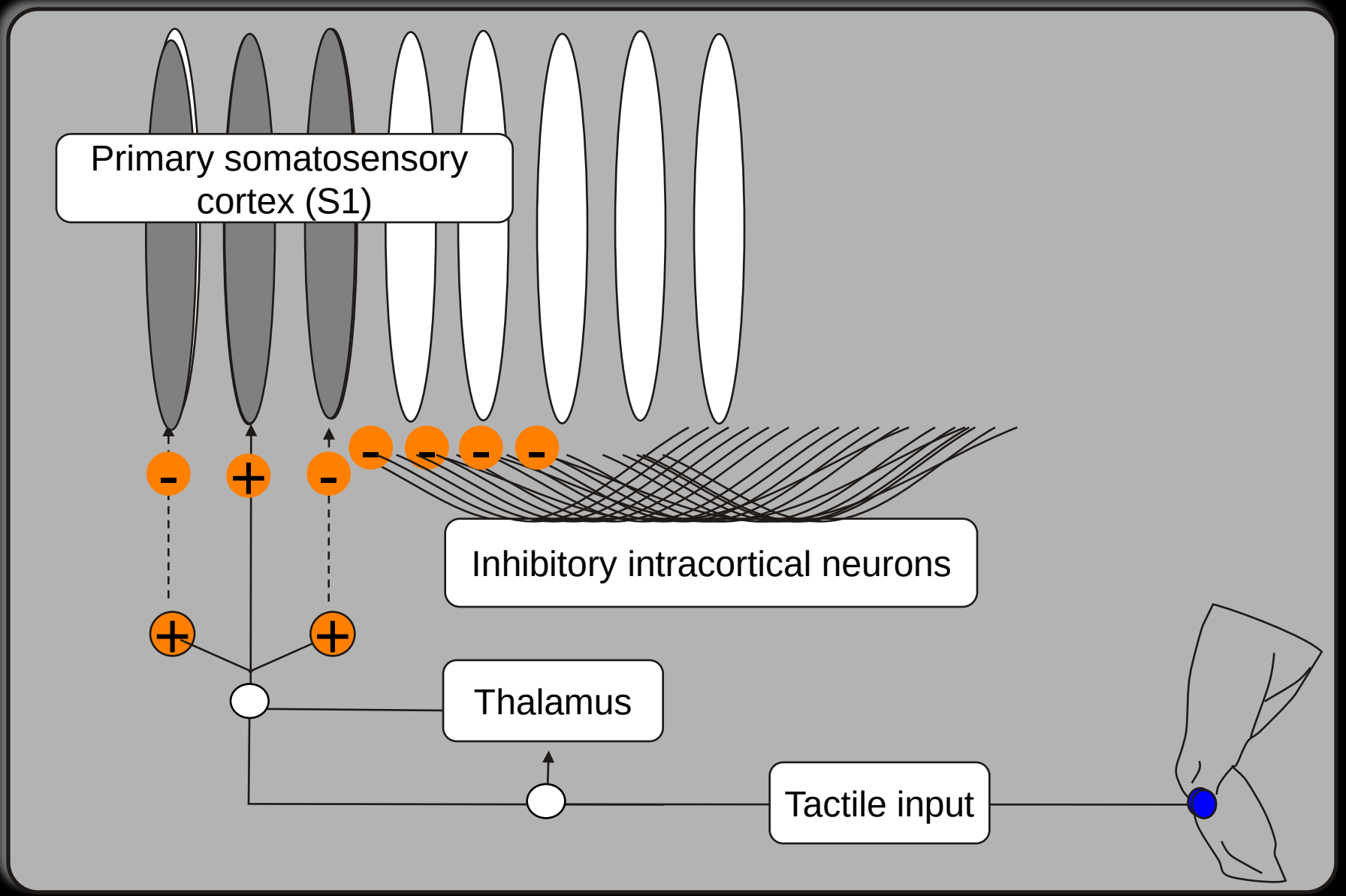


Disinhibition

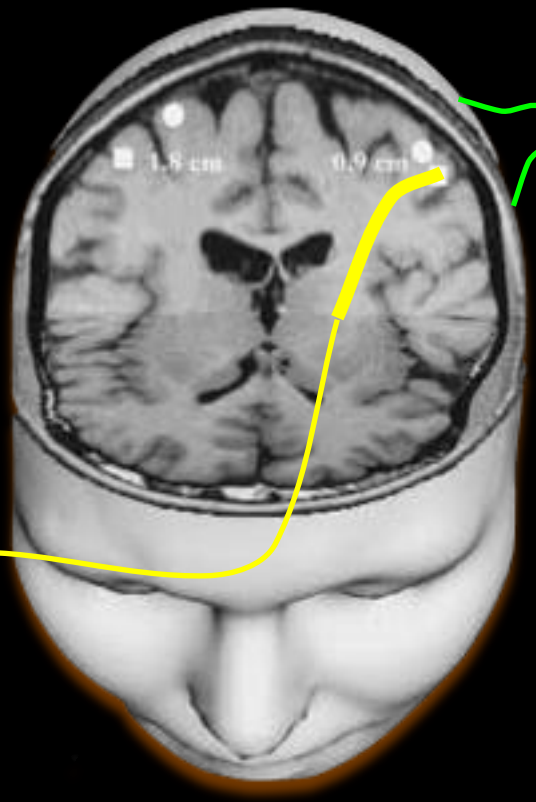
Inhibition = precision.



DISinhibition = IMprecision.



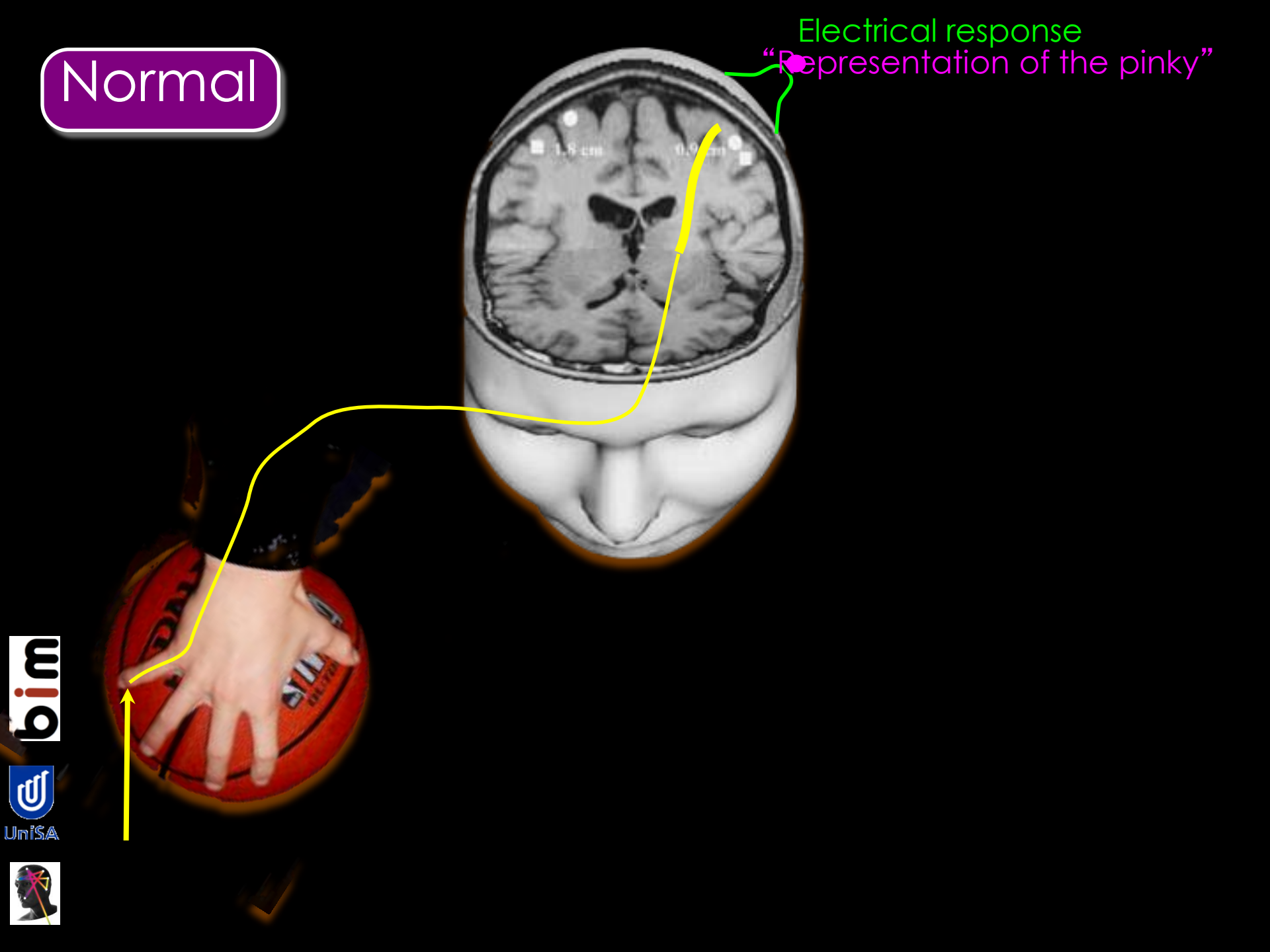
Normal



Electrical response

- "Representation of the thumb"

Normal



Normal

Representation of the pinky

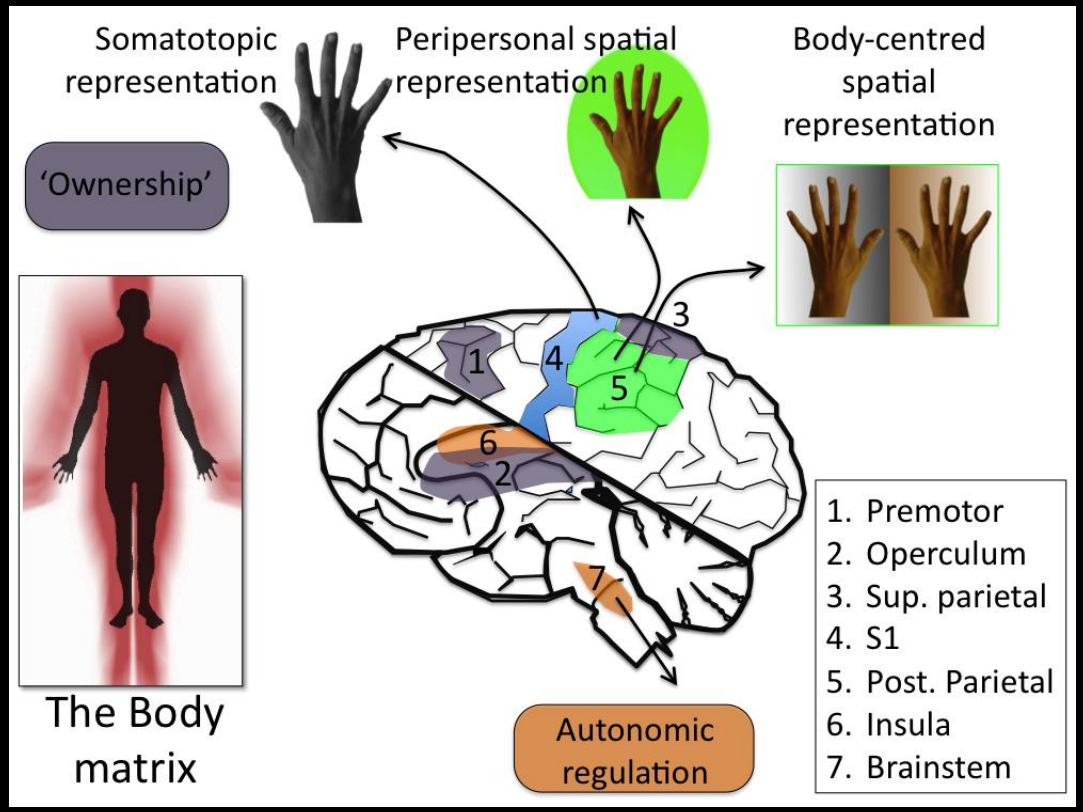
Representation of the thumb

Maihofner et al 2003 Neurology 61 1707-15

Imprecision within cortical body matrix – multiple system dysfunction

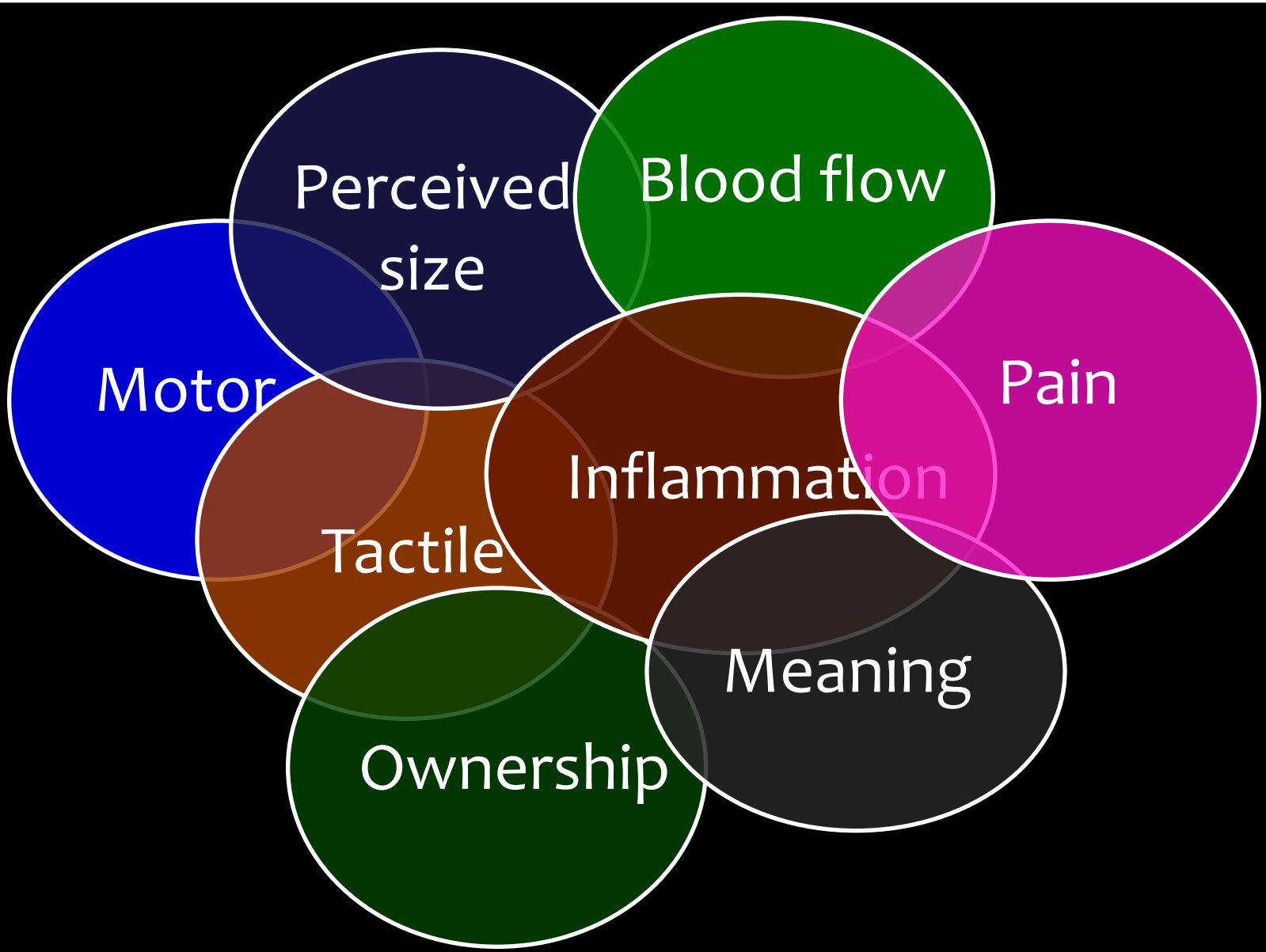
The cortical body matrix:

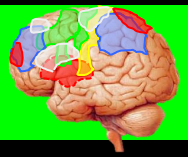
- A network of neural loops that subserves the protection and regulation of the body, both physiologically and psychologically.



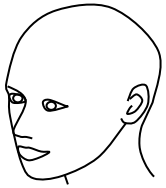
Moseley et al 2012 Neurosci Biobeh Reviews

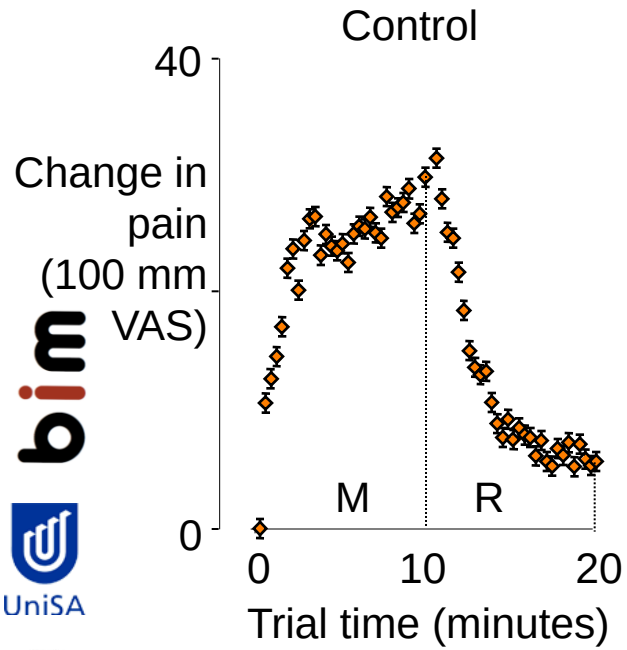
Imprecision within cortical body matrix – multiple system dysfunction



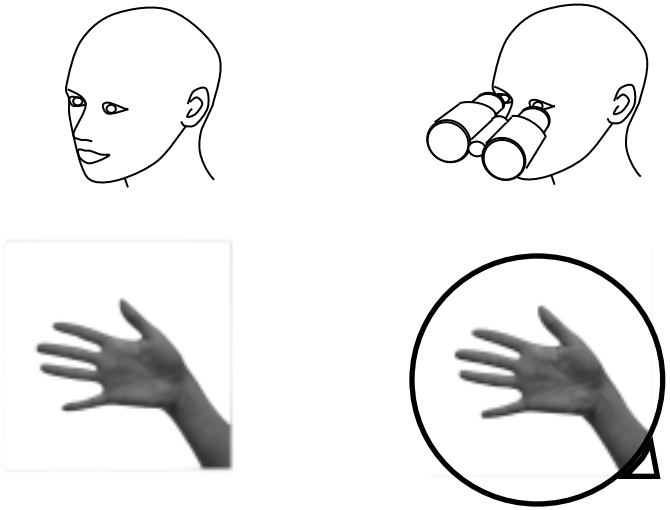


Top-down effects of cortical body matrix dysfunction



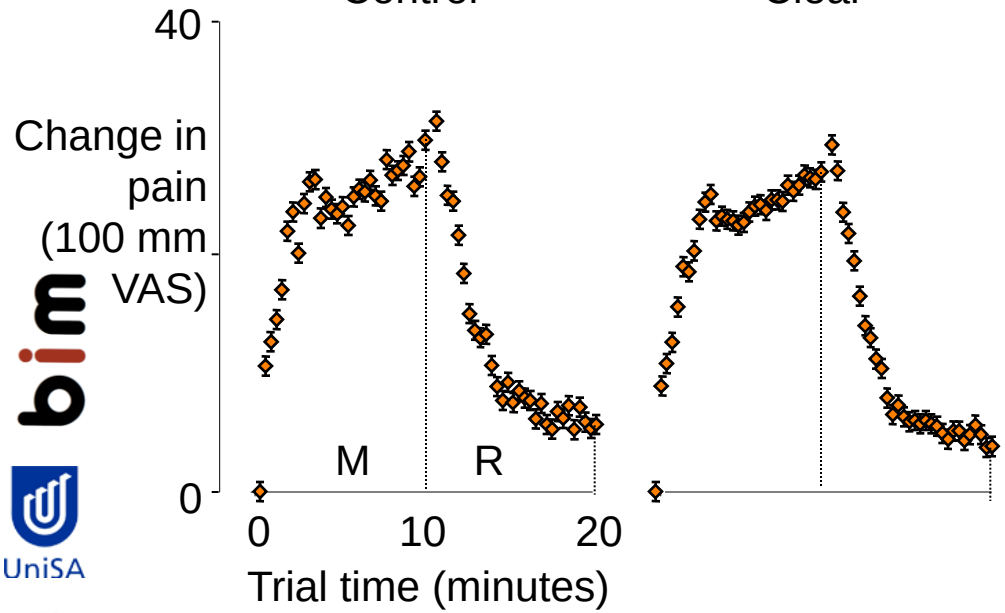


Moseley et al 2008 *Current Biology*

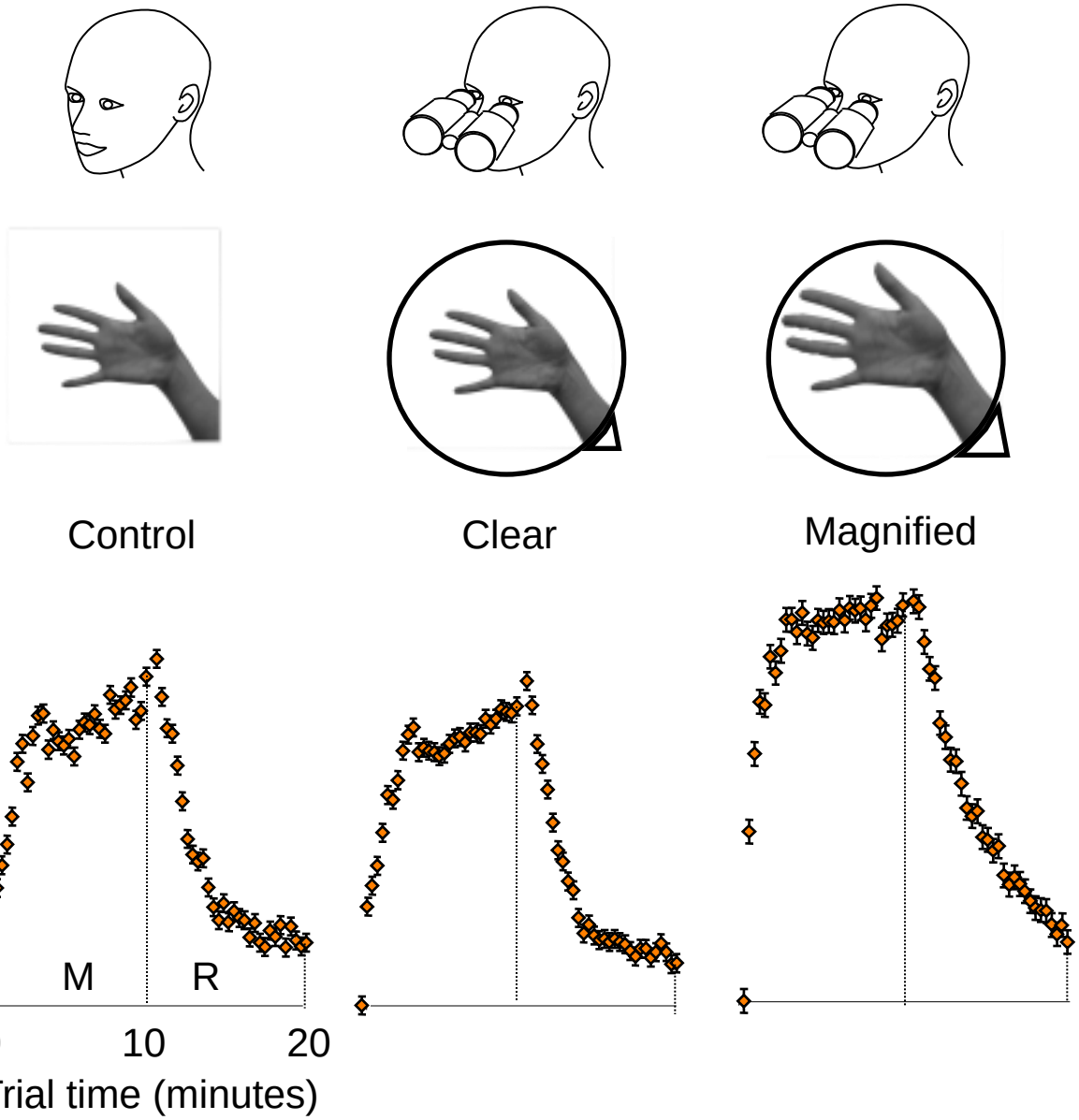


Control

Clear

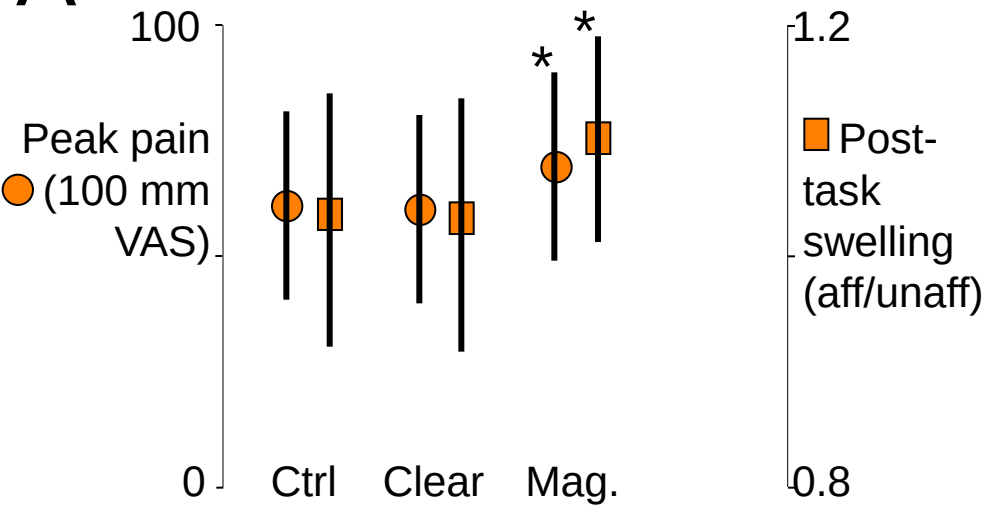


Moseley et al 2008 *Current Biology*

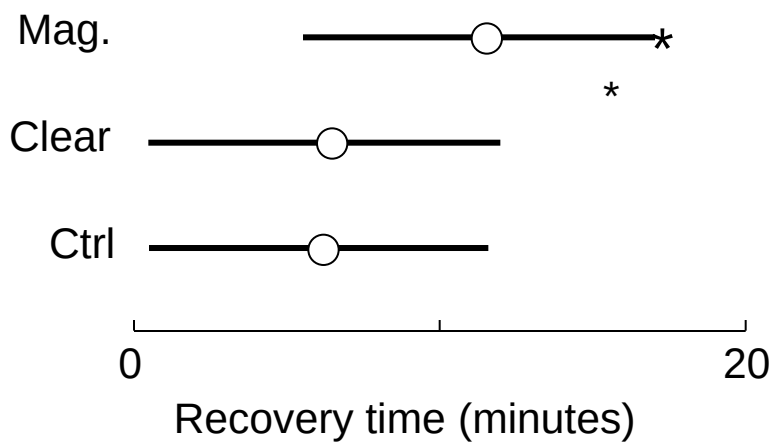


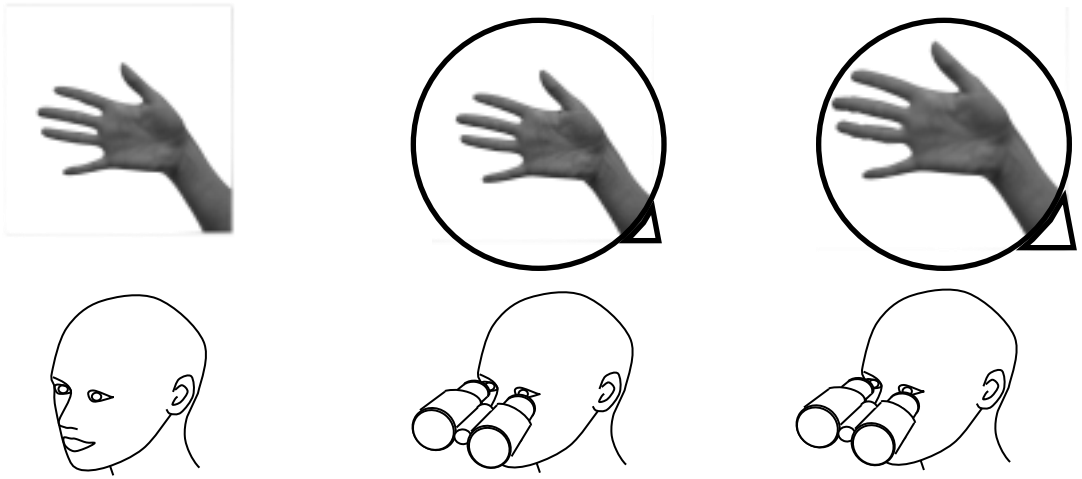
Moseley et al 2008 *Current Biology*

A



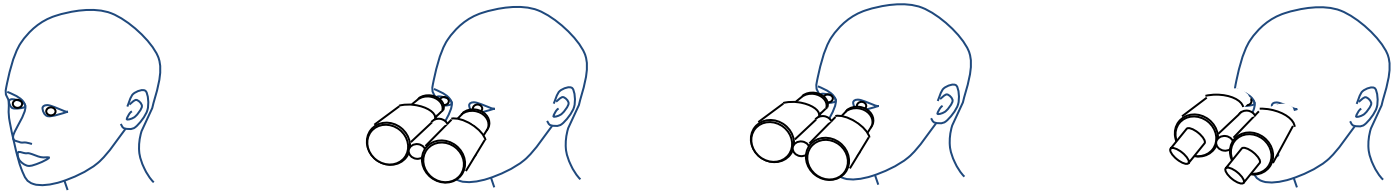
B



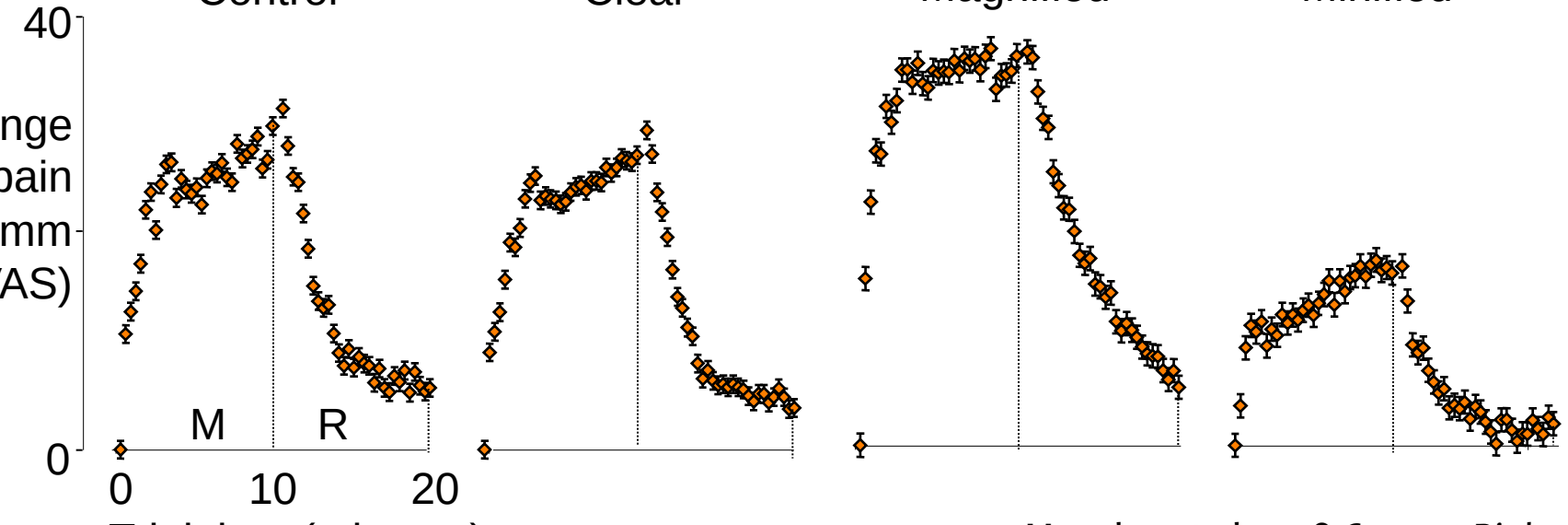


Control Clear Magnified

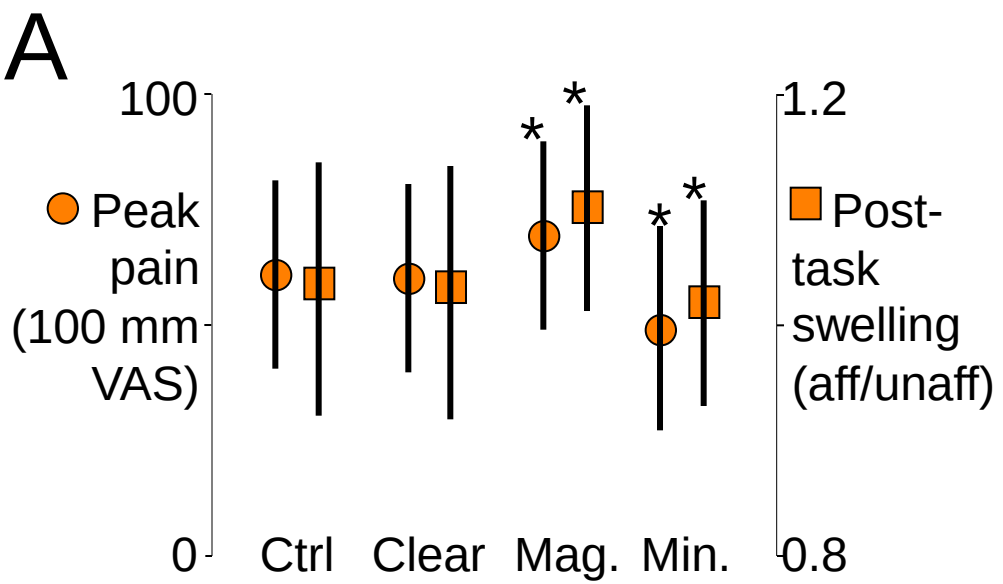
Moseley et al 2008 *Current Biology*

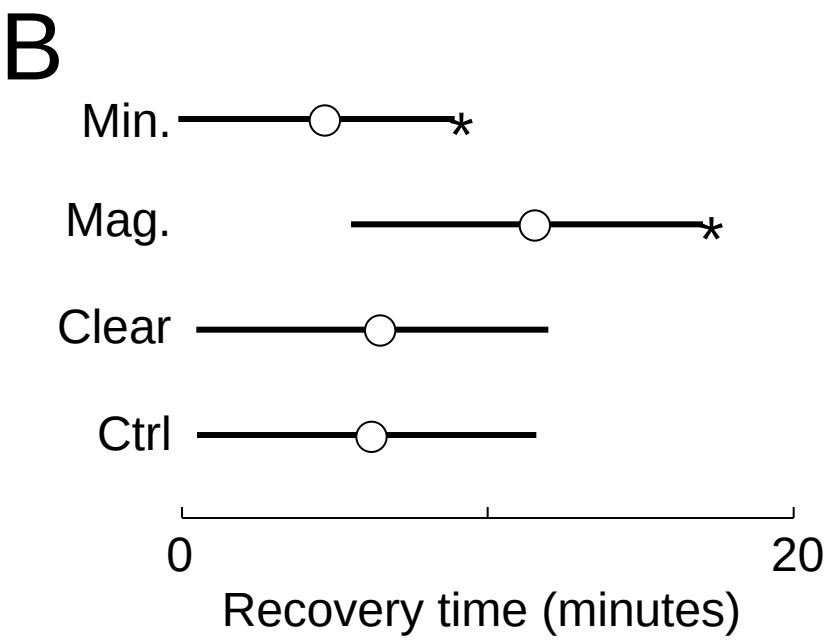


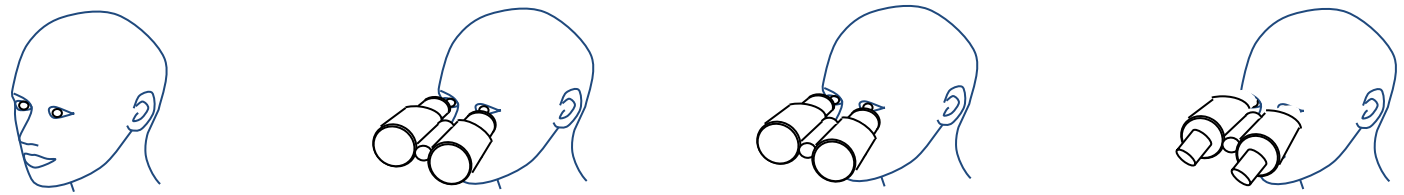
Control Clear Magnified Minified



Moseley et al 2008 *Current Biology*

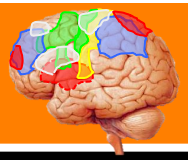






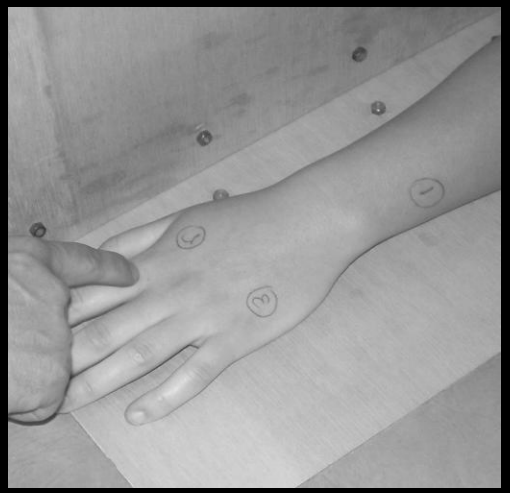
Control Clear Magnified Minified

Moseley et al 2008 *Current Biology*



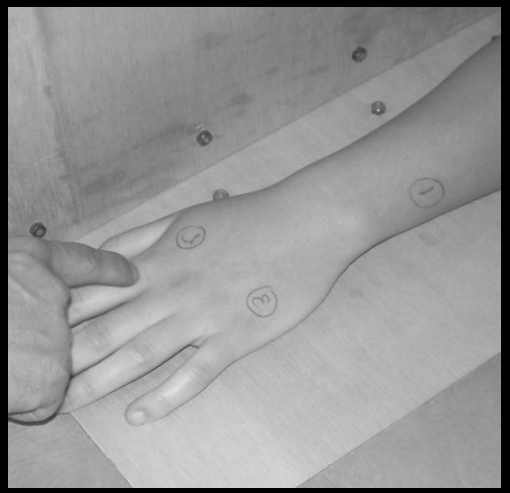
Disownership

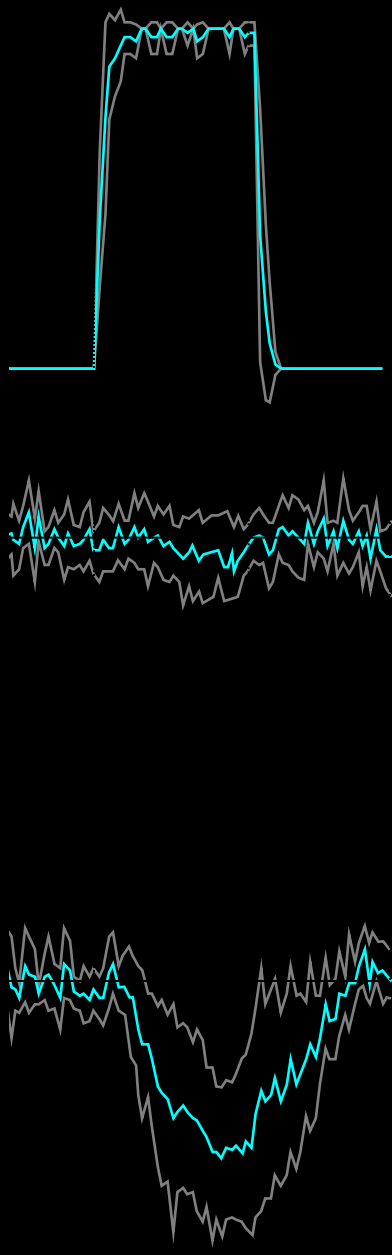
The rubber hand illusion



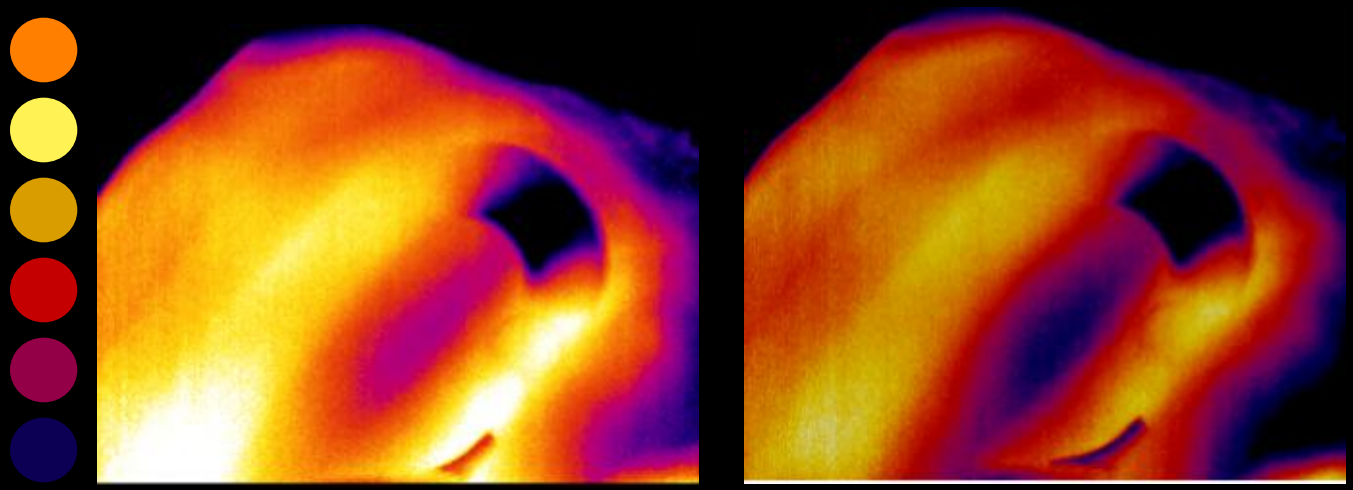
Moseley et al 2008 *PNAS* 105(35), 13169-73

The rubber hand illusion



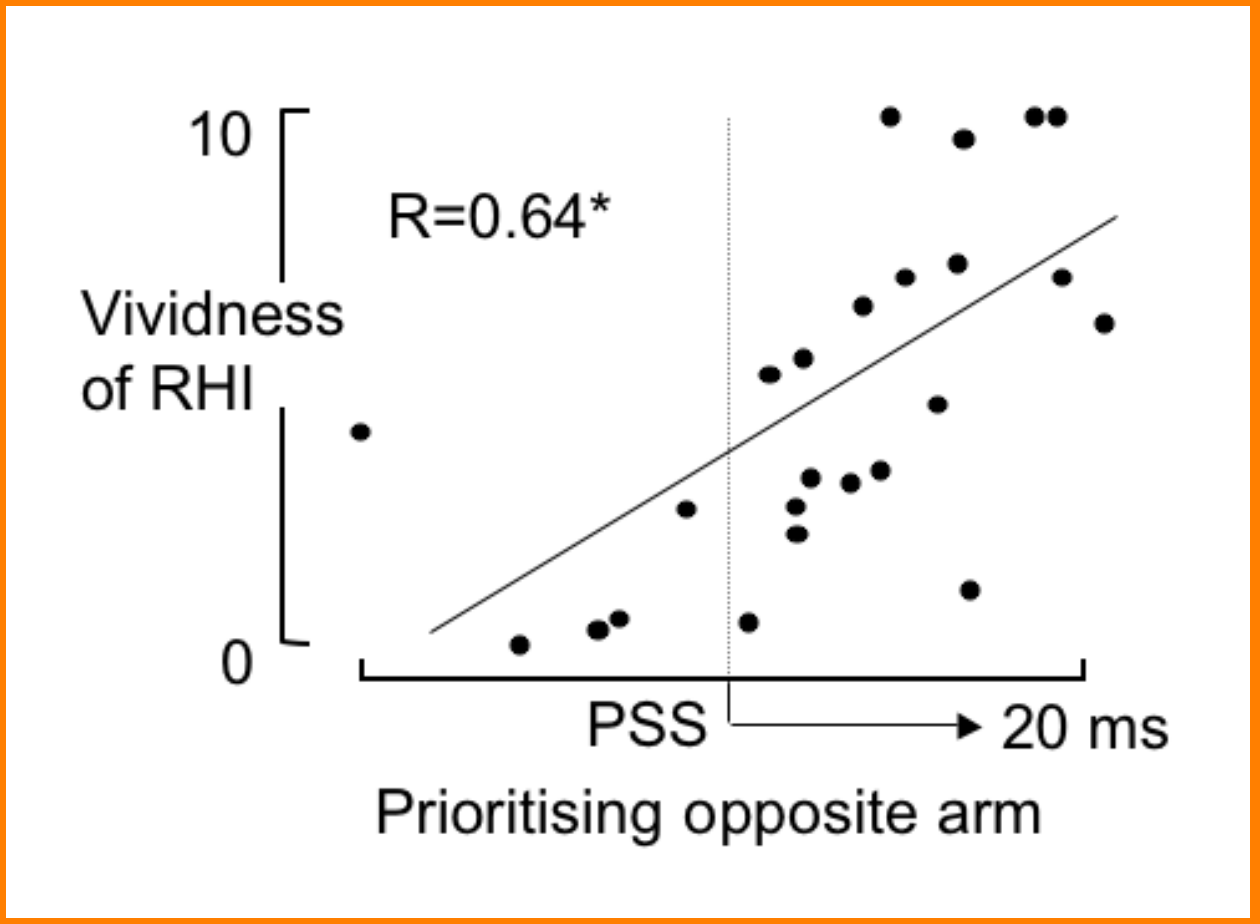


Moseley et al 2008 *PNAS* *105(35), 13169-73*

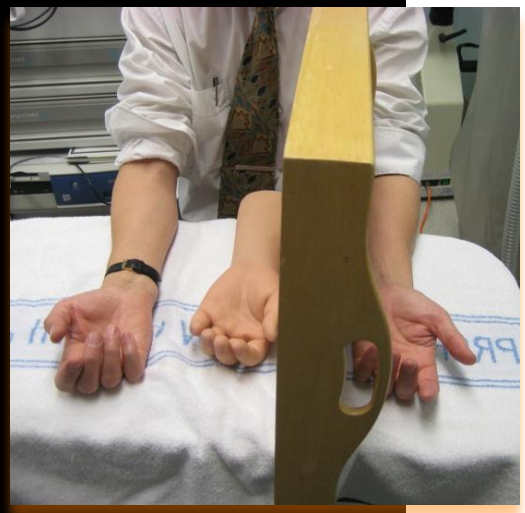


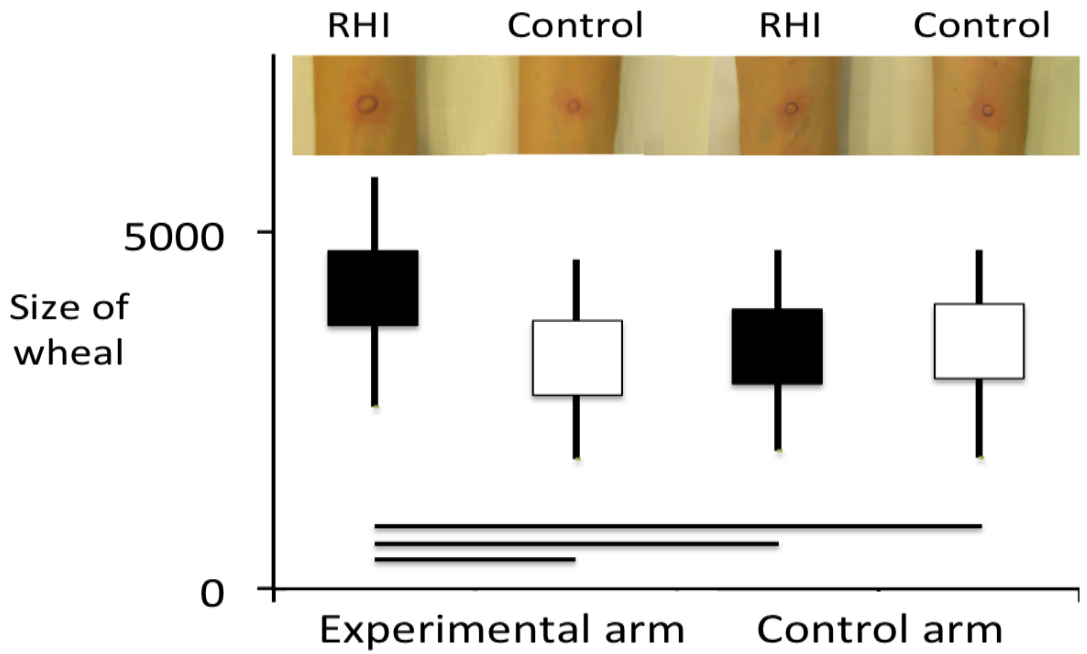
Moseley et al 2008 *PNAS* 105(35), 13169-73

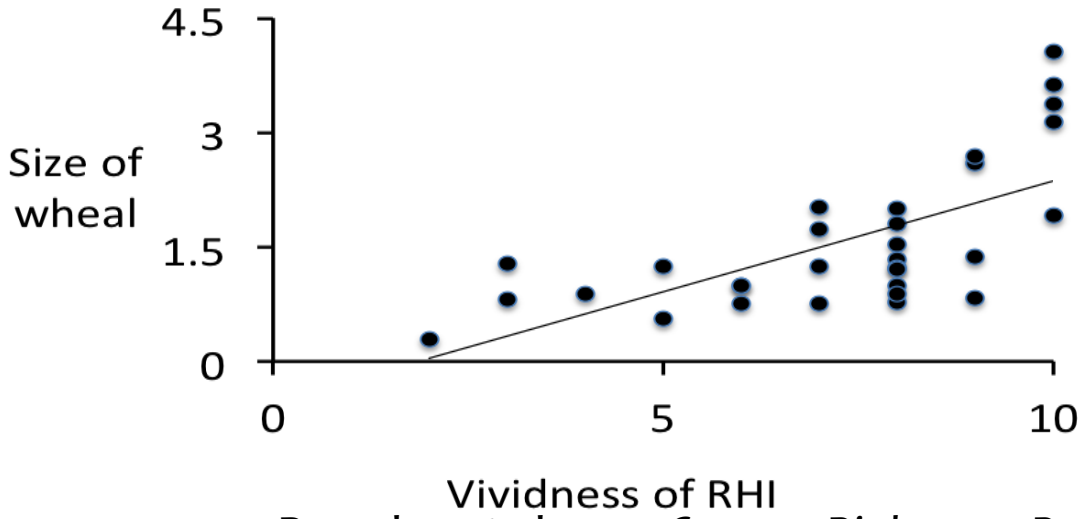
Moseley et al 2008 *PNAS* 105(35), 13169-73



Moseley et al 2008 *PNAS* 105(35), 13169-73





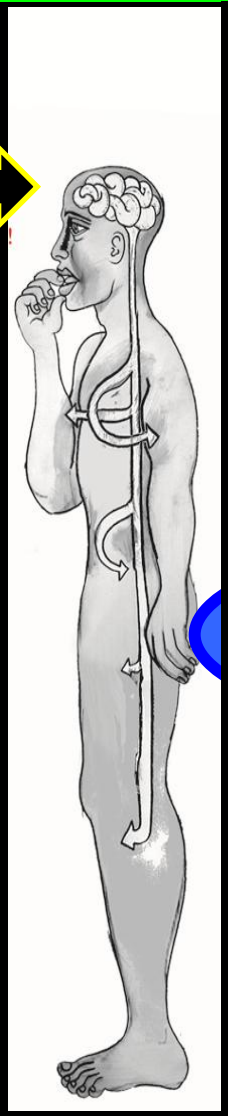


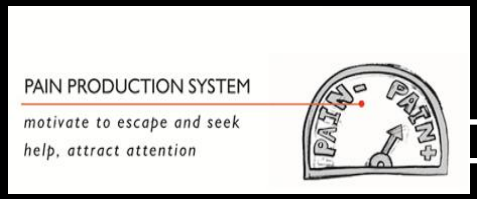
Barnsley et al. 2012 *Current Biology 21:R945-6.*

The key: Pain is an *output* related to perceived threat to body tissue

Nociception
Other cues
Beliefs
Logic
Knowledge
Previous exposure
Social context
Culture
Expectation

'Meaning, mood & biological advantage'





consciousness

Concerted behavioural response

Understanding this helps.

Nociception
Other cues
Beliefs
Logic
Knowledge
Previous exposure
Social context
Culture
Expectation

‘Meaning, mood & biological advantage’

Therapeutic targets

1. *Understand* pain

2. Identify & defuse all threats

3. Normalise the cortical body matrix

Therapeutic targets

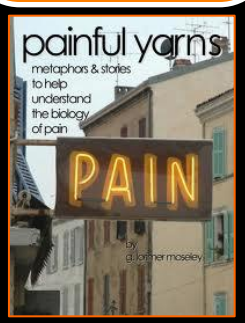
1. *Understand* pain

Metaphors & stories

Get under the conceptual radar

Randomised controlled trial
Gallagher et al 2012 Clin J Pain

Decrease catastrophising
Increase pain-related knowledge
Increase participation in subsequent intervention



Therapeutic targets

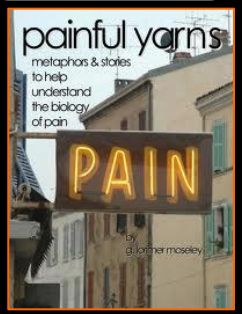
1. *Understand* pain

Metaphors & stories

Get under the conceptual radar

Explain pain biology

Reconceptualise pain



Randomised controlled trials

Moseley et al., 2004 Clin J Pain
Moseley 2004 Euro J Pain
Moseley 2005 Aus J Physioth
Moseley 2006 J Man Manip Ther
Meeus et al., 2007 Clin Rheumatol
Meeus et al., 2010 Arch Phys Med Rehab
Ryan et al., 2010 Man Ther
Van Oosterjick et al., 2011 J Rehab Res Develop
Louw et al., 2012 In press

Systematic reviews/meta-an.

Clarke et al., 2011 Man Ther
Louw et al., 2012 Arch Phys Med Rehab

Decrease pain & disability
Increase participation in subsequent intervention

Therapeutic targets

1. *Understand* pain

2. Identify & defuse all threats

Truly biopsycho social	Cognitive behavioural principles
Graded exposure	Coping skills
	Continual and conservative

Therapeutic targets

1. *Understand* pain

2. Identify & defuse all threats

3. Normalise the cortical body matrix

Graded motor imagery

Randomised controlled trials and Meta-analyses

Decrease pain & disability

Moseley 2004 Pain
Moseley 2005 Neurology
Moseley 2006 Pain
Bowering et al., 2012 J Pain
Daly & Bialocerkowski 2009 Euro J Pain
Goebel et al., 2012 Euro J Pain

Therapeutic targets

1. *Understand* pain

2. Identify & defuse all threats

3. Normalise the cortical body matrix

- Graded motor imagery
- Tactile discrimination training

RCTs & replicated case series

Decrease pain & disability

Flor et al., 2001 The Lancet
Moseley et al., 2008 Pain
Wand et al., 2011 Clin J Pain

Summary.

Nociception is neither sufficient nor necessary for pain

BodyinMind.org

UniSA Sansom Institute for Health Research

Neuroscience Research Australia
Discover. Conquer. Cure.

Summary.

Nociception is neither sufficient nor necessary for pain

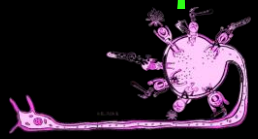
Pain is an emergent property of the human

Summary.

Nociception is neither sufficient nor necessary for pain

Pain is an emergent property of the human

Nociception refers to activity in nociceptors and their projections



Summary.

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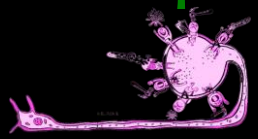
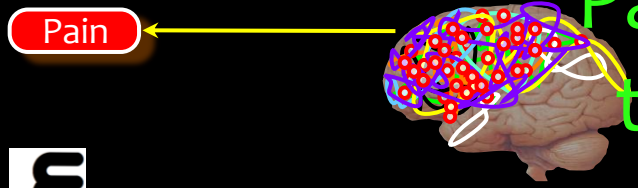
Nociception refers to activity in nociceptors and their projections





Pain relates to implicit evaluation of threat to body tissue and serves to protect

Summary.

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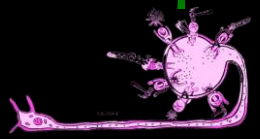

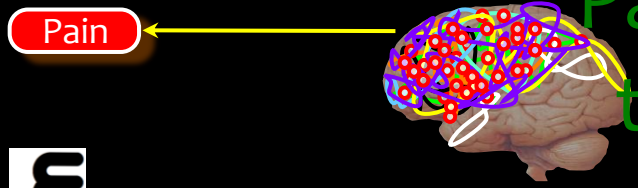

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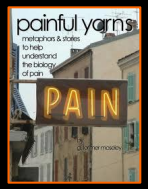


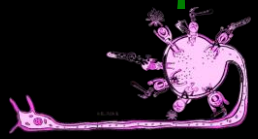
Understanding this helps

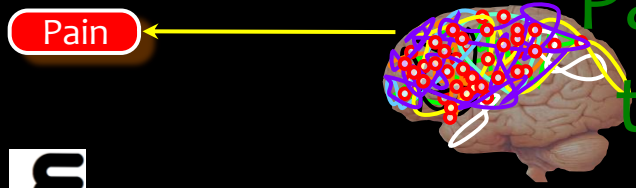
Summary.

Nociception is neither sufficient nor necessary for pain

Pain is an emergent property of the human

Nociception refers to activity in nociceptors and their projections





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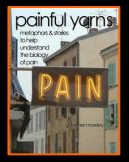

Understanding this helps

Targets for treatment are: Meaning, exposure and the cortical body matrix

Who we are.

Emily Carolyn Jane Heidi Helen Tracy Tasha Abby Flavia Luke James Laura

Owen Jackie Gaynor Daniel Sarah Ann John Mitra Valeria Audrey Hayley Luzia Mark Eva

Our cortical prostheses.

Giando Alberto Charlie Andre Simon Mick Neil Ben David Frank Bob Han Herta Johan Jill