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Abstract. This position paper argues how there has to be much more to smart city learning than just wayshowing, and something better as augmented reality than covering the world with instructions. Attention has become something for many people to know better in an age of information superabundance. Embodied cognition explains how the work-ings of attention are not solely a foreground task, as if attention is something to pay. As digital media appear in ever more formats and contexts, their hybrids with physical form increasing influence how habitual engagement with persistent situations creates learning. Ambient information can just add to the distraction by multitasking, or it can support more favorable processes of shifting among different kinds of information with a particular intent. As one word for this latter process, foraging deserves more consideration in smart city learning..

Keywords: attention, embodiment, habit, foraging, form, situation, architecture

1 Introduction

Augment reality, perhaps, but do not cover it with instructions! The topic of smart city learning invites this position. There has to be more to urban digital media than tags and descriptions for purposes of navigation. An emphasis on learning invites designers and researchers to reconsider the workings of attention.

Good learning goes beyond first time usability or passive instruction. It depends on active social participation in appropriate, purposeful contexts. It cultivates agility with different kinds of information. Pervasive media may alter these dynamics, and increase the importance of engagement with context. As interaction designers know from activity theory, aspects of embodiment, habit, and tacit knowledge all increase engagement in ways quite different from foreground tasks with symbolic media. Especially for habitual engagement in the spaces and places of everyday life, much more knowing and mastery exists, or needs to exist, than simply being shown how to get around.

Although many people do use cities without much familiarity or skill, whether as first time visitors, displaced global workers not very assimilated to where they now live, or as anyone usually focused on urgent tasks at the expense of general awareness, this is not justification to treat everyone so, nor to assume that such people prefer to remain so. Instead the design and cultural challenge of ambient technology for smart city learning involves deeper, more habitual, more satisfying use, for

becoming more at home: city as medium; citizenship as participation; learning from everyday rounds; with foraging very important; and with ambient, tangible interface as a more subtle new set of triggers.

2 New Triggers, Different Overloads

Urban experience has been changing for the better, at least relative to past phases of industrial pollution or automobile obsession, as digital media play important roles in in making the city more usable. Information media now appear in more formats, more contexts, and more everyday activities than ever before. Today's handheld mobile media have become the new obsession. Much as with previous obsession with automobile monoculture, this may take decades to reveal its hidden costs. But at least one cost is apparent in disconnection from surroundings. So right now, one immediate design challenge for urban computing is to assert how there are situated technologies too. The mo-bile meets the embedded in the city. Instead of disconnection, new kinds information channels and interfaces now interleave with material objects and settings. Cities have always been complex and overwhelming, but this recent development may well change how. This seems like a good time to rethink learning and attention in urban contexts.

Any sense of overload may be changing too. Whereas the industrial city filled the senses with pollution effects of noise, soot, and bright lights, and led to a new kind of blasé made famous by the sociologist Georg Simmel [1], today the informational city fills the senses with effects that have been designed to appeal, and placed with a purpose. Although earlier industrial side effects may remain, generally they are receding, and can sometimes be masked, as by the use of headphones; whereas media effects are advancing, and they are experienced voluntarily. Altogether, never has more of the human perceptual field been cognitively engineered. So while many people still lament overload, often the greater problem is overconsumption [2]. As with salt, fat, or sugar, humans have an innate preference for something which was once rare but now is abundant, and so they now take on far too much of it. One more accepting word for today's condition (at least in the well-developed cities that are the topic here) is superabundance. Living with a superabundance of information is one best way to characterize these times.

Whether a superabundance of situated urban information leads to learning or just to distraction has to be a matter of design. This design challenge differs from previous approaches to information technology, where that was something to sit down to, usually in the workplace. Now you have to live with, even in, the results. The design challenge of urban computing must give much more emphasis to habit, embodiment, and attention.

3 A Matter of Attention

The importance of attention practices cannot be underestimated [3]. New triggers of ambient, pervasive, situated, tangible, urban computing push it to the forefront.

Every-where people try to handle ever more information as if that doesn't cost anything. So it is worth reciting the well-known warning from cybernetic pioneer Herb Simon, forty years ago: "...[In] an information-rich world, the wealth of information means a dearth of something else: a scarcity of whatever it is that information consumes. What information consumes is rather obvious: it consumes the attention of its recipients. Hence a wealth of information creates a poverty of attention..."[4]

As today is not so much an information economy as an attention economy, it follows that more people need to become mindful of attention. There are many kinds of attention, of course. Too many practices assume some of these and not others. Modern broadcast culture advances a belief that attention is something you pay. Advertisers assume attention is something to buy, and that it is mainly visual; everyone competes for eyeballs. Desktop computer media for the workplace assume attention is foreground, deliberative, thought. Social criticisms of overload and distraction, especially in con-texts of learning, assume attention is a span that is increasingly divided, even stolen. People distrustful of cities find them full of assaults on the senses, and so a source of much involuntary attention. Technology designers thus usually assume that media us-age is disconnected from context, and takes people out of context, often for the very purpose of tuning it out.

All of these lead to the popular misconception that attention is like a spotlight—a directed focus that illuminates—and a limited resource for which there is great competition. Because vision jumps around, people assume attention jumps around too. Although misconceptions about multitasking and “digital natives” dominate many debates about attention and learning [5], it is safe to say that at some level, especially for executing tasks, the workings of attention involve biologically fixed processes for allocating mental resources. Limits do exist.

This does not mean that switching among stimuli always detracts, however. For when using many different kinds of information, some of them intrinsically embodied in context, their differences might just reinforce one task. Whereas too much consideration thus goes to multitasking, and too little to the use of multiple information channels for ongoing particular intents. This effect seems welcome, for example, amid activity also done for its own sake, like talking a walk (figure 1).



Fig. 1. Foraging involves unplanned movement among proximate patches of relatively rewarding information. These patches may be physical areas, co-present media, immediate social con-texts, or any combination of these. This process works especially well when moving about, as on a walk.

The workings of attention also involve capacities of basic awareness and orientation. Even focal actions may involve presence, configurational knowledge, and acquired mastery of context. Learning researchers may understand these as “spatial ability.” (There is much research literature on that, but from a generation ago, when understandings of embodied attention were more primitive [6].) The exercise of spatial ability can be satisfying, as if it taps latent skills. These come out amid socialization, sport, craft-like work practices, or enjoyment of place. Here it is fair to speak of “effortless attention” [7]. Under the right circumstances, increased engagement comes with decreased sense of effort at staying focus. Interaction designers understand this as flow.

So here is another way to say that something important has changed when media appear in so many more formats and contexts. Instead of persistent focus of foreground tasks (which definitely produces a sense of overload), today's reality of attention involves many more shifts—among media, between foreground and background perceptions, and so among different kinds of attention. Although this means attention can feel badly divided, it also means attention can shift comfortably before it fatigues from one mode, and can use proximal cues to guide where. This means that attention to surroundings can help give scope and sustenance. While at one level this may seem trivially obvious, how context helps learning, nevertheless at another level there is a subtle new design challenge, one that has to do with diversification of information contexts and formats. What happens to the dynamics of attention as mediation and objects interleave and remain persistently in particular places?

Among designers and theorists of information and interface, one increasingly important word for this contextual sensibility of switching among channels is foraging [8]. This idea has been recognized among researchers for twenty years, but now comes into more widespread consideration with the rise of urban computing. In contrast to searching, where you know what you are after but not where; or browsing, where you are open to whatever might appear interesting; or navigating, where the goal is to get somewhere; foraging involves tacit knowledge of environments where you might both find something good, and get relatively more of it there, relatively conveniently, enough so that this process of access might influence your intent. Foraging thus belongs to an economics of attention.

Two ideas that information scientists often link to foraging illustrate its natural, environmental qualities [9]. “Patches” are relatively persistent contexts in which returns are relatively good. Those contexts can be proximate areas but also co-present media. To forage is to move casually among patches without trying to clean out any one, without trying to decide which is the optimal one, and with tacit knowledge of when to remain and when to move on. “Scent” is a word for continuity of proximal cues, as when leading from one patch to another. Prominent data in the environment inform what else might be found there, whether to value and remember a patch, and whether to remain at one for the moment.

As an information practice for habitual mastery and learning, foraging seems more pertinent than more usual, non-contextual notions of multitasking. Foraging does better at integrating physical and digital media, and at self-regulating overconsumption or overload. To understand the relevance of foraging to smart city learning, it helps to approach the question of attention from the scope of embodiment.

4 Understanding Embodied Cognition

Anyone alive in an attention economy who would wish to understand the workings of attention might benefit from considering a turn in the cognitive sciences known as "embodied cognition" [10]. After a decades of emphasis on symbolically processed knowledge representations, the cognitive sciences now also admit of other processes of attention, engagement, and more tacit kinds of knowledge.

The widely-read roboticist and cognitive scientist Andy Clark has explained this as well as anyone. "In general, evolved creatures will neither store nor process information in costly ways when they can use the structure of the environment and their operations upon it as a convenient stand-in for the information-processing operations concerned." On the nature of engagement, Clark summarized: "memory as pattern re-creation in-stead of data retrieval; problem solving as pattern completion and transformation; the environment as an active resource, and not just a domain problem; and the body as part of the computational loop, and not just an input device" [11] (figure 2)..

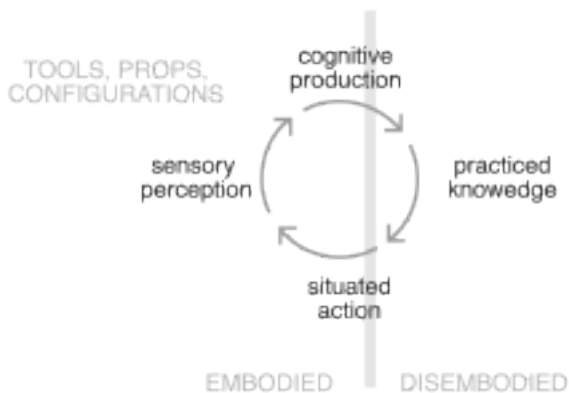


Fig. 2. Embodied cognition does not just use sensory perception as a one-time input to higher mental processes but instead continually makes use of environmental features as building blocks for thought.

When the environment is an active resource, and not just a preliminary input to mental processes based on non-contextual knowledge representations, this has implications for learning. Not all learning requires names and procedures for things; some practices are better learned through active engagement than from passive instruction. For example, it is said that seeing is forgetting the name of what you are looking at. You can catch something thrown at you before recognizing what it is. You can sense that a surface might work as a step or a table without it having been designed or declared as such [12]. Much of this has long been familiar to educators, to managers, and to artists and designers. Know-how complements knowing-that; reflection-in-action makes activities into ends-in-themselves. Moreover, the rise of rich digital media has tipped this balance; tacit knowledge plays on dense notations and diversified data streams. Know-how is not just for an underclass of artisans. And

as universities increasingly recognize, project based learning and the cognitive role of context have become much more important than they were formerly thought to be.

At least as interpreted by interaction designers, embodied engaged activity allows a continual rebalancing of internal and external knowledge representations [13]. External tools, props, and circumstances act as internal tools. The interplay of internalization and externalization allows developed ability to adapt to changes of circumstances. This lets experts play situations in an adaptive back-and-forth way that gives external components an active role in knowledge, and that continually unites perception, action, and knowledge. That in turn cultivates sensibilities, and with them changes in the practices of attention [14]. That shifts the role of interaction design beyond casual usability by beginners toward mastery by habitual stakeholders. It also makes it more important to make technology part of the environment. There the discovery of useful circumstances depends on a cultivated situational awareness that is different from mere instruction.

5 How Form Informs

Now turn from these general ideas of embodiment and attention toward the role of architecture and the city. It is said that people need to get to know their world better, and to do so on foot. "Environment" is not just someplace far away, without people and technology; it is also close at hand. A better built world has become one of the main de-sign challenges and opportunities in any larger environmentalism. This is not just a matter of wasting fewer resources but also, more fundamentally, of noticing surroundings once again.

This taking notice may begin with a re-engineering of physical comfort. Too much of twentieth century building assumed that warmth, air, and light were best unnoticed; but such uniformity is neither attainable nor affordable nor sustainable nor healthy. With the benefit of more finely adaptable sensor-actuator systems, a smarter, greener architecture may resume the role of providing delightful, grounding contrasts in atmospheric experience. This approach to ambient interface may cultivate other sensibilities to variety and engagement in surroundings. Smart city learning might begin with a rediscovery of simple environmental operations. An act so simple as being able to open a win-dow or roll out a sunshade may cultivate larger sensibilities to the participatory adaptation of surroundings. Such tasks are a benefit (and not a burden) to larger mindfulness with attention.

In its next most fundamental role, the built environment configures groups or people for particular activities, and expresses the intent, the social standing, and the work practices behind those [16]. This is especially the purpose of urbanism. And per Benjamin, all this is experienced habitually, in the background [17]. It exercises spatial abilities of social distance. Sophisticated urban citizens know better than suburban internet addicts how far to stand from one another, when to share civil attention or inattention, and how to use a sidewalk well.

Now besides these most basic anthropological facts of social distance, the built environment also configures space, people, and their expectations for high specialized

activities. This is why architects' most usual services are to institutions. There the discipline of interaction design has grown to understand communities of practice quite well too. One word for how context informs a community of practice is sensemaking. One core belief among interaction design is that experts don't necessarily follow procedures; instead they play situations. The sociology of sensemaking explains how groups act their way into understanding of what is going on [17]. This tends to involve much tacit knowledge. It also depends on habit. An expert can tell what is different about a situation this moment. A group that has become habituated to a context can use a lot of its structure tacitly instead of relying on more obtrusive (and often overconstraining) names and procedures for conditions. This is clearly an instance of embodied cognition.

Especially in mobile activities, sensemaking may also be understood as an application of foraging [figure 3]. Spatial abilities tend to readjust constructs constantly in response to situations; spatial mental models are seldom singular, metric, or disconnected from action. Instead, the workings of attention shift frames of reference to recombine components of knowledge representations with components of less articulated cognition of current environment. They also shift among form and media in the environment, and among patches of scope-giving circumstances. As is often the case, foraging occurs as a part of other activities, that give it purpose. One does not intend to forage; instead the process occurs amid other intentions, and sometimes shifts those intentions.



Fig. 3. Foraging as an attention practice, possibly amid sensemaking processes, with shifting frames of reference, and as a part of situational awareness.

Habits and familiarity matter a great deal to such agility. These let stimuli recede into the background. In terms of foraging, habit builds knowledge of patches [18]. At some fundamental biological level, the role of embodiment in habitual context has far more impact on sensemaking than information technology design has realized. Although this may invite the “digital natives” argument (that attention practices are fully adapted to whatever media landscape people grow up with), remember that attention resources have their limits, and despite its amazing “neuroplasticity” the brain cannot become just anything [19]. Moreover many of the existing capacities that support attention’s diversity depend on persistent structures, often physical context, and do not work so well when almost all the perceptual field is fast, changeable, and mediated.

Regrettably, too much information technology design assumes that habit is inert, resistant, and unteachable legacy, that must be cleared away with algorithms, ontologies, and instructions. In worst cases, these informational measures eliminate the possibility of physical context playing a role, and so preempt some development and use of tacit knowledge. Here is a case of "augment reality, perhaps, but do not cover it!"

For an easily understandable argument of how an information overlay can activate (or be activated by) a built environment, instead of ignoring or replacing it, consider the theatrical principle of *mise-en-scène*. Digital cities pioneer William Mitchell argued this very well, as "placing words." To shout "fire" in a crowded theater means one thing, he wrote; to shout "fire" to a squadron of soldiers means another; to affix a "fire" label to a plumbing fixture indicates where to hook up a firehose; but "if I receive the text message fire on my mobile phone, at some random moment, I can only respond with a puzzled HUH?" Many words refer to or take scope from the places in which they are ex-changed. A dramatist would understand this as *mise-en-scène*: a script needs a setting; objects provide orientation. "The meaning of a local, spoken, synchronous message is a joint product of the words, the body language of the participants in the exchange, and the setting." Mitchell explained. "But the introduction of technologies for inscribing physical objects with text, and the associated practices of writing, distribution, and reading, created a new sort of urban information overlay. Literary theorists sometimes speak of text as if it were disembodied, but of course it isn't; it always shows up attached to particular physical objects, in particular spatial contexts, and those contexts, like the contexts of speech, furnish essential components of the meaning" [20].

Not only may physical form help construct meaning of transmitted data, but in some cases it can inform without any data transmitted at all. Light in the east means a day is coming. Tracks in the snow reveal that someone has walked by. A warm stone plaza out of the wind suggests sitting down there. As the epistemologist and information ethicist Luciano Floridi has explained, such "immanent data," where "immanent" means that the form or structure of some phenomenon is coupled to the state of another, should be recognized as "environmental information" [21]. The world often informs without any messages being sent. This is especially true where the form of one phenomenon indicates state of the other, as fingerprints left at the scene of a theft indicate who were the thieves. When a bike rack has been placed outside a café, you don't need instructional signage to park your bike there, nor a "this side up" instruction label to remind you how to park it.

6 Rethinking Urban Contextual Learning

Just as there have been misconceptions of attention and cognition, there may be some misconceptions about smart city learning. Much as some aspects of attention in context may seem trivial and obvious at first, but now involve subtle challenges from ambient information technology, so for some aspects of learning. Consider four.

To begin, learning cannot be dominated by disembodied visual media. Perhaps it never was, but now more is known why. Engagement of physical props, situations, and tokens remains too important. Tacit, pre-ontological knowledge has too great a role. But where before media were separate from the world, or were the application of organizations and procedures to straighten a messy world, today they instead become part of it. Computation increasingly becomes part of things not thought of as computers. To some designers, these hybrids make information seem like just one more material of objects and situations [22]. More so than any independent stream of data, this hybrid form, scale, and *mise-en-scène* is what informs, and supports richer learning. One *de-sign* challenge for urban computing is to use the intrinsic structure of situations more effectively; another is to cast local data into forms that are less demanding and more immanent.

Second, learning cannot be dominated by any one information channel, even an embedded one. The ability and desire to shift channels couples with an agility to shift and corroborate different kinds of attention. Although there are abuses for the pleasure of multitasking, there are also advantages in shifting frame of reference, in coupling orientation with execution, or presence with deliberation, that immersion in any one channel does not afford. (That includes immersion in built surroundings without any information overlay—those would be less usable.)

Third, actively situated learning involves intentionality and not just behavior. As activity theorists like to emphasize, settings are not just for particular purposes but also about them. As architects like to emphasize, true architecture is not just any persistent configuration but especially one with intent. The urban designer's intent is to set the stage, not to induce predictable behaviors. The citizen's intent is to forage the unofficial, cultural, and resource sharing prospects of the city. Meanwhile, as developmental learning researchers have shown, intent and goals do affect environmental knowledge acquisition. Tacit knowledge of urban places does not just consist of gradual additions to a unified, metric mental model, but instead involves series of adjustments to previous constructs. Mental collages of patches environmental knowledge emerge around habitually and intentionally encountered places of engagement. Moving around such mental collages, and jumping from one media patch to another, is less a matter of navigating or browsing than of foraging.

It is worth repeating that urban media overlays must not be reduced to wayshowing or other forms of instruction. Because and because learning goes beyond navigating, because processes of sensemaking, habituation, and intentionality are so important to the engagement necessary for richer learning, and because increasingly diverse and ambient media may help or hinder those processes, the design challenge of smart city learning must uphold these more masterful processes by inhabitants, against a technological boom in instructions to newcomers. You might think all this is obvious, but from the looks of the locative media business, it is not.

7 Toward a New Kind of Commons

To summarize: form informs, and to inhabit habituates. Any new overlay of information mediation must respect and trigger these processes, and not mask or prevent them. Smart city learning practices must respect form and habit, and with them many of architectures cognitive roles, as ways toward a higher, better version of urban computing than so much instruction and wayshowing, as if people were utterly without spatial abilities and environmental knowledge without those. As ever, but with an increasingly vital impact, the design challenge of pervasive computing is to use technology to under-stand and use the world, not to overcome or tune out from it.

Learning how to make use of the city in ways where engaged, flowing attention becomes an end in itself cannot be reduced to tourism, entertainment, or tagging everything with opinions. As many early researchers, conferences, publications, and exhibits on urban computing and ambient information arts have begun to demonstrate, many more substantial applications exist. Many of these involve learning about the flow of resources, energy, people, and goods. A public education in industrial ecology has begun to occur. Many researchers advocate citizen science. But with respect to attention, perhaps the first step is to get beyond entertainment to a quieter, better fascination, and in doing so, to get beyond a distracted multitasking of disembodied media to a more mindful, still playful foraging of media and architecture about the resources at hand.

Technologies, products, services, and cultural productions do exist for urban foraging, as for many other applications of urban computing beyond wayshowing. Everyday bike and car share systems do so for instance. Design laboratory prototypes and public art pieces have successfully demonstrated a rich range of genres for urban computing, as in environmental monitoring and public eco-feedback, spontaneous gathering and crowd-sourced events, neighborhood lore, museums without walls, finding a parking space, and many more. A galaxy of researchers, curators, critics, and communities of practice steadily grows around these.

In the economics of attention, a famous paradox states that the solution to too much information usually is more information—metadata, filters, anything that gives scope and validation to the data at hand. Less often noted, the intrinsic structure of the built world provides an important component to such information. People who lose awareness of the world are often the very ones lamenting overload. Something about fascination with the world grounds other media practices and restores some capacities of attention. Taking notice of surroundings, which at first seems like one more outlay of attention, may have overall benefits on overall practices of attention.

Ultimately, this is perhaps a new kind of thinking about commons. When interfaces with the city have both personal and cultural benefit, and one's own attention practices become understood as a relation of those effects (instead of escape), this creates thoughts of a commons [23]. Yet a tangible information commons differs from a dis-embodied cornucopia information commons, and from a depletable pooled resource commons. Its stock is public places; its fluxes are media practices there; its self-governance micro transactions have to do with the economics of attention. This is

not so far fetched an idea as it first may sound, given the progress made in the last twenty years on such ambient concerns as light pollution, signage law, or smartphone etiquette. Now as more people take notice of surroundings, the superabundance of ambient in-formation forces people to be more mindful about attention, both in their individual practices and at some cultural level of governance. This position paper has argued how learning, mastery, and richer plays of attention support and accelerate such advances.

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