Mobile Being: How Inbodied & Embodied Practice May Inform Mobile Cognition

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Figure 1 the Forest Walking (mobile cognitive work) that helped generate the thinking for this presentation

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Abstract
What is “mobile cognition?” This is a term at the early stages of use. This paper explores the opportunities for human-systems interaction technology research and design in framing “mobile” as a modifier for a *type* of cognition – cognition on the go. It offers a rationale for foregrounding this brain/body connexion.

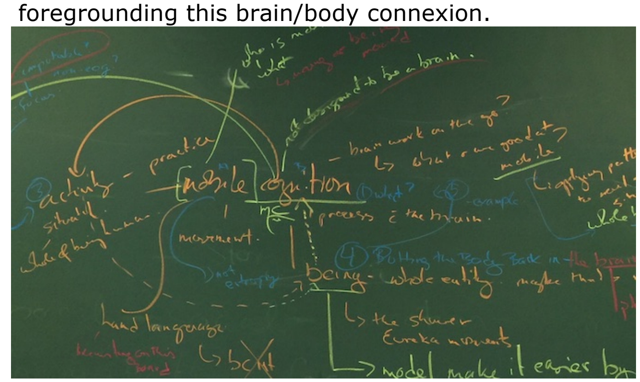


Figure 2 The large gestures of the chalk board that captured an overview for this presentation.

Author Keywords
Cognition, mobile cognition, brain body connexion, inbodied five, in5, embodied.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI)

Mobile Cognition Systems

Figure 3 the Ad hoc standing desk to write up the chalkboard into an outline for this paper.

After the walk (Figure 1) and the chalkboarding (Figure 2), being outside in the sun, standing to work at a tablet with removable keyboard – to facilitate setting up a standing desk easily - also enabled me to keep moving, while also getting bright light, keeping all my body clocks in sync. The whole process supported both play and flow in a safe, inviting environment. Those concepts recur throughout this paper.

Introduction

What is "mobile cognition"? The subtitle of this first workshop suggests a definition to be "using mobile devices to enhance human cognition." The workshop description amplifies this sense of mobile as referencing the device types: to focus on the use of sensors to capture more of one's life by having more ubiquitous and pervasive sensors, and that with such monitoring, opportunities to support strategies like "behaviour change" become more available. The description reads:

applications can help monitor physiological data, motivate behavior change, but also create new ways to aid human memory…to track activities beyond the physical realm, make sense of that data and feed it cognition.

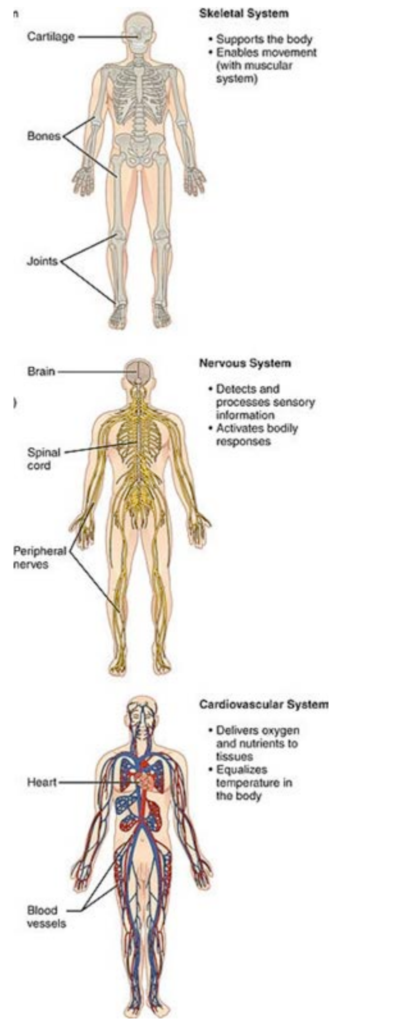
In other words, rather than the term mobile cognition describing a type of cognition, like embodied or distributed or external cognition, the workshop proposers seem to be describing a type of system or digital technology that can monitor, intriguingly, "activities beyond the physical" using not just data sources like photos and calendar entries but where one is able to make use of eye position and heart rate and any other physiological sensor (which of these is "beyond the physical"?) to aid "cognition." In other words, we are asked to understand "mobile" as modifying the type of technology that is used to capture data that can then feed back to the person to assist cognitive processes. Here, too, what cognition is understood to be is also left fairly undefined: are we speaking of cognition as computation or as dynamical systems [9], for example? Either model will effect what we prioritise in either data capture or interaction design. Similarly, we may also ask: why focus on support for cognition (alone) rather than the class of attributes (as well) that educators in particular cast as "non-cognition" – like perseverance, imagination, discernment or "grit" [8]].

Given the current openness of "mobile cognition" as a term, in the following sections, I propose to explore some of the opportunities afforded by this term space; of how it provokes the question "what does this mean?" In the first part of this meditation, I will explore resonances around "mobile" and in the second part, some questions and opportunities around "cognition." To conclude, I will suggest a few opportunities for interactive systems based on these approaches.

Preliminary Experiment: Suspending "user" for People.

One of the espoused ambitions of the workshop is to use "mobile cognition" systems to support "behaviour change." Once we consider behaviours, we need to consider the informing contexts. Therefore, as part of this following meditation, I would ask that, as an experiment, we suspend the term "user" from our minds, and think about us, you and me, and others outside an us, that is, people. In other words rather than frame the human interacting with a system only as a separable part that can be characterised as a "user" – that we think about the very messy, incredibly complex organic system (us) that is interacting with our far simpler technological systems for some particular purpose that are themselves contextualised by larger socio-political, cultural systems. We have learned in HCI [7] these systems interact with our cognitive processes. Indeed, *embodied* cognition asserts that there is no fixed boundary of mind/body distinct from these contexts.

Another challenge in "mobile cognition" may be how to incorporate these environmental cognitive extensions into our consideration. In the interim, however, let us



The 11 systems of the body: skeletal, nervous, cardiovascular

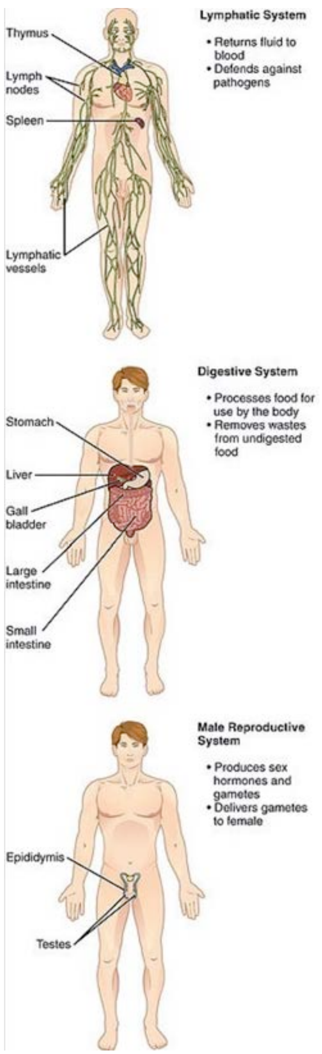
focus on a more immediate framing for *us* of what we may call "inbodied" aspects of our human system that informs cognition.

Cognition on the Go

In this section, let us consider the term mobile cognition to be where mobile is heard as a modifier of cognition. This framing provokes a notion of "cognition on the go." That is, a capacity to make decisions, to cogitate, while operating physically – moving - within a dynamic context. The body is moving the brain, where most cognitive processes seem to occur. Sport offers perhaps the most obvious examples of such brain/body engagement. For instance, a footballer must combine motor skills with decision making to make and execute rapid tactical decisions such as to whom to throw a ball without the other team stopping movement forward. The action is informed by a strategy: get the ball closer to the goal. There are many tales in sport of players who were not the fastest or the strongest on the field, but were the *quickest*: who could react rapidly to enact these decisions. Off the field, a person physically navigating heavy traffic on a bike must respond quickly to an environment with unexpected life-threatening vehicles around each corner thus
subtle. Research over the past decade shows that cognitive executive functioning tasks (including planning, decision making, coordination, error correction) are enhanced by movement in a variety of ways, both in chronic and acute measures.
In terms of chronic, or daily performance from youth to adulthood, people who have an established movement practice, measured by cardio vascular fitness, perform better in school and over the lifecourse in assessments than those more sedentary (less cardio vascular fitness). Indeed, the Whitehall Study also shows that the longer one is sedentary over the lifecourse, the more poorly we perform on cognitive tasks.
Research over the past decade, however, shows that a single bout of aerobic activity, for instance 20 minutes effort on a stationary bike, immediately improves age groups (see [19]for review of these studies).
Within a specific moment, we also see that movement favours particular kinds of cognition. Walking tests have shown that a particular class of problems such as a focus on solving a challenging math problem causes us to slow, to stand and finally to sit as test problems become more complex [1]. Other in the moment cognitive processes are enhanced by walking/standing, from pre-verbal cognitive processing – what is often referred to as back burner type thinking – to brainstorming for new ideas and insights. Even movements as simple as hand gestures contribute to cognitive processing [2]. As Albrecht Schmidt comments, Imagine what brain-only interfaces may do to cognitive performance [16].
There are fundamental neuro-physio-electo-chemical *et cetera* reasons for these cognitive effects related to movement, and lack of movement. As "mobile cognition" is interested in designing tools to support cognition then some understanding of these interactions will help ensure our designs are aligned *with* these processes, rather than potentially against them.
In the next sections, I overview several of currently understood factors around what i call the Brain/Body Connexion, and in particular the relationship of that connexion to mobility.

The Brain/Body Connexion: Primer

In order to make sense of the role of movement in cognition at a systems level, let us consider the system



The 11 con't: Lymphatic, Digestive, Reproductive (male)

we're describing: us. We embody incredibly complex sets of interacting, complex systems. Models of the human body include 11 inter-operating systems: integumentary (hair, skin, nails), I, Skeletal, Endocrine (hormones), Nervous, Lymphatic, Respiratory, Urinary, Reproductive, Digestive, Immune, as per the 4 graphics[1]

The key component we need to understand with respect to "cognition on the go" is that the brain is a strongly inter-connected *part* of this system. In the above systems, this is strongly foregrounded in the nervous system via the brain and spinal cord. No matter where we may think the mind is – in the body; out of the body; a mix - the brain is unequivocally part of the body.

Like every other part of the body, it likewise requires similar support: nutrients, air, circulation. Like other parts of the body it utilises and creates energy in metabolic processes; like other parts of the body, it requires stimulation or it atrophies [13]. Regions of the brain do grow physically, measurably, when stimulated. An example is the recent focus on the hippocampus. The hippocampus is associated with translation of short to long term memory, imagining the future and with spatial navigation, each important for cognition on the go. Size of hippocampus seems to be related to aspects of performance. Heavy drinking on the one hand has been correlated with smaller left hippocampus regions than controls and related effects on hippocampal processes [15]. Increased practice of spatial/directional navigation has also been correlated with increasing hippocampal size, as per the London Cabbies study, where drivers to be licensed must demonstrate a high proficiency ("the knowledge") of navigating London streets from recall [24]. In terms of fuel, the brain, like the rest of the body, requires glucose to support the firing of its synapses and refreshing of its cellular tissue. But just as with the rest of the body, it seems, too much sugar causes a hormonal breakdown known as insulin resistance, where the body can no longer effectively process this fuel.[11] has shown that a highly processed food diet that results in chronic abundance of sugar on the brain creates a similar inulin resistance that results in what she has termed Type III diabetes, also known as Alzheimer's disease.

The key take away for our consideration of "cognition on the go" is that the operation of the brain, just like the other parts of the body, is highly dependent upon and influenced by not only its own state, but the state of the rest of its body-system members. In the following section we will take a brief look at examples of this interaction, in particular those that happen prior to any cognitive engagement, but which effect cognition.

Cognition via the Brain/Body Connexion

Our research design interests are most often focused on conscious, cognitive interaction: where we are consciously carrying out a particular task – making deliberate choices, such as reading this paper. Our designs are not particularly sensitive to whether or not, for instance, we are nervous, aroused or tired. In lab studies, we try to mitigate these very effects clogging up our results by using enough participants, or enough test blocks.

As our focus shifts from supporting specific tasks to support cognition more generally, where the expressed design goal may be to support cognitive performance

[1] Human Body Systems and Organs, http://www.the-human-body.net/systems.html. Images under CC license, https://en.wikipedia.org/wiki/File:Organ_Systems_I.jpg and https://en.wikipedia.org/wiki/File:Organ_Systems_II.jpg

itself, pre-conscious, autonomous and reflexive responses can be directly incorporated into design considerations. This incorporation does require some understanding of how our 11 systems interact. At some point we may, as a community, wish to consider whether those of us interested in this space need a new curriculum of study to understand the neurophysiology and energetics of our bodies, but by way of introduction, some elegant models are available.

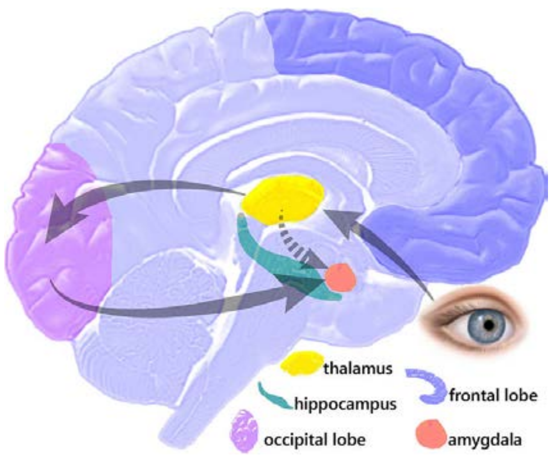
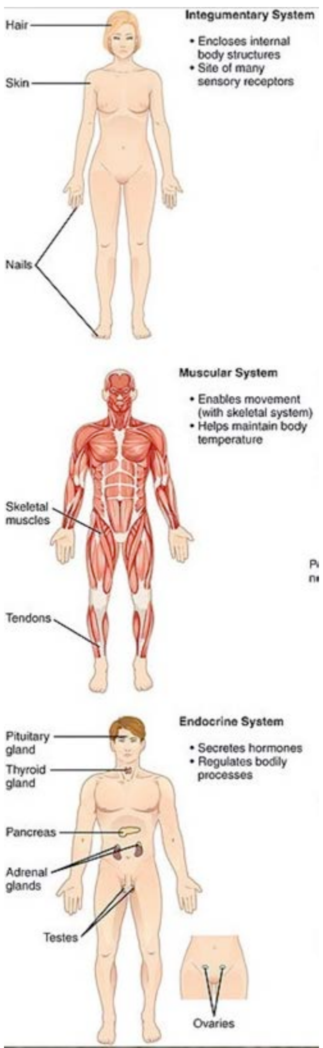


Figure 4 High/Low road response from visual input, source: https://commons.wikimedia.org/wiki/File:EQbrain_optical_stim_en.jpg CC

Threat, The Emotional Brain & Pattern Matching.
We are responding to stimulus all the time. Indeed, it seems our wiring is very fundamentally binary: to detect threat or no threat, where these initial checks are pre-cognitive – physically – they occur before getting to the more cognitive, conscious parts of the brain. Our responses can be frames as Reflexes, Reactions and Responses. *Reflexes*, like pulling a hand away from a hot element, happen in the peripheral/central nervous system within their 300ms arc. These responses do not touch the brain; there is no conscious intervention. *Reactions* on the other hand, have about a 500ms window and reach to our early brainstem and midbrain. Here, according to work by Joseph Le Doux, a signal that hits the thalamus (old brain/mid brain) is effectively split on what he frames as a High Road/Low Road path: one path, the low road, goes to the amygdala (more old brain) for fast threat assessment, and the other slightly slower path goes to the neo-cortex (new brain)[12]. The theory around this split is that the old brain checks first via tight coupling with the hypothalamus (memory processing) for patterns that match previous fight, flight or freeze responses. When there is a match, a set of *Responses* ensue. In other words, there is a fast check for threat or no threat. If there is no match, the neo-cortex path steps in literally “to make sense of” the experience and other *Responses* are cued.
In 1996, Daniel Goleman coined the term “amygdala hijack” to describe the state in which the low road “irrational response” of the Emotional Brain detecting a fight/flight/freeze reaction overwhelms the high road/Rational Brain response [10]. Both scientists have been interested in calming inappropriate threat responses. Of particular interest here are the associated brain/body connected consequences associated with either a low or high road response.

Threat Response and Cognition
As soon as threat is detected, according to LeDoux and Goleman, we experience fight, flight or freeze. It’s important for our consideration to realize that these reactions trigger physiological responses. These



The 11 con't: Integumentary, Muscular, Endocrine

responses create a chemical/physiological signature of us in this state, and it's our hormones that send the necessary signals to create this state.

Hormones and State Setting

Various states of the body/brain, from hunger to arousal to fear, are triggered via hormonal signaling. While most of us are familiar with names of hormones like insulin, estrogen and melatonin, few of us have a sense of what they do. Hormones are, effectively, the body's middle management system. That is, they have coordination roles. And if we were to personify them further we may say they are not called upon to be that bright: they have a limited set of resources with which to handle a problem.

The fight or flight reaction itself is the result of a suite of hormones being triggered to prepare the body to act and to survive: cortisol, norepinephrine and adrenaline, are just three of the main hormones involved. In this case, they prepare us to fight, flee or freeze. What does this actually mean? These hormones signal other hormonal messengers to stop digesting food; to get the blood being used for digestion out of the gut and into our limbs so we'll be ready to go. This preparation not only effects muscles; sex drive is also turned down as this is just not a safe place to get it on. Melatonin – the hormone to signal sleep onset – is suppressed. Blood pressure goes up; insulin is also triggered as blood sugar is pushed into the blood stream for fast take up as energy. Adrenaline, another hormone in a stress response will causes vision physically to narrow (to aid focus on the threat), hearing to decrease and time to distort (experience of time slowing or speeding up).

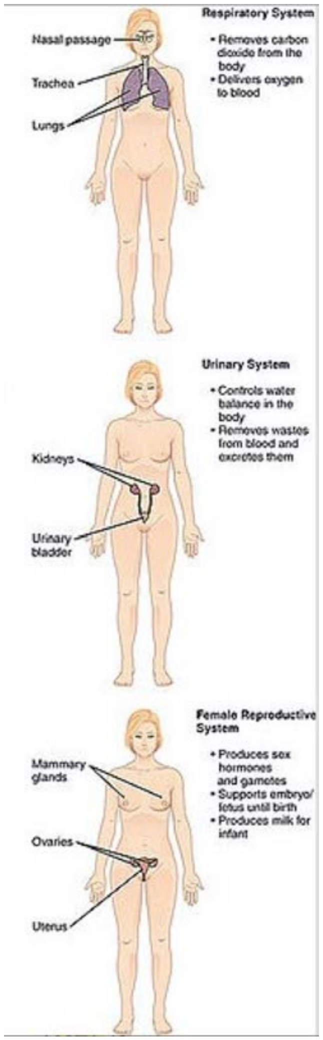
The question we need to consider around cognitive performance is what happens if after all this physiologic preparation, to do a very physical thing: to move in a fight or to flee, run away from that fight, we neither fight nor flee?

Working with Acute vs Chronic Responses

Not responding to the body's hormonal triggers with body-based responses is a risk for us *because* our hormones are not bright; are very much not cognitive. When we do not respond to a hormonal trigger, our bodies typically send out more hormones. It's rather like when someone does not speak one's language, and the person thinks if they just say the same thing LOUDER (with more volume), then *that* will be understood. Same thing, more or less, here. No physical response: more hormones, the volume goes up. More of the same hormones more of the time is not good. That more moves an *acute* or immediate response into a *chronic* response.

Let's consider Fight or Flight. And let us call it by its more typical name stress. Both workplace anxiety and exercise are types of stress. Both trigger the fight/flight hormonal signature. This similarity is one reason why it is not great to exercise soon after eating, as the exercise signals a switch from digestive processes - digestion, as we have seen being turned down so blood moves from gut to limbs to support movement processes – before our food is digested. For the body, these hormones are simply supporting requirements for movement to be optimized.

The difference between exercise stress and workplace stress can be duration. A bout of exercise creates a short or acute bout of stress. The very act of exercising, however, simultaneously *responds* to those hormones. When the exercise is over, the hormones shift to support the new state. In workplace stress, the perceived threat or stressors can become chronic, enduring, the norm.



The 11 Completed: Respiratory, Urinary, Reproductive (Female)

Chronically elevated hormonal patterns as noted mean that the body is not getting a response that says the situation has been addressed so that we are out of threat. In Goleman's terms the longer the amygdala is hijacking the rest of the system, the longer we can be in distress.

Thus our bodies are in a state of chronic threat, with a chronic hormonal ON sending signals that: keeps us from sleeping, digesting food, having sex, or seeing or hearing outside a narrow field of focus. We asked in the section above, what happens if we are wound up to fight or flight, but we do neither and have only a chronic ON signal to do so – where that chronic signal keeps getting louder but unheard? Eventually, chronic hormonal on's cause us to break. We see this in the rise of sick leave due to stress and its associated metabolic syndrome and cardiovascular risk.

For cognitive performance, there are considerable opportunities in designing to respond to the chronic stress response. We look at these below, but first, let us consider our usual response to stress and how, while driven by the brain/body connexion, it works against the brain/body connexion.

Intellectualizing Stress vs Physically Responding

Culturally we have learned that a physical fight is rarely appropriate. Verbal fights can be equally problematic, though more common. Verbal fights often demonstrate the various side effects of our hormonal threat response, of various systems being heightened and others shutting down.

Consider the typical thinking in a stress/threat situation: that person *hates* me (I hate that person); I can *never* get a break. Your *always* pick on me. A psychological framing for this kind of talk is the language of the child: all vulnerability and extremes – always, never, hate, love.

In terms of threat response, this language reflects cognitively that physiological narrowing of peripheral vision, of ability to see options, and that we may be erasing times that clearly contradict the "always" or "never" of our very narrow recollection in that moment. This focus on the negative is not a surprise, once we understand the physiological response driving it: in the narrowed vision of threat, we only see what is salient, the threat and the pattern of threat. In the high/low road framing "you *never* listen to me" suggests that the amygdala recognized this exchange as an established threat pattern, potentially feeling caged/trapped unable to get through/communicate.

In these stress contexts, we are not wired to focus on something positive if it is out of our immediate field of view. That distraction may be experienced as a risk, and one our bodies are telling us to avoid. The trigger is fight or flight; not reflect. And yet, it is just such cognitive, intellectual processes we are often encouraged to pursue when experiencing stress to relieve that stress: try to see the good in a situation; think of a happy place; meditate.

With the best of intentions, these strategies make life harder for us than it needs to be: our very body-based responses to perceived threat are most immediately mitigated by body-based responses. In the case of stress, we need to move. Movement, getting out of a chair, getting the heart rate up – like flight – tells the body we have heard the call to protect ourselves, and we have removed ourselves from the situation.

Increasingly, tactical self-defense courses take exactly this approach: they design movements in a threatening situation to work *with* these reactions rather than try to work against them[4].

Recently as well cognitive behavioural "mindfulness therapy" has attempted to disarm such situations

Pre-Historic Shore Life: Red River, EaLF-1, mc

Working as site archaeologists along the Red River locks in Canada, we saw rich examples of pre-historic (i.e. pre about 1600) shore based, creative life as per Cunnane's model: fishing (evidenced by layers of fish scales in middens); trade (evidenced by pottery patterns from different communities along the river) and skills practice (evidenced by some outrageously crooked projectile points also ending up in middens). Artefacts from such meetings go back thousands of years, up to the present (see fishing in background, above image) Hunting the more elusive deer or bear becomes more of a special outing than a necessary component of spring/summer/fall survival.

before they happen: to help the person recognize a pattern and therefore be able to step outside of it [20]
If we consider the high/low road response, we can see Mindfulness therapy as an attempt to get a person to the high road. What we know again from tactical defense training is that that would take a great deal of deliberate practice to re-see patterns previously seems apparent that doing that deliberate practice outside of we take our work/stress home with us or our home/stress to work with us, finding that space may become a challenge.
Unless we begin to walk to work.
In other words we can begin to use the body/brain connexion more deliberately to deal with the body/brain connexion for optimizing cognition.

Threat Response Takeaways
We have five takeaways about from threat detection and response that show us how tightly coupled the brain/body connexion is for cognition

1) Based on the high/low road model, these responses are at first *reactive* – pre-cognitive; they happen without our conscious awareness; they will *influence* what is translated into a cognitive response; they will strongly affect our cognitive perception.
2) They are immediate: our nervous system responds all the time and immediately to our environment triggering cascades throughout the 11 systems from hormones, that affect musculo-skeletal, cardio-vascular, intestinal, immunological, nervous processes.
3) As focus narrows, our ability to be creative, to be cognitively effective, is compromised to the degree our bodies are responding to threat.
4) Our environments can induce these threat reactions from cultural practices to physical systems: if a particular context matches a threat pattern, we have a threat response; if a physical situation inhibits a threat clearing response (like fight or flight) we may be stuck in that response.
5) Being in a chronic state of threat will cause us to break.

THREAT AND COGNITION/CREATIVITY

From these takeaways we can see that creativity and problem solving fundamentally requires being able to see options. Stress – whether acute, such as nerves before a talk, or chronic, like feeling constantly under pressure at work – is a global descriptor for a threat response that reduces our creative, problem solving performance capabilities, not the least because it shuts down our ability to generate options (we physically no longer see a wider, or peripheral, field of view).
Maintaining this wider field of view, the necessity of being unstressed to be creative, is supported by work around flow[23], play [21] our evolution [[3]] and applied tactics like the OODA Loop [14]. Each of these framings runs counter to the usual narrative of how and why we developed big brains, and particularly relevant here, the tools, the cognitive problem solving devices, that emerge as the product of those larger crania.
The usual Big Brain narrative has been that we developed tools to deal with an hostile environment: skinny hairless apes are no match for lions and tiger and bears. Therefore, under duress of the requirements of the hunt, to kill or be killed, our creative genius sparked, and lo! spears, fire and bigger brains.
Based on what we have just seen about the older, pre-neo-cortex brain being the first to fire to detect threat – of which a large response is run away – it is hard to imagine that our ancestors had the mental space to

The Laser Pointer Episode

At a recent guest talk, a colleague, well prepared for his lecture, had techno failure with his a laser pointer he had used for years. He coolly asked if anyone had new batteries, and quietly attempted to change them. Didn't work; he opted to let go of the device and get on with the talk. I asked if I could have a go. Unlike him, I had the time and relaxed state to look for the outrageously tiny demarcations that indicated which way to align the batteries. I also had time to test these markers – as it was not entirely clear in fact the marker for "+" was a + for that end of the battery. It worked. As suspected, the batteries had simply been put in backwards. Even though familiar with the device, his wee bit of stress reduced his ability to fix this problem. Not a bear; not a spear, but still a stress- induced options failure.

craft ingenious tools if daily life were experienced as living in constant danger.

In his research in the development of the brain[6] Cunnane makes the case that we developed big brains not because we were threatened around every corner for our survival but because, at some point, we gained a steady, secure food supply. He refers to a shore based economy where a variety of food sources including fish, bivalves, shore vegetables and so on were readily available. In other words, plenty of food sources that do not pose the risk of turning the hunter into prey.

In relation to the development of the brain, in particular the neo-cortex, a safe food supply means two essential things for big brain development: (1) plenty of calories, essential for the growth of our huge, fat-based brains and (2) a temporally safe space for an incredibly physically vulnerable/incapable human infant to learn and explore and be nurtured, allowing the brain the time and stimulus to develop. A safe environment for our cognitive development, in other words, means that *play* is possible.

Play, researchers like[21] argue, is essential for our cognitive wellbeing. And play, taking risks in a risk reduced environment to explore options, new ways of problem solving, of invention – we can see from the above discussion of stress, is only possible outside of threat. This is not to say that stress does not have a role in invention/play. As the theory of Flow notes[5], one must be sufficiently challenged to remain engaged. But too much stress is debilitating.

Sport is a tremendous model of play, flow, challenge, and as I have recently proposed, a potential research challenge to translate the practices of the field to knowledge work environments [17]. Sport is a terrific way to see the balance between sufficient challenge vs too much stress. Wimbledon for example regularly shows how great tennis players can "fight back" from being two sets down to come back and win. We are told they "find an extra gear." The best players also make "impossible shots" on the court, when skill and practice support dynamic creativity to "read the court" rapidly. We also see exceptional players collapse with one opponent where, in similar situations with another, they have succeeded brilliantly. Post game interviews say they were tired or nervous. Too much stress to read the court, apply their skills.

Threat *mitigation* for cognitive performance.

These evolutionary insights around environments that support cognitive growth and invention motivate design challenges for mobile cognition, for cognition that seems at its best when on the go: not only how can our designs reduce or mitigate threat, but how can they help create not just interactions but environments that sustain play? A first principle of our designs, based on the brain body connexion, may be to move, to support cognition on the go.

Just as the induction to threat is physiological, mediated throughout the body via hormonal signals that trigger other physiological responses, the responses to threat, to reduce it, are also physiological. For example, a fantastically effective response to stress, of fight or flight, is to do what we are primed to do: to flee. We can walk up and down stairs; go for a walk; find a bathroom at the other end of the hall. When we move, especially at a vigorous tempo sufficient to raise our heart rates, other hormones are signaled to say the threat is being addressed; that we are responding – just like with exercise. We are responding to the signals. With that response, the threat response hormones can, effectively, stop yelling.

Teacups at Dagstuhl

At a recent Dagstuhl seminar on designing for health and wellbeing [*], in an effort to walk the talk, before breakfast, many of us went for an easy 5k run, lead by Jochen Meyer. We reorganized the room seating to enable standing without interrupting anyone's view. Ad hoc standing desks were created with wine bottle crates. Before sessions, we did a whole body movement known as a "teacup" [**] (shown above). Before dinner, we had a playful "burn for the beer" 20-30 min body weight workout.

*http://www.dagstuhl.de/en/program/calendar/semhp/?semnr=15262

** https://youtu.be/-ffpcRxWgsg?t=29s

As we slow down our movement, come off a vigorous stair climb, we notice our heart rate and breathing slowing, our vision widening and our hearing broadening as well. There may even be a euphoria.

In terms of enabling cognitive performance, we can begin to see why, as presented at the start of this paper, walking meetings may be beneficial for coming up with new ideas: they will, automatically and of necessity, diffuse stressors, whether these are fear of not fitting in, or fear of running out of time to complete and let us restore the wider view.

The act of walking together, falling into step, synchronizing, also triggers another fundamental hormone, oxytocin, key in social bonding[22]. We build trust more readily when we walk, sing, play physically together – act in the physical world, together. While we have options to walk or sing to release oxytocin, optimizing on walks has multiple benefits: building trust and de-stressing.

Another aspect of walking is that if we also look up while doing so, help our posture to be erect rather than flexed, we also signal to our brains that we are feeling less vulnerable – we are not, as I put it "protecting the squishy bits," but signaling safety and security.

Consider the stereotypical signals of success in sport at the end of a challenge: chest out, both arms raised to the sky, a mighty "YES" of expression.

In terms of design, from this posture's effect on perception of safety and confidence, we can also see why working at a whiteboard may help one generate more ideas than working at a computer: not only are we upright, extended, we are also making larger limbed gestures, moving, and opening a field of view, all of which has benefit for cognition, for creativity.

With this model of movement as a stress buster, we may better understand why, from research presented at the start of this paper, people with a lifetime of aerobic movement practice perform better on exams over the course of their lives than those who do not.

We can begin to understand why: stress has a physical cost: as we have seen it effects each system of the body, especially as acute stress bouts turn more chronic. The aerobically fit seem to have several advantages over the sedentary in dealing with stress. First their training gives them greater physical and psychological endurance than less aerobically fit. As we have seen, their physical practice itself will help them "blow off" stress responses. Their threshold to be triggered by stress may also be chronically higher than a sedentary person's, who may be in a more constant state of low grade threat for the reasons discussed above, and thus chronically less able to break out of threat-based focus to see options. Those with a history of sport may also have more practice with more types of threat, of being challenged on the field to respond with *quickness*.

Daily stress combined with sedentarism physiologically simple shuts down those cognitive processes that allow better problem solving. Movement seems both to reduce onset in the first place and offers strategies to mitigate it when it arises. A research and design challenge for mobile cognition again, how keep us in motion, as it were, thinking on our feet?

In5 - Move Eat Engage Cogitate Sleep = resilience to brilliance

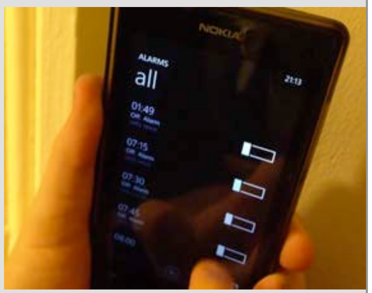


Figure 6 Kill the alarm: in5 pilot with Ogilvy Labs to improve sleep (tinyurl.com/in5ogilvy)

Movement is a key factor in health and wellbeing. Supporting movement is key to this paper's argument for cognition. It is our fundamental driver, but as presented elsewhere [18]it is also one of five fundamental *in-bodied* processes that support the brain/body: we need to move, eat, engage, cogitate and sleep. Improve one, the others improve as well. The role of interactive technology to support in5 asks for novel approaches. For instance: what is an un-alarm (Figure 6) to support sufficient sleep?

Figure 5 Whiteboard wall paint, sit stand tables, kettlebells, eyecharts and lots of coloured pens (mc's office may2015) enable planned and opportunistic solo and collaborative mobile cognition work. What are the interactive technology opportunities here?

Wrap: Mobile Cognition; Mobile Being

Mobile cognition tends to focus us on a concept of mind in the abstract, and usually just the brain if we think of the body at all. In this brief overview, I have illustrated two key ways in which the brain is part of the body: (1) pre-conscious threat responses affect the entire body, including the brain (2) preconscious THREAT reactions critically trigger a cascade of reactions throughout the brain/body system that all affect our cognitive performance. I have also suggested two ways that mitigate this threat response: in an acute, in the moment response, movement helps, for reasons addressed above. To sustain a chronically creative, cognitive environment, based on research around flow, play and the evolution of the brain/body connection, it seems a basic place to start is to design for opportunities to move *more*, and more of the time, playfully, collegially. Hence the titular proposal that our interactive research and design for optimal cognition, will be *mobile* cognition, cognition on the go. But to foreground the IN-bodied-ness of the brain, in the brain/body connexion, our work may benefit from considering the mobile *being* first.

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