

Gesture as Thought?



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- 1. Gesture as Thought**
- 2. Causes and Mechanisms**
- 3. Messy Minds**
- 4. An Open Question**

Gesture as Thought

Goldin-Meadow (2003)
McNeill (1992) (2005)



Q/ Might the active hands and arms, during non-iconic, spontaneous gesture, count as genuinely **part of the process or mechanisms** of thinking.

Or are the physical acts only there for **communicative purposes?**

Some clues that gesture might be part of thought include:

- that we do it when **talking on the 'phone**
- that we do it when **talking to ourselves**
- that we do it **in the dark** when no-one can see.

+

- gesturing **increases with task difficulty.**
- gesturing increases when **genuinely reasoning about a problem rather than merely describing the problem or a known solution.**

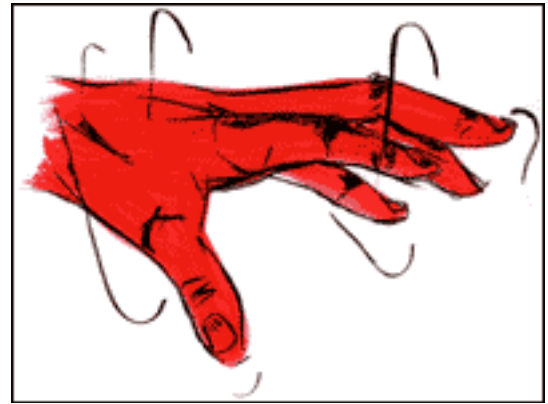
“Just a residual association? Or done for an imagined listener?”

BUT:

- Speakers **blind from birth**, who have never spoken to a visible listener, and never seen others moving their hands as they speak, gesture when they speak.

- Moreover, they do so **even when speaking to others they know to be blind** (Iverson and Goldin-Meadow 1997, 1998, 2001)

Might our gestures be doing cognitive work?



A Study (Goldin-Meadow (2003) ch. 11, 12)

2 groups:

Memorize a list of words

Explain how they solved a math problem,

Recall the list.

While explaining, 1 group could **freely gesture**, the other **told not to gesture**.

Results:

restricting gesture has a **robust and significant detrimental effect on the separate memory task**

Suggests that the physical gesturing brought some kind of **'cognitive bonus'**

But what, and how?

GM's Conjecture: That gesture plays an active (not merely expressive) role in learning, reasoning and cognitive change, perhaps by providing an **alternative** (analog, motoric, visuo-spatial) **representational format** in which we can express our emerging thoughts and understandings

According to **McNeill (2005)**, ongoing encodings in that format enter into a kind of **coupled dialectic** with verbal encodings.

There arise 'growth points': **points of instability** (even conflict) whose attempted resolutions **move forward our thinking**

(see D. McNeill, (2005) *Gesture and Thought*)

Q/ Is the vehicle of this alternative encoding the **gestures themselves** or something **purely neural**?

An intriguing suggestion is that **the actual physical gestures act as problem-solving elements in their own right.**

McNeill (2005) is especially clear here, writing that:

“the gesture, ***the actual motion of the gesture itself***, is a dimension of thinking” (McNeill (2005) p.98, stress in original).

Neural systems co-ordinate with, produce, exploit, and can be entrained by, these gross bodily motions.

Speech, gesture and neural activity are said to together form a **single integrated cognitive system** (Iverson and Thelen (1999))

= (to me) the most exciting and promising idea hereabouts

A Dynamical Reading?

Physical gesture, according to Iverson and Thelen, **continuously informs and alters verbal thinking which is continuously informed and altered by gesture** i.e. the two form a **truly coupled** system.

Upshot = "a dynamic mutuality [involving words, gestures, and neural activity] such that activity in any one component of the system can potentially entrain activity in any other"
Iverson and Thelen (2001) p.37

Words, gestures, and neural activity would thus form a **mutually perturbing system** (like wall mounted pendula) in which each one continuously affects the rest)



Continuous
Reciprocal
Causation

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Typical Deflationary Move:

"Gesturing [or scribbling etc] is not itself part of the thinking or the cognitive process: instead it *merely impacts* it by e.g. somehow 'lightening the load' on the *real (inner-neural)* cognitive processes".

To think otherwise, according to critics like Adams and Aizawa (2001) (2008), and Rupert (2004) is to make a **causal / constitutive error:**

to mistake inputs that causally act on a cognitive system for parts of the cognitive system itself.

A "causal-constitutive fallacy"?

The fallacy of moving from the **causal coupling** of some object or process to some cognitive agent, to the conclusion **that the object or process is part of the cognitive agent, or part of the agent's cognitive processing.**

Many things (like the weather) impact cognition but are not thereby parts of the cognizing machine.

CCF Attributed in varying degrees and manners, to, among others, Van Gelder and Port (1995), Clark and Chalmers (1998), Haugeland (1998), Dennett (2000), Clark (2001), Gibbs (2001), and Wilson (2004).

Reply: **it all depends.....!**

Thought Experiment 1

Suppose the rhythmic pulse of rain on my Edinburgh window somehow helps the pace and sequencing of a flow of thoughts.

Is **the rain now part of my cognitive engine?** Probably not.



Thought Experiment 2

A robot that **deliberately seeks those conditions**, because it is designed to use raindrop sounds to time, sequence, and pace some internal operations essential to proper cognizing.

??

Thought Experiment 3

Imagine a robot that evolved to **spit stored water at a plate on its own body** so as to use the auditory signal to time and sequence key neural information-processing operations.



Those **self-maintained, self-stimulating signals** are best seen (I claim) as part of the cognitive mechanism itself. A **neural clock or oscillator** would surely count after all...

Much of advanced cognition involves the deployment of **cognitive processes that create (or sometimes just elicit) the inputs that continuously drive those and/or other cognitive processes along** (speech, sketching, writing, and gesture, seem like prime examples of such self-created systemic inputs).

In these special contexts, the simple **input vs part-of-processing** distinction, with its associated **ban on counting inputs as parts of processing mechanisms** seems wrong.

= A Self-stimulation Route from Mere Inputs to Parts of Mechanisms..

Compare: the car makes exhaust fumes (outputs) that are also inputs that drive the turbo that adds power (often around 30% more power!) to the engine.

The exhaust fumes are **outputs that are also self-created inputs that surely form a proper part** of the overall power-generating mechanism

Automotive self-stimulation!

A possible self-stimulation model (drawing on McNeill, Goldin-Meadow, Gallagher, Cole, Vygotsky)

In gesture, as when we write or talk, we **materialize our own thoughts**...we bring something concrete into being, and that thing (in this case, the arm motion) can **systematically affect our own ongoing thinking and reasoning**

This is what Dennett (1991) calls the power of **'cognitive self-stimulation'** : we can now see it as a kind of cognitive turbo-drive

It seems unlikely that gesture is an isolated case.

At many levels, **self-generated motor activity** acts as a "complement to neural information-processing", creating whole, highly complex, systems of **non-linear re-entrant processing** in which, according to Lungarella and Sporns (2005):

“'information structuring' by motor activity and 'information processing' by the neural system are continuously linked to each other through sensorimotor loops”

That deflationary worry again!

“But surely all the **real thinking** is still realized by the **neural activity that drives and that responds to the gestures**, even if the gesturing is indeed useful (in this self-stimulating kind of way) for driving our thinking along, or in otherwise reducing the cognitive load.....”

What we might dub the “**mechanism of cognitive unfolding**” may thus be bigger than the brain, but only some bits of it **actually count** as the machinery of mind, of thinking itself..and **those are all neural**.

(see Adams and Aizawa (2008))

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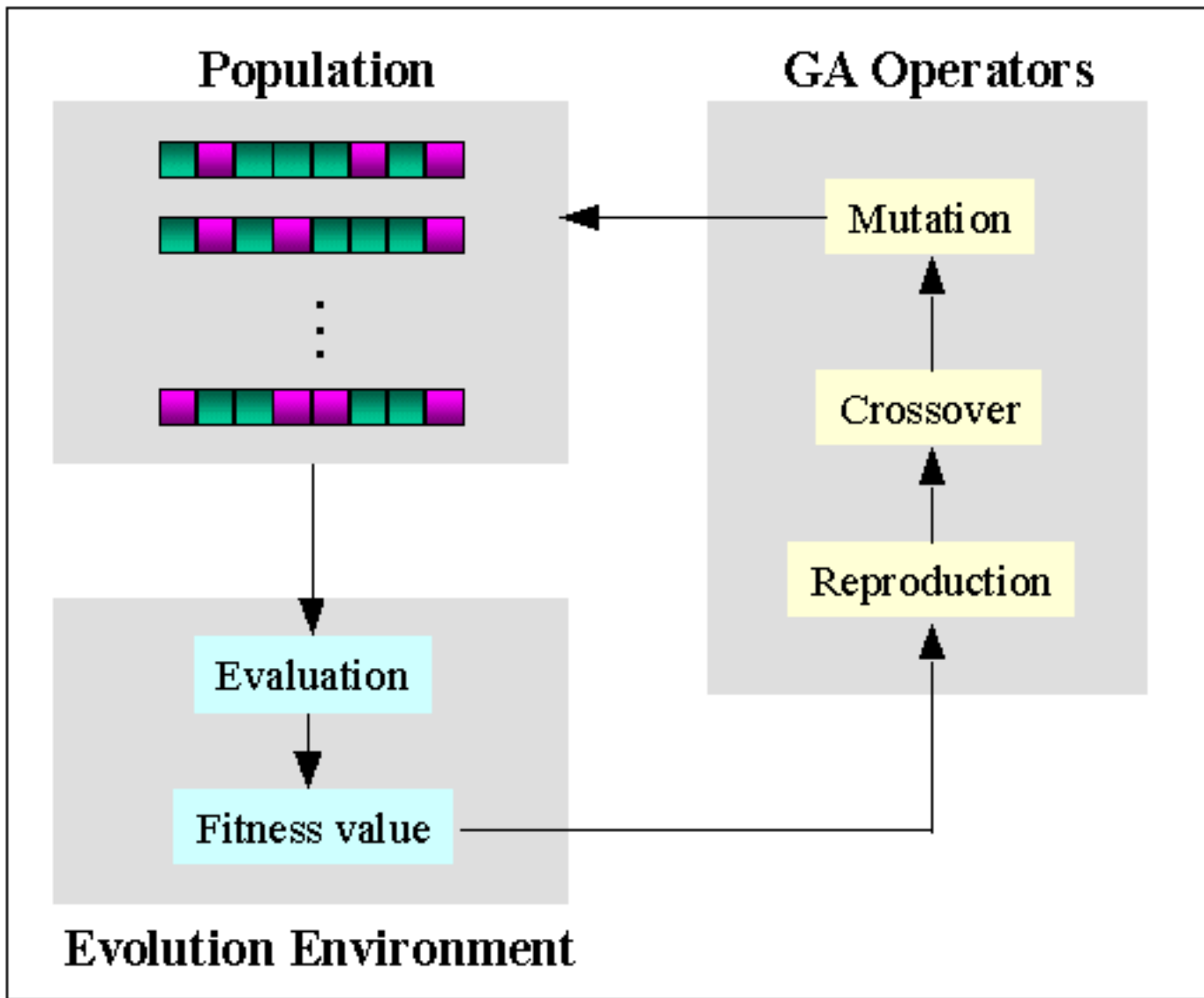
a detour into Artificial Evolution....

Recall the typical use of Genetic Algorithms (GAs)

GAs operate upon a population of disembodied bitstrings encoding candidate solutions to some problem.

An initial random set of bit strings is **assessed against a fitness function** and the best (probably very bad) are selected, mutated, crossed-over etc to form the next generation

the **cycle of breeding and assessment** continues until (hopefully) success is achieved.



An Instructive Variant, “Evolutionary Electronics”

= the use of artificial evolution to evolve not just bitstrings but **real electronic hardware** (see Adrian Thompson et al (1996) (1998)).

Specifically, reprogrammable silicon chips
(FPGA's)

Instead of operating upon mere bitstrings, the candidate solutions are implemented, and the key fitness tests run, using **specific real (reprogrammable) silicon chips**

So each evolving solution is keyed to a **unique real-world chip: a specific bodily platform!**

Results: Highly efficient but 'messy' hard-to-understand solutions.

The evolved circuits turned out to exploit **all manner of physical properties, some specific to that very chip**, of the kind usually ignored or deliberately suppressed by human engineers.

Eg some were interacting with the main circuitry through a kind of between logic block **leakage** ('magnetic flux').

And most of the logic blocks were acting in hard-to-understand, non-linearly interacting, **analogue fashions**, not as simple on/off switches.

Plus any given **solution could not be 'run' on any of the other 49 reprogrammable hardware chips in the population**

The Moral: Nature is happy to use **any properties, drawn from any level, type, or location, of physical functioning, if they help to solve the problem.**

It is not interested in firewalls, neatness, or single-purpose components. **It doesn't distinguish between physical properties and features apt for 'cognizing' and the rest.**

It is not interested in building systems that are easy to understand, rebuild, or take apart.

All that matters is recruiting a motley of resources apt to support cheap problem-solving **success.**

(for a nice treatment of the evolvable hardware story, relating it to CRC, see Wheeler (2005) chapter 10)

Back to Gesture:

Perhaps what the gesture case shows is something similar: that there are **no firewalls** restricting the states and processes that realize human thought and reason to **states and processes played out using the neural apparatus alone.**

Thesis of Bodily Cognitive Spread

Bodily acts may be so complexly, multiply, and sub-personally, interwoven into many of the routines in virtue of which we enjoy the **kinds of cognitive success we do**, that it is mere **neurocentric prejudice** to depict the neural contributions as **physically realizing** human cognizing while insisting that all the other contributions (of body and world) are **merely causal**.

Gesture may thus be a striking example of what is actually a **pervasive fact about human intelligence:**

That we are the kinds of mindful agent we are in part **because of** the ways our gross-bodily acts **productively interweave** with neural (and possibly extra-bodily) goings-on.

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An Open Question: True Neural ‘Screening Off’?

It might still be the case, however, that neural activity is actually doing all the cognitive work that I have been ascribing to the actual gestures themselves.

This would be so if it turned out that **all the cognitive benefits** (assuming there are some!) of gesture are actually secured by a **covert, fully neural, route.**

Two reasons why folk might suspect this....

First Possible Reason:

Gesture is experienced by some subjects born with no arms.

(see Ramachandran and Blakeslee)

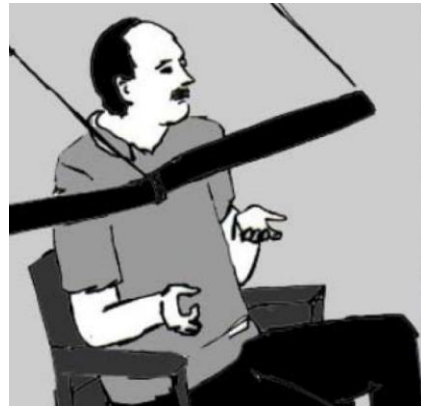
Might they be gaining the cognitive bonus too??

Second Possible Reason

IW, who has no feeling below the neck, and receives no proprioceptive feedback from his arms, now produces (even in an artificially blind condition) **delicately time-linked expressive, non-iconic gestures** in what seems to be a **spontaneous, often unconscious, fashion.**

See Cole, Gallagher, and McNeill (2002)

If IW gains cognitive benefits in the blind condition, it must be via some covert purely neural route



	<p>-y hands now ←</p> <p>-to try(in') ⇒</p> <p>Hands back in phase, both move outward.</p>	
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Possible Covert Neural Route:

Any 'cognitive bonus' might be "due to **pre-motor preparatory processes** involved in the generation of the gestural movement rather than from the gestural movement itself"(Cole, Gallagher, and McNeill (2002) p.62)

But compare **McNeill (2005)**

"the gesture, **the actual motion of the gesture itself**, is a dimension of thinking" (McNeill (2005) p.98, stress in original).

McNeill (2005), McNeill, Duncan, Cole, Gallagher and Bertenthal (In Press) suggest that our gestures activate our own **mirror neuron systems**, stimulating our own brains in the same way that **seeing the same expressive acts performed by others** might.

McNeill dubbed this **'Mead's Loop'**

But here too the **same ambiguity arises:**

is the MN stimulation achieved by a **wholly neuro-internal route**, eg via some internal emulation circuit that predicts what the gesture would be like if we were to make it, or via the **real loop into expressive physical motion?**

Looks to be an **open empirical question.**

If co-ordinated speech/gesture reflects a single evolved cognitive/expressive resource, that fact alone explains the **presence of gesture** in the phantom case and the re-emergence of gesture in IW.

But if **actual physical gesturing** confers **cognitive benefits in the messy, leaky, loopy way** I suggested, we should **not** see these same benefits to the same degree in those cases (unless some other strategy rushes in to compensate, such as mouth gestures, or micro-body motions...)

But if it is all **really** messy and leaky, we might be getting **some** cognitive benefits from gesture via wholly inner and others via partially outer routes...

Compare:

It may help our thinking to try to write things down, **even in the dark, and even if we couldn't feel the motion of our hands!**

But the benefits may **increase if (unlike IW) we can feel our hands moving, thus adding a self-stimulating loop.**

And they may **increase still further if we can also see what we are writing** as we write it, completing another self-stimulating loop (but imagine doing this using rapidly disappearing ink)

Finally, we may get **still further benefits if the traces persist longer**, so that self-stimulating loops can be shared and spread out in various ways across time and space

So:

We need to check experimentally whether IW and/or phantom gesturers **really do** get the putative cognitive bonus,

and even if they do, **whether they get it to the same degree.**

And even then, we need to check for any **alternative, compensatory, but still body- involving loops**

(eg signers have been shown to use some mouth motions as a form of **spontaneous non-iconic gesture-** see Fontana (2008))

Final Worry: **Cognitive Damage versus Cognitive Bonus.**

Weiskopf :gestures not as turbo but as **mere, yet essential**, “cognitive exhaust”

Worry is that **EVEN IF** all our experiments seemed to show that real gesture matters to thought (i.e. no pure neural route to **the same** cognitive performances) that **STILL** won't be enough!!!

- **Compare:**
 - Plugging a car's exhaust pipe will impair the engine's performance
 - Preventing real physical gesture will impair a subject's cognitive performance
- “Gestures might be *indicators* of cognitive states and be *necessary* to normal performance without being *part of* cognitive processing”



Final Confessions: I don't really much care how we end up using the term 'cognitive' or 'cognitive system'

What matters is to explore the many ways in which human thought and reason are **potentially altered and empowered** by the complex and temporally nuanced interplay between **what we do with our bodies** and **what we do with our brains**

So The Real Moral Is

We should be alert to the **vast potential for cognitively potent self-stimulation** created by the fact that that we are:

mobile active beings,
replete with **effectors**,
richly endowed with **sensory systems**,
with vast swathes of neural tissue devoted to the detection (**interoception**) of our own bodily states,

evolved by means **insensitive** to the demands of neatness.....

and **uninfected** by the meme
that 'minds are simply what
brains do'!

