

# Human Nature: Work-in-Progress?

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Bruce Sterling shares this pessimism...

“Another troubling frontier is physical, as opposed to mental, augmentation. Japan has a rapidly growing elderly population and a serious shortage of caretakers. So Japanese roboticists envision walking wheelchairs and mobile arms that manipulate and fetch.

But there’s ethical hell at the interfaces. **The peripherals may be dizzyingly clever gizmos but the CPU is a human being: old, weak, vulnerable, pitifully limited, possibly senile”**

Robots and the Rest of Us: Fear and Loathing on the Human  
-Machine Frontier Bruce Sterling, *Wired Magazine*, May 2004 p  
.116

And here's another way of being trapped.....some versions of evolutionary psychology depict us as **'stone age minds trapped in a modern world'**

Idea = that our minds are adapted to the **EEA: Environment of Evolutionary Adaptedness**



Uniting all these is a fundamentally misconceived vision of our own humanity: a vision that depicts us cognitively as ‘**inescapably locked-in agents**’

as beings whose minds, senses, and physical abilities are fixed quantities, apt (at best) for **mere support and scaffolding** by their best technologies.

Alternative: human minds, bodies, and sensoriums are essentially open to episodes of **deep and transformative re-structuring**, in which new equipment can become quite literally **incorporated into the sensing, thinking and acting systems that we identify as agents and persons.**

(for lots of this, see Clark (2003) (2008), Clark and Chalmers (1998))

Dennett,  
Hutchins,  
Donald,  
Wilson,  
Vygotsky,  
Varela,  
Thompson  
Rosch,  
Bruner,  
Norman,  
Heidegger,  
Gregory,  
Gibson,  
Merleau-Ponty  
Bateson

.....just fill in your favorites....

# Sensory Augmentation Workshop

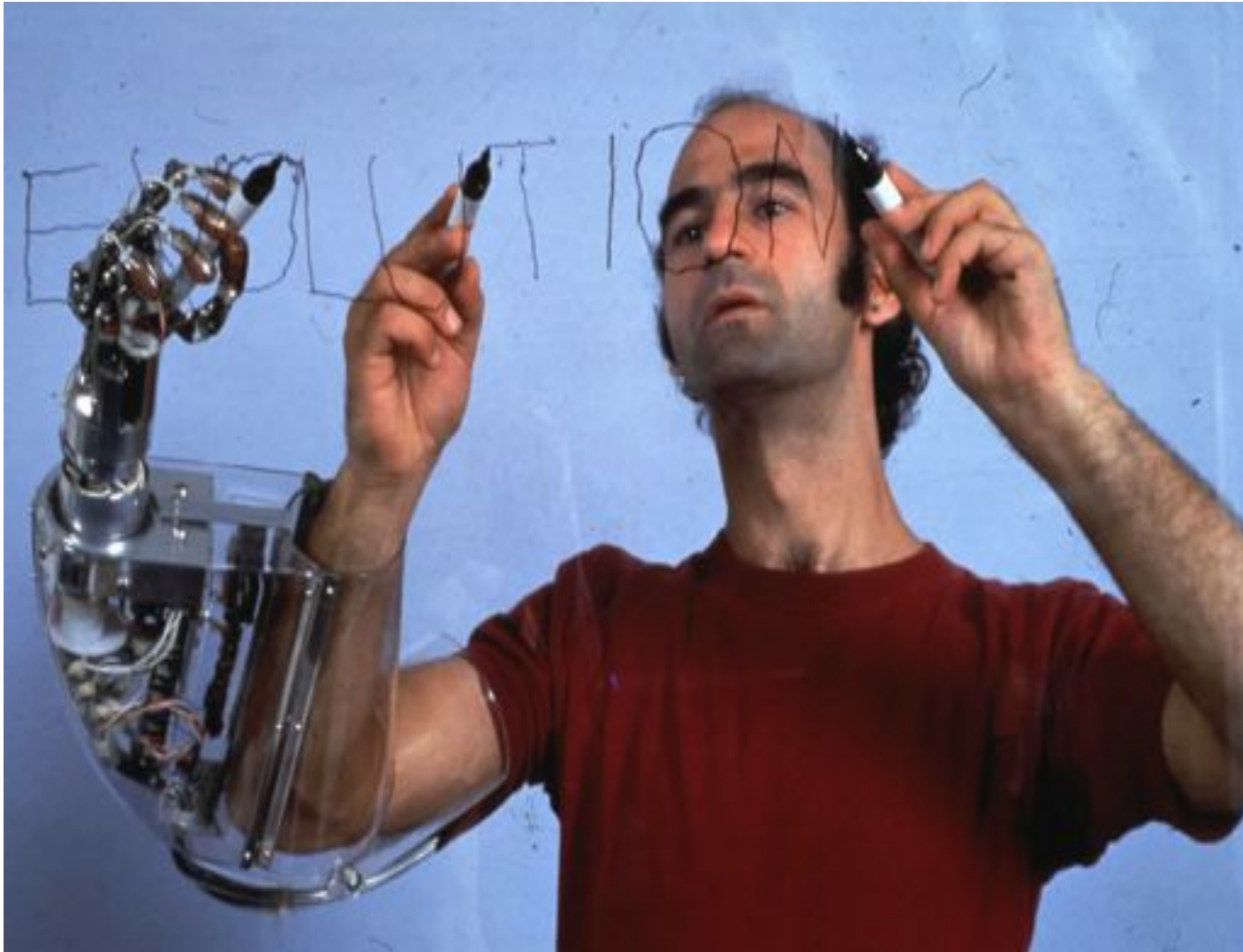
0. Preamble

**1. A (Too) Simple Model of Bodily, Sensory,  
(and Cognitive) Extension**

2. Beyond Transparency?

3. Deeper in the Can of Worms

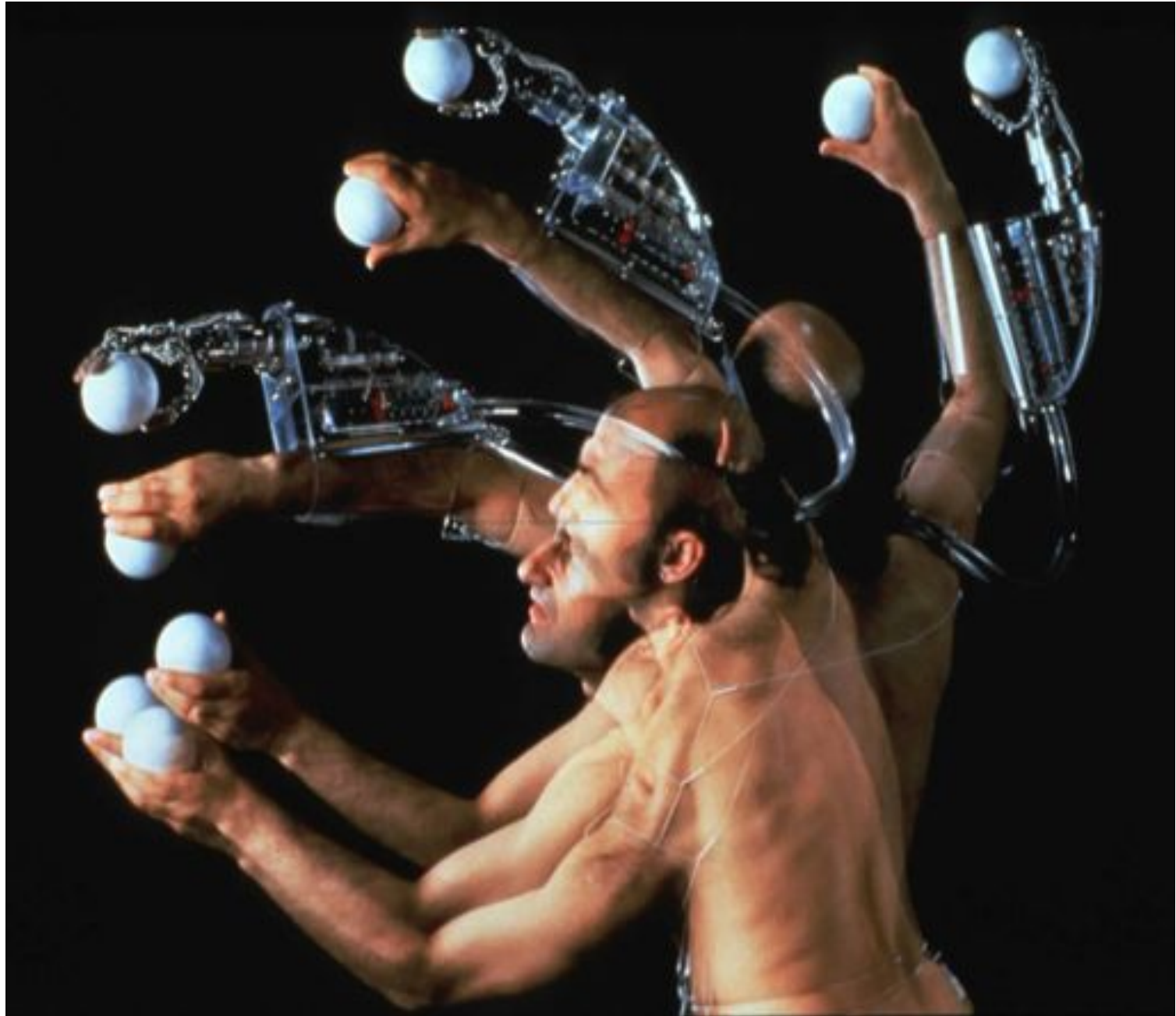
# Bodily Extension/ Body Prosthetics



EMG signals are detected by electrodes placed on four strategic muscle sites on Stelarc's legs and abdomen. The third hand is **controlled via muscle commands to these sites that are then relayed to the prosthesis.**

Since these sites are not normally used for hand control, the third hand can be **moved independently of the other two**





Stelarc's Third Hand now functions as **transparent equipment** : equipment through which he can act on the world **without first willing an act on anything else.**

(see Heidegger (1927) on the 'ready-to-hand')

Seems that a third hand could, in time, become fully incorporated into ones body image and body schema...a **genuine bodily extension**

Such a capacity makes biological sense

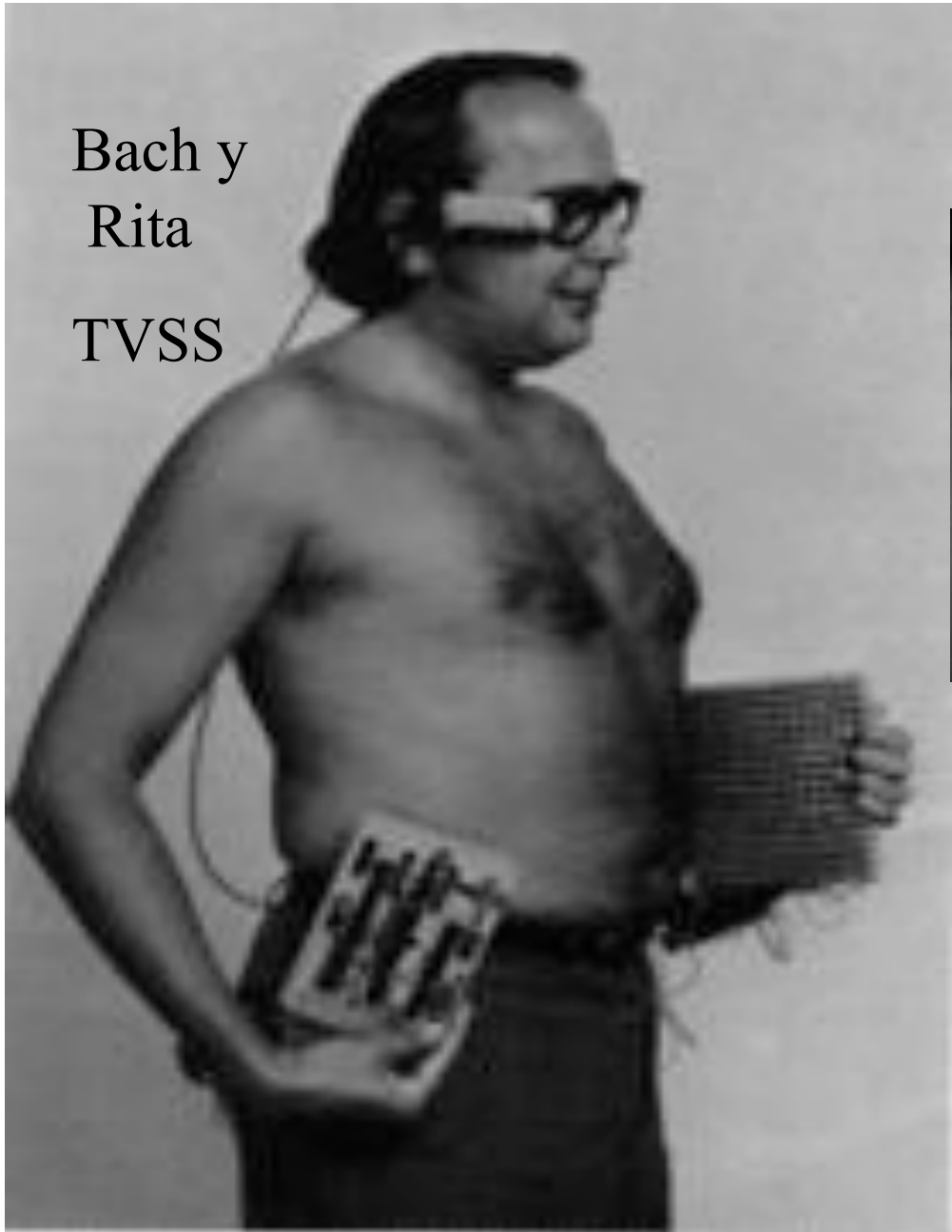
Human bodies grow over a lifetime. They change and alter. **Bits grow, and bits drop off** and become useless.

So it is sensible to compute the body-image moment-to-moment **“on-the-fly”**, on the basis of current evidence, rather than locking in a rapidly outdated image from birth.

Brains like ours are thus **naturally** open to a variety of forms of embodiment.

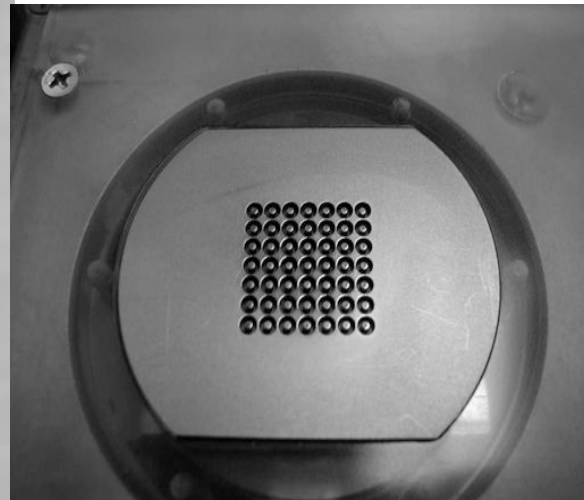
**“Your own body is a phantom, one that your brain has temporarily constructed purely for convenience.”**

V.S. Ramachandran and S. Blakeslee

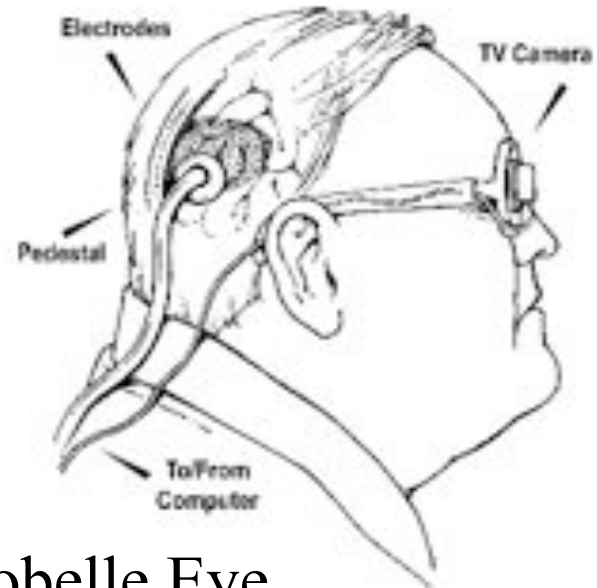


Bach y  
Rita  
TVSS

Sensing



Brain Port



Dobelle Eye

All three routes seem prima facie **viable**.

In each case agents need to exert some kind of **control over the sensor** (or at least over the information sensed) and then, with experience, they can learn to use the new sensory channel so as to respond fluently to the world, sometimes claiming **'quasi-visual'** experiences of looming etc

**New sensory circuits seem apt for incorporation into the human machine**

Leprosy patients who have lost feeling in their hands.

Fitted with a **sensor-laden glove** that transmits signals to a forehead mounted tactile disc-array, they **report feeling sensations of touch at the fingertips .**

This seems to be because the motor-control over the sensors runs via commands to the hand, so the **sensation is projected to that site.**

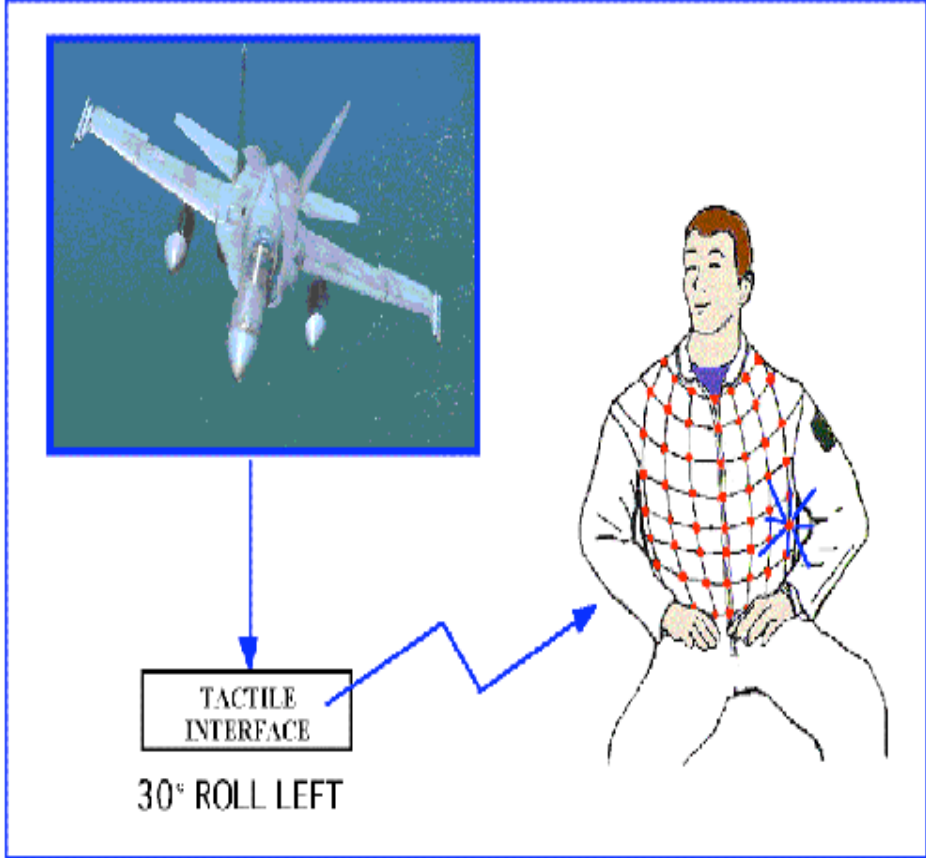
Bach y Rita and Kerzel “Sensory Substitution and the Human-Machine Interface” *Trends in Cognitive Sciences* 7:12:2003

## Body and Sensing?

### Tactile Flight Suit (US Navy)

Jacket delivers small puffs of air controlled by complex sensors that determine if a plane or helicopter is tilting to the right or left or forward or backward.

The pilot feels a **puff-induced vibrating sensation** on the side of the body corresponding to the direction of tilt, and can control the vehicle's response by moving their body so as to **cancel the puff/vibration**.



The suit is so good at transmitting and delivering information in an intuitive way that it allows even inexperienced helicopter pilots to perform difficult tasks such as **holding the helicopter in a stationary hover**, while military fighter pilots can use it to **fly blindfold**.

The suit thus rapidly links the pilot to the aircraft in the same kind of closed loop interaction that linked bio-Stelarc and the third hand, or the blind person and the TVSS system

While wearing the suit, the helicopter itself behaves very much like an extended **body and sensory sheath**.

Novel circuits for thinking? Not today thank you....



Why should we think of all this as bodily and sensory extension and transformation rather than as **stable ‘locked-in’ minds** coming to be **in fluent command of a few new tools (the third hand) and sensors (in TVSS etc)?**

Towards a **notion of incorporation rather than mere use.**

A clue from work on sensing, tool use, and bodily extension

(Maravita and Iriki “Tools for the body (schema)”  
*Trends in Cognitive Sciences* vol 8:2:2004, p. 79)

Case: A macaque uses a rake for 5 seconds to reach for some food.

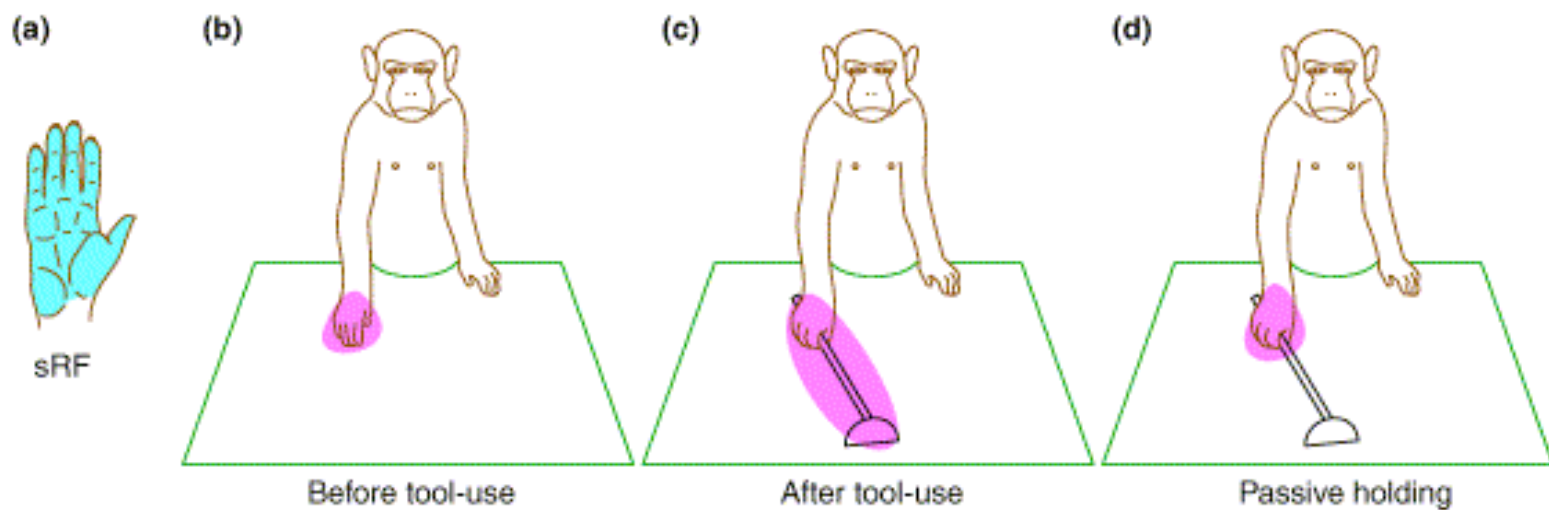
Yields alterations to the vRF of **bi-modal parietal** neurons...

**Pre-tool use**, these respond to both touch on the hand and to visually presented objects in the space around the hand (hence, ‘bi-modal’)

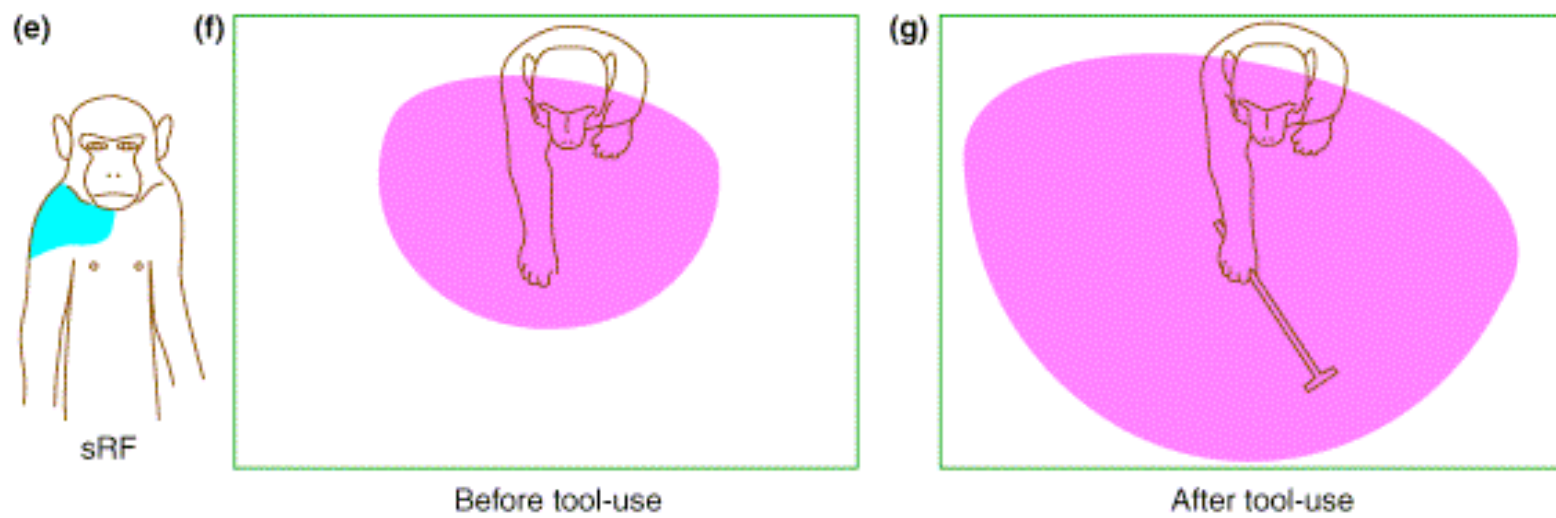
After 5 seconds of using a rake to reach for food, the vRF’s of some of these neurons **alter** to respond to visually presented objects **within the reaching space created by the hand-rake combination.**

Lots of similar findings, including alterations caused by reaching with a virtual arm using a computer display...

### Distal-type neurons



### Proximal-type neurons



“Such vRF expansions may constitute the neural substrate of **use-dependent assimilation** of the tool into the body-schema, suggested by classical neurology”

(Maravita and Iriki 2004: p. 80)

## = Incorporation?

New device or resource enters the scene, and over time becomes **recruited into multiple problem-solving routines, that criss-cross personal and sub-personal levels**, in ways that are sometimes not even fully understood by the agent herself

Getting used to the device/resource involves a process of **dense sub-personal interweaving** whose upshot is the feeling of being 'in touch' with the problem domain itself, **rather** than with the resource itself

adding **bodily, sensory (or cognitive)** augmentation

= adding a new resource to a **big messy web** of intertwined personal and sub personal resources and allowing some kind of deep sub-personal **reorganization of the whole** to occur.

In this respect, bodily, sensory, and cognitive extensions are plausibly **alike**.

But there may be a hitch.....

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A simple worry...

We can become expert at using a rake, a fork, or chopsticks, in ways that plausibly involve just such **dense sub-personal interweaving**, temporary re-  
-settings of **receptive fields in bi-modal neurons**, etc ,  
all yielding **transparency** in use.

Yet we don't feel that the chopsticks are **parts of our body**.

Nor (Humphreys) does the car driver feel **genuinely disabled** when outside the car.

in the sensory realm:

we can become expert users of eg microscopes, which may also fall **transparent** in use, while never feeling as if we have just **lost** a sensory capacity when the microscope is not available

(though the FeelSpace project has some interesting, though not yet decisive, evidence here)

Q/ Is this all **just a matter of degree** or might there be **more** to genuine incorporation than transparency and sub-personal interweaving alone?

In the bodily case, interesting new evidence suggests an **additional factor** that helps make sense of this

Consider the famous **Rubber Hand Illusion**



see Tsakiris and Haggard (2005), Tsakiris, Constantino, and Haggard (2008) and **De Preester and Tsakiris (2009)**

Longo et al (2008) note that you don't feel as if you have 3 hands!

Rather, the rubber one seems to **displace** your own.

(indeed, Moseley et al (2008) show that the **skin temperature of the real right hand drops** when subjects experience the illusion!)

+ replacing the rubber hand with a wooden stick **abolishes** the RHI

+ placement of hand matters..it needs to **fit normal postural range.**

De Preester and Tsakiris:

all speaks in favour of some role for a **longer-term**  
**‘abstract body model’** that acts as a **constraint**  
on genuine (phenomenological) incorporation

Body model encodes information about the “visual,  
anatomical, and postural properties of one’s own  
body”

And it plays a role in incorporation in **addition** to  
the kind of on-the-fly schema that is responsive to  
eg tool use

Body-model that is not built moment-by-moment on the fly.

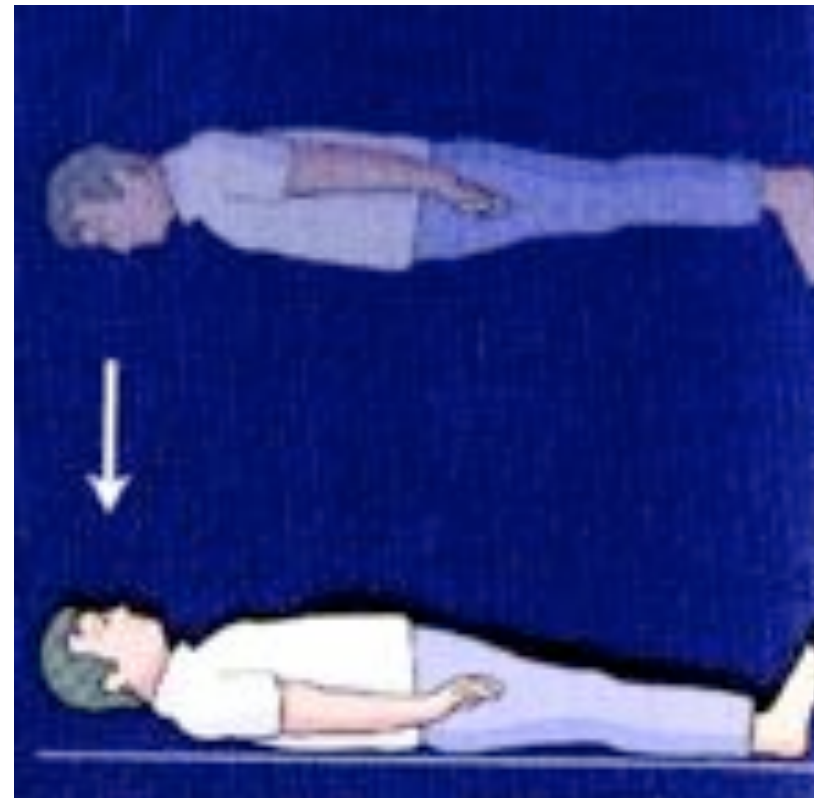
It plays a role in how we **experience** new resources ie whether they are treated merely as **body -extensions** (even if with receptive field changes, transparency, etc) or as **genuine body-parts**.

(a question to discuss later: what are the **functional consequences** of treating something as a **genuine** body part or sensory capacity: what **difference** does it make, and **how** (if we leave aside self-report) **can we tell?**)

## Physiology

De Preester and Tsakiris also note that other research suggests **rTPJ** (right temporal and parietal junction) as a **likely site** for this longer-term model.

Direct stimulation here can produce **out-of-body experience** and lesions linked to **denial of ownership of body parts** etc.



## TMS Study

Tsakiris et al (2008) TMS'd rTJP right after the time-locked RHI stimulation, and found that (1) it **reduced** the rubber hand incorporation effect, while (2) **increasing** the effect for non-similar objects like spoons.

“[TMS] blocked the contribution of the body-model in the assimilation of current sensory input, making the discrimination between what may or may not be part of one’s body ambiguous” De Preester and Tsakiris (in press-2009)



Aside: rTPJ has been more generally described (Decety and Lamm (2007) as **‘filtering sensory events for their importance or attribution to the self’** (De Preester and Tsakiris (op cit)

Q/ If such a body-model is indeed playing a role, is the model **innate or learnt?**

De Preester and Tsakiris present good evidence that **at least some details** may be innate, eg phantom limb effects in those born without the limb in question.

AC: But even if some of the detail is innately specified, that **does not yet make it locked in**...it might still be **overwritten** by long-term experience of alternate correlations.

**Open empirical question?**

So: with the **old story and the new, body-model, challenge** on the table...**what about sensory systems??**

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The obvious question. **Is there a sense-model too?** And if so, **what does that imply** for attempts at sensory augmentation and extension?

(aside: Is there a mind-model?)

Comments: I now think there probably **IS** such a model. Human brains seem to be **expectation-devices** through and through. So they will surely learn to expect certain bodily, sensory, and even cognitive patterns to be displayed.

And **full phenomenological incorporation** may in each case fail where there is a lack of fit.

It is plausibly adaptive to distinguish what is made available by some **transient context** from what is **always/mostly available**.

But the case of sensory augmentation is further complicated by the fact that there are **multiple factors that such a self-sense model might track.**

It won't track the **look** of the sense organs presumably!

Could track:

1. The **kinds of content** delivered (eg for vision: distal, egocentric, with information about colour, shape, size, motion)
2. The **sub-personal format** of the encodings
3. Those elusive **qualia!**

Or any combination.

## Some **comments on qualia**

Nick Humphreys (Berlin meeting) doubts that **any truly new forms of qualia** could be supported by **any sensory extension** we can currently claim to be plausible

Do we have any **actual cases** that really look like new forms of qualitative experience?

## FeelSpace maybe???



But does it **really feel like anything distinctive** to use that information, or is it more like a combination of non-qualitative pick-up + signal eg a beeper signal that allows you to become consciously aware of the content of some pheromone information as it is being picked up...no new qualitative experience, just new content (does this make sense??))

Finally, might one of our planned e-sense experiments help here?

**Extending peripheral vision** via an e-sense hoodie!



## Possible Outcomes:

1. No qualitative effect: just an **information channel**
2. Qualitative effect but **like a new channel**.
3. **Integrated quality.**

(my guess) all **updateable** even if have **initially constraining self-sense-model**, so could **extend field, with qualitative integration**

but a final note of **extreme caution/pessimism**:

**Schwitzgebel**: we really don't know what we experience anyway, even in normal cases!

(“Were you experiencing the feel of your feet in your shoes just before I asked you?”)

If we don't even know that, we may learn little by asking people what they feel or experience in these new and interesting cases! **They may not know.**

## **(in)conclusions**

Minds like ours seem to thrive on the **unstable borderlands** between the biological and the artifactual, and that this takes us very far indeed from any rigid, locked-in, or ancestrally-closed image of human cognition

But the **body-model** results are important and suggest a **constraining role for our own models** of our own structure and (perhaps) our sensory and cognitive capacities

Perhaps such models, too, are **learnable and plastic?** Even if elements of the models are innate, that doesn't mean they cannot be **over-written.**

In the case at hand, sensory augmentation, three special issues arise:

**Is there** a self-sense-model?

If so, what **difference** does it make?

And (relatedly) **over what is it defined?**

Finally: on the upbeat.

I think that this workshop is **itself** important **evidence** in the wider sensory augmentation debate.

For it is one more sign that we are entering an age of **celebratory self-re-engineering**

**self-aware, upfront, unapologetic, non-remedial self-re-engineering**

human nature laid bare

