Creative Practices Embodied, Embedded, and Enacted in Architectural Settings: Toward an Ecological Model of Creativity

Laura H. Malinin*

Department of Design and Merchandising, College of Health and Human Sciences, Colorado State University, Fort Collins, CO, USA

Memoires by eminently creative people often describe architectural spaces and qualities they believe instrumental for their creativity. However, places designed to encourage creativity have had mixed results, with some found to decrease creative productivity for users. This may be due, in part, to lack of suitable empirical theory or model to guide design strategies. Relationships between creative cognition and features of the physical environment remain largely uninvestigated in the scientific literature, despite general agreement among researchers that human cognition is physically and socially situated. This paper investigates what role architectural settings may play in creative processes by examining documented first person and biographical accounts of creativity with respect to three central theories of situated cognition. First, the embodied thesis argues that cognition encompasses both the mind and the body. Second, the embedded thesis maintains that people exploit features of the physical and social environment to increase their cognitive capabilities. Third, the enaction thesis describes cognition as dependent upon a person’s interactions with the world. Common themes inform three propositions, illustrated in a new theoretical framework describing relationships between people and their architectural settings with respect to different cognitive processes of creativity. The framework is intended as a starting point toward an ecological model of creativity, which may be used to guide future creative process research and architectural design strategies to support user creative productivity.

Keywords: creativity, architectural design, embodied cognition, embedded cognition, enactive cognition, affordance, ecological psychology, niche construction

INTRODUCTION

Stories abound about how creative people feel their physical environments become part of their creative process. Kipling (1937) described in detail the office where he wrote and espoused the importance of his “working tools,” including obsidian black ink and a camel hair brush, as the “magic” behind his creativity. Marcel Proust wrote from his childhood bed at the Haussmann Boulevard residence, in a dimly lit room where he lined the walls and ceiling with cork providing protection from dust that triggered allergies and social intrusions that might distract him from his work (Fuss, 2004). Immanuel Kant habitually gazed at the Löbenicht church steeple from the window of his home at 87–88 Prinzessinstraße and, feeling so strongly its importance to his creative process, insisted his neighbor’s tree be cut down when it grew to obscure his view.
Creativity is typically described as extraordinary (defined by ideas that are a significant departure from those in the field) or everyday (encompassing ideas that are original to the person or persons who conceived them (Csikszentmihalyi, 1996). Places designed to support creativity generally target users whose work is deemed creative by others, but may not be extraordinary (i.e., creative practitioners).

The gap in the literature as it concerns the physical context of creativity. Next, theories of embodied, embedded, and enacted cognition (the 3Es) are used to examine relationships between creative cognition and architectural settings. The 3Es serve to organize first person and biographical accounts of creativity around common physically situated processes. This organization informs three propositions about person–environment relationships during creativity. The propositions are illustrated in a new conceptual framework, integrating and extending prior theoretical work in enactive cognition by Varela et al. (1991) and ecological psychology by Gibson (1977). The framework describes the dynamic relationship between people and features of their architectural settings during situated processes of creativity, providing foundational work for an ecological model aimed at better understanding and predicting creative behaviors in designed environments.

**CONSIDERING THE PHYSICAL CONTEXT OF CREATIVITY**

Scientists acknowledge that creativity is a complex and multifaceted phenomenon that cannot be fully understood from the perspective of a singular approach or domain of study (Runco, 2007; Sawyer, 2012), yet the physical context of creativity has received relatively little attention in the literature (Hunter et al., 2007; Dul et al., 2011). In fact, much research conducted over the past century has focused only on certain aspects of creativity (Fryer, 2012), organized by Rhodes (1961) as the Four Ps: Person, Product, Process, and Press (environments supporting creativity). Within the press research strand there have been some efforts to understand how creative performance results from interactions between different dimensions of creativity, including social (but not physical) environments. Process research strands largely focus on purely mental operations, with consideration for the socially situated nature of certain creativity stages reflected in some recent models. Whether creative processes are also physically situated remains largely uninvestigated, with the notable exception being Csikszentmihalyi’s (1990, 1996) flow theory, describing a single creative process. From the architectural design perspective, there have been a few attempts to understand impacts of workplace designs on user creative productivity, however, studies are often limited to participant observations in the workplace, ignoring the wider social context.

**Architectural Design Strategies Promoting Creativity**

Social behaviors are frequently promoted in modern architectural designs intended to increase creativity. For example, in his
design for the Salk Institute, Kahn separated scientists’ offices (inspired by monastic cells at Assisi) from their laboratories, providing courtyard gardens between to host impromptu conversations he envisioned occurring when people walked between their workspaces (Kahn, 2003, pp. 71, 132–134, 142–145). Office buildings incorporate strategies to increase communication and collaboration by encouraging social density in ‘attractor’ spaces such as workrooms, atriums, and cafés (Fayard and Weeks, 2007; Yaneva, 2010; Sailer, 2011) and eschewing private offices in lieu of open office designs (Ekvall and Tångeberg-Andersson, 1986; Vithayathawongwong et al., 2003; McCoy, 2005). Research examining effects of these strategies is minimal and results contradictory (McCoy, 2005; Fayard and Weeks, 2007). Some studies find better information and idea exchange in private offices than multi-purpose rooms, cafés, meeting rooms (Grajewski, 1993), or open offices (Hatch, 1987; Vithayathawongwong et al., 2003) and others discover increased quantity and frequency of social interaction in open offices, but higher quality of communication (Ekvall and Tångeberg-Andersson, 1986) and greater creativity (Sailer, 2011) in private offices. There is no clear evidence of how spatial configurations might support creativity. Further, studies do not consider the full range of creative behaviors involved in different stages of creativity, focusing only on communication and social interactions as predictors of creative productivity.

Aesthetic qualities people believe inspire their creativity are a frequent subject in first person accounts, and studies show those environments people perceive as inspirational generally do increase their creative productivity (McCoy and Evans, 2002; Dul and Ceylan, 2011; Dul et al., 2011). However, identification of specific architectural features or attributes remains elusive. Scientists have examined people’s preferences for different design features in meeting rooms (Ceylan et al., 2008; de Korte et al., 2011) libraries, offices, living rooms, hallways, dining facilities, sports facilities, and retail stores (McCoy and Evans, 2002). Findings suggest people prefer rooms with natural lighting and views of nature (McCoy and Evans, 2002; Ceylan et al., 2008), but color and material choices are unclear; people preferred warm colors and materials high in visual complexity in one study (McCoy and Evans, 2002) but cool colors and low visual complexity in another (Ceylan et al., 2008). Hypothesizing that spatial arousal effects impact creative ideation, de Korte et al. (2011) found although red rooms are more arousing than blue and green rooms (as measured by heart rate variability), room color did not significantly impact ideation fluency. Mehta et al. (2012) find ideational fluency and originality improves in conditions with moderate background noise (such as found in a café), however, effects are not likely due to spatial arousal as first hypothesized, but processing disfluency (low level distraction) which increases abstraction, reduces confirmation bias, and consequently improves ideation. Anecdotes describe different types of places as creativity unfolds; yet impacts of spatial qualities on behavior and cognitive processes during different stages of creativity (from problem finding through product implementation) remain largely uninvestigated.

Process Models and Their Limitations for Informing Architectural Designs

Scientific understanding of creative processes has largely been informed by studying what eminently creative people do (or say they do) (Sternberg, 1999). Wallas (1926) developed one of the earliest and most enduring stage models from first-person accounts of creativity — a speech by German physicist Hermann von Helmholtz (pp. 79–80) and a book chapter written by the French mathematician Jules Henri Poincaré (p. 75). His model describes creativity as conscious (explicit) and subconscious (intuitive) mental processes involving stages of: (1) preparation, where knowledge is acquired; (2) incubation, a period of rest when knowledge is subconsciously restructured; (3) illumination, a moment of insight; and (4) verification, when an idea is evaluated and possibly applied. The Wallas model continues to be extensively referenced in the creativity literature despite criticisms it (a) neglects to identify all sub-processes of creativity and (b) does not adequately explain relationships between stages including how people sequence between them (Lubart, 2001; Fryer, 2012). This paper argues another limitation is it reduces creativity to mental operations, giving little consideration for physically situated processes.

Many researchers have developed their own process models attempting to address limitations of the Wallas model, including those cited in Table 1. Some identify additional sub-processes of creativity by dividing Wallas’s preparation (Osborn, 1953; Sternberg et al., 2002) or verification stages (Feldman et al., 1994; Csikszentmihalyi, 1996; Sternberg et al., 2002). Others propose entirely new stages, such as Evans and Russell’s (1989) frustration stage or Sternberg’s (2006) redefine problems (first) and sell idea (last) stages. Many models reflect a shift in thinking about creativity from purely individual to a socio-cultural process, incorporating social activities such as brainstorming (Osborn, 1953) for ideation and feedback from critique or use during implementation (Van Gundy, 1987; Mumford et al., 1991; Feldman et al., 1994; Isaksen et al., 2000). This social aspect of creativity is often reflected in modern workplace designs; however, when and how during the creative process social interactions improve (or inhibit) creativity remains unclear. For example, studies find brainstorming groups are less effective at generating ideas than the same number of people working alone (Diehl and Stroebe, 1987; Diehl and Stroebe, 1991; Mullen et al., 1991; Kohn and Smith, 2011), however, many people attribute social interaction to breakthrough on a creative problem (Johnson, 2010). Modern workplace designs are largely based in trends emphasizing ‘attractor’ spaces to provoke social interactions, with little understanding about how social interactions engender, support, or inhibit different creative processes, or sequences of processes — nor do they measure impacts these spaces have on innovation and organizational performance (Waber et al., 2014).

4Eminently creative people are frequent subjects of empirical investigation, but creativity is understood to involve ordinary cognitive processes (Ward and Kolomits, 2010).

5For example, a version of the Wallas model is incorporated in Amolyis’s componential model and the DIFI model.
Process models are explanatory, describing sequential stages of creativity; although they often inform creativity training approaches, they have not had much predictive power (Runco, 2007; Sawyer, 2012). The creative process is understood to be iterative, suggesting people move through stages multiple times, possibly out of sequence (Armbruster, 1989; Csikszentmihalyi, 1996), and as they deem appropriate (Lubart, 2001). There are few models that consider relationships between stages. Evans and Russell (1989) suggest during the preparation stage the mind eventually reaches a limit to the amount of information it can absorb, leading to a frustration stage, which then incites an incubation stage. Finke’s (1997) Genoplore model describes complementary generative and exploratory processes during ideation. People generate initial ideas, which he describes as incomplete plans, and test these through exploratory actions. Outcomes of exploration are used to develop the idea, generating new exploratory actions, and so forth, until the creative product emerges from the process. Csikszentmihalyi’s (1990, 1996) flow theory describes complementary processes of thinking and acting when people feel immersed in a creative experience and at their most productive. During flow, people maintain undivided attention to the task at hand, externalize a creative idea through making, perceive immediate feedback from their exploratory actions or strategies, and have a sense of personal enjoyment while engaged in the experience (Csikszentmihalyi, 1996, pp 110–113). Flow is described as a mental state of creativity, but is engendered through physically situated activities and sustained by specific environmental conditions. Flow requires significant mental effort; people rely on familiar tools and materials to sustain attention and prefer comfortable settings to help them focus (Csikszentmihalyi, 1996, p. 120). As a mode of physically situated cognition, flow may begin to provide insight into why creative people attribute importance to particular settings or features of their physical environment. Flow theory does not account for other stages (or modes of situated cognition) that occur throughout the creative process.

Popularity of the Wallas model persists, researchers suggest, because it (a) describes what eminently creative people have written about their creative process, (b) it resonates with what people feel they do when they are creative, and, (c) although researchers have sought to address its limitations, they have yet to provide a better model (Armbruster, 1989; Fryer, 2012). Because it was developed over a century ago, it does not reflect new knowledge from brain sciences, including how people leverage social and physical resources in their environments to improve cognition. As a starting point toward better understanding the physically situated processes of creativity, Table 1 organizes commonly cited stage models, and Csikszentmihalyi’s physically situated process of creative flow, around common modes of creative thinking they describe. This organization guides analysis of first person and autobiographical accounts of creativity for evidence of physically situated processes. Modes are organized as follows. Problem-finding categorizes all stages prior to novel idea ideation, including problem definition/framing and knowledge acquisition (e.g., the Wallas preparation stage). Ideation includes generating stages describing processes for coming up with new

---

**TABLE 1 | Creative stage models compared.**

| Model Author(s) | Problem-finding/Problem-framing | Ideation | Implementation/Feedback from use |
|----------------|---------------------------------|----------|---------------------------------|
| Wallas, 1926   | Preparation                     | Formulation, Critique, Invention | Incubation, Illumination | Verification |
| Rossman, 1931  | Observation, Analysis, Survey   | Hypothesis | Incubation | Synthesis, Verification |
| Osborn, 1953   | Orientation, Preparation, Analysis | Immersion, Divergent Exploration | Explore Approaches | Selection, Articulation, Transformation | Implementation |
| Gordon, 1961   | Groundwork                      | Idea Finding | Germination, Pasturation | Solution Finding | Acceptance Finding |
| Bransford and Stein, 1984 | Identify Problem, Define Goals | Flow | Incubation, Insight | Evaluation, Elaboration |
| Van Gundy, 1987 | Objective Finding, Fact Finding, Problem Finding | Novel Combination, Ideation | Evaluation | Implementation and Feedback |
| Barron, 1988   | Conception                      | Generative | Exploratory | Submit to Field, Evaluate, Disseminate |
| Evans and Russell, 1989 | Preparation, Frustration | Flow | Generate Novelty | Externalize Ideas |
| Csikszentmihalyi, 1990, 1996 | Problem Construction, Knowledge Acquisition, Concept Selection | Generate Ideas | Develop Solutions | Build Acceptance |

---
ideas, incubating stages involving subconscious processes when people are not explicitly working on a problem, and elaborating, characterized by stages of verification, articulation, selection, and refinement. Implementation involves stages when a creative idea is tested and evaluated in a socio-cultural context. This paper focuses on the three modes of ideation.

The following section considers how creativity may be physically situated; documented accounts by creative practitioners are organized by mode of creative ideation they describe and examined with respect to the situated cognition theories of embodied, embedded, and enactive cognition. The intention behind this effort is to better understand if/how features and qualities of the physical environment constrain and/or enable creative ideation.

PHYSICALLY SITUATING CREATIVITY WITH THE 3E’s

Environmental structure is now understood to be critical to human cognition (Thagard, 2005; Leidlmair, 2009; Robbins and Aydede, 2009) and situated cognition theory describes knowledge as “inextricably situated in the physical and social context of its acquisition and use” (Brown, 2001, p. 65). Three central ideas in situated cognition (the 3E’s) consider how cognition is physically situated: (1) the embodied thesis – that cognition encompasses both the mind and the body (Varela et al., 1991; Lakoff and Johnson, 1999; Gallagher, 2005); (2) the embedded thesis – that people exploit features of the physical and social environment to increase cognitive capabilities; (Kirsh and Maglio, 1994; Clark, 2008a), and (3) the enactive thesis — that cognition is constituted through a person’s actions in the world. Enactive cognition is generally treated as a theory separate from embodied and embedded cognition, however, Ward and Stapleton (2012) argue if cognition is enactive it is also embodied and embedded. Enactive cognition serves here as an overarching theory, focusing attention on the importance of action in ways people implicitly understand how settings provide resources for thinking-in-action. Figure 1 defines and describes relationships between the 3E’s to guide analysis of first person and biographical accounts

---

6 A growing number of researchers challenge cognitivist categorical structural (i.e., people create mental models of the world from which they plan and problem-solve) and centralized processing perspective (i.e., first people perceive, then they think, and finally they act; Thagard, 2005).

7 The extended mind thesis is often included as a fourth “E,” but not part of this analysis.
for evidence of physically situated cognition. In the next section the 3E’s are discussed separately, focusing attention on common themes describing person-environment relationships during different modes of creativity. Later in the paper, findings are summarized in a table which associates 3E theories with modes of creative cognition, illustrating how embodied, embedded, and enactive processes are integrated within the modes.

**Embodied Experiences in, Between, and with Architectural Settings**

The embodied thesis maintains cognition depends upon physical characteristics of the body (Wilson, 2002); its sensory and motor capabilities shape the mind (Robbins and Aydede, 2009). The thesis has philosophical roots in existential phenomenology works of Edmund Husserl, Maurice Merleau-Ponty, and Martin Heidegger who, among others, believed the body is central to perception and experience (Varela et al., 1991; Gallagher, 2009; Pallasmaa, 2010). With their book *The Embodied Mind*, Varela et al. (1991) proposed a phenomenological study of cognition considering physical characteristics and abilities of the body in determining how and what sensorimotor knowledge people are able to construct through interactions in their environments. Influences of phenomenology and embodiment are found today in architectural designs by Zumthor (Mallgrave, 2013), Holl, and Pallasmaa (Holl et al., 2006), with Pallasmaa largely responsible for bringing awareness of embodied cognition to architectural design (Mallgrave, 2011) by advocating for multisensory environments engaging hearing, smell, and touch as antidote to the visual bias in architecture, which he believes yields “impoverished environments” causing feelings of detachment and alienation in users (Pallasmaa, 2005).

Another historical influence for the embodiment thesis is Gibson’s (1977) work in ecological psychology, including his *theory of affordances*. Gibson believed people understand the world in terms of functional relevance and possibilities for action (affordances). Although Gibson (1976, p. 413) proposed that his ecological thesis could provide a much-needed foundation for architecture, affordance theory has been more influential in product design. Gibson defines affordance as a *relationship* between person and environment, dependent upon the person’s intentions and physical abilities with respect to *action opportunities* provided by features of the environment (Figure 2). From his perspective, knowledge is constructed through goal-directed exploratory actions. The “bottom-up” approach to cognition he describes is reflected in Brooks’s (1991a,b) seminal artificial intelligence research and Clark’s (2001) concept of “intelligence without [mental] representation,” arguing minds are not for *thinking* but for *doing*. Some in the architectural design community champion affordance theory to better predict behavioral outcomes of designed spaces (Maier et al., 2009; Lang and Moleski, 2010), however, there is little evidence of its effectiveness in practice.

A key difference between the philosophical and ecological approaches to embodiment in architectural design is the concept of user agency. The philosophical perspective is more concerned with how the body *constrains cognition* (Borghi and Cimatti, 2010), emphasizing ways spatial features and attributes affect user (subjective) experiences. In architecture the user is viewed as a passive recipient of design interventions. The ecological perspective considers the role the body plays in *constituting cognition* (Reed, 1996) suggesting people actively exploit features and attributes of architectural settings as part of their cognitive system, taking ownership of their experiences in their settings. The ecological perspective is most clearly evident in creativity narratives, including those of Kipling, Kant, and Proust mentioned in the introduction to this paper. Two overarching themes of the ecological approach emerge from personal accounts of creativity: first, people use artifacts in their environment (e.g., tools and materials) as transparent equipment shaping perceptions during intuitive ideation, and second, people personalize their settings to help initiate and sustain creative flow by incorporating them into ritual and sense of creative self.

**Thinking-in-Action: Seeing Through Tools and Materials**

People feel tools and materials used during creative ideation become an extension of themselves, serving to organize creative experiences (Sennett, 2008; Pallasmaa, 2010). Accounts by creative practitioners suggest artifacts in their environment are embodied when they (a) are customary and familiar, (b) facilitate thinking-in-action (such as through writing, drawing, and model making), and (c) deepen immersion in the creative process by enabling immediate feedback from exploratory actions, shaping experiences in a creative situation. Personal narratives describe strong feelings for tools and materials with some seeming almost superstitious about roles they play in creative performance. Kipling (1937) describes how his creative “Daemon” responds to particular writing instruments.

---

8Norman popularized the term in his book “The Design of Everyday Things” (Norman, 1998). Gibson considered affordances all actionable properties of the physical environment, whereas Norman defined them as perceived actionable properties.

9For other examples, artist interviews (Fig, 2009) or Csikszentmihalyi (1996, p. 119) quoting Barry Commoner describing how his favorite fountain pen allows his ideas to flow, whereas a ballpoint pen does not offer the same experience.

---

![Affordance Diagram](https://via.placeholder.com/150)

**FIGURE 2 | Affordance according to Gibson (1977), is a transactional relationship between animal (e.g., person) and environment.**
and materials, expressing distress when the nib of a favored pen failed him during “an evil hour.”

And with what tools did I work in my own mold-loft?...I used a slim, octagonal-sided, agate penholder with a Waverley nib. It was a gift, and when in an evil hour it snapped I was much disturbed....For my ink I demanded the blackest....All blue-blacks' were an abomination to my Daemon. ...My writing-blocks were built for me to an unchanged pattern of large, off-white, blue sheets....With a lead pencil I ceased to express—probably because I had to use a pencil in reporting. — Kipling (1937)

We surmise from his writing that Kipling (1937) has come to favor certain tools and materials; he uses them regularly (they are customary), and expertly (they are familiar) so they do not distract from his writing. A favorite pen has a tight relationship with the way he thinks creatively; he sees through the tool to the creative situation. When such a tool fails to perform as expected, his creative process is negatively impacted, the tool no longer transparently part of his thinking. Instead it becomes a distraction, a source of distress. Creative practitioners describe intuitively thinking-in-action when tools and materials are fluidly incorporated into their idea-generating processes through activities like sketching, drawing, writing, and model making. Externalizing an idea allows people to perceive “feedback” from the situation, identifying unanticipated opportunities in a creative situation and initiating new actions in response to them (Schön, 1983, pp 163–164). Aalto (1997, p. 108) describes his process of intuitively sketching to reconcile the complex and contradictory requirements of an architectural design:

"I forget the whole maze of problems for a while, as soon as the feel of the assignment and the innumerable demands it involves have sunk into my subconscious. I then move on to a method of working that is very much like abstract art. I simply draw by instinct, not architectural synthesis, but what are sometimes quite childlike compositions, and in this way, on an abstract basis, the main idea generally takes shape, a kind of universal substance that helps me to bring the numerous contradictory components into harmony."

Sketching is used to (1) “handle different levels of abstraction simultaneously,” (2) “enable identification and recall of relevant knowledge,” (3) “assist problem structuring through solution attempts,” and (4) “promote the recognition of emergent features and properties” of the design idea (Cross, 2006, p. 37). Studies have shown the tight relationship between thinking and acting with tools — demonstrating activation of motor processes in the brain when people think about using tools, say words associated with tool use, or watch someone else use a tool during experimental tasks (Pulvermüller et al., 2005; Mahon and Caramazza, 2008). Intuitive process of thinking-in-action is described in Csikszentmihalyi’s (1990, 1996) flow theory, with understanding gained through unselfconscious participation and direct experience in a creative situation. The improvisational jazz performer anticipating each new note as he hears the last one played (Schön, 1983, pp 55-56), the painter responding to the texture of the paint and the colors of pigment on a canvas as she positions the brush to make the next stroke (Csikszentmihalyi, 1996, p. 208), and the scientist working through the structure of DNA by manipulating and reconfiguring a physical model of machined parts (Watson, 1968, pp 193–197) are examples of flow. In these cases there is fluid intertwining of action and perception, and understanding comes from first-hand experience in a physical context.

The ability to immediately perceive feedback from exploratory actions deepens feelings of immersion in the creative situation, blurring the boundary between creator and creation. Berger (2005, p. 3) describes how he becomes more and more immersed in the creative process through drawing until he feels he and the product of his creation have merged.

Each confirmation or denial brings you closer to the object, until finally you are, as it were, inside it: the contours you have drawn no longer marking the edge of what you have seen, but the edge of what you have become.

Each new action is a response to the current set of circumstances; ensuing immersion in the process characterized as activity involving “continual reciprocal causation” (Clark, 2008b, p. 24) when Berger (2005) is simultaneously affecting his situation and being affected by it. Clark (2008b, p. 25) describes a famous exchange between physicist Richard Feynman and historian Charles Weiner to illustrate this principle. Feynman argues with Weiner that a paper he wrote is not a record of his thinking, but actually is his thinking. Feynman’s use of pen and paper is “responsible for the shape of the flow of thoughts and ideas.” Jung (1952, p. 230) eloquently describes a similar relationship between Goethe and his writing as follows: “The work in process becomes the poet’s fate and determines his psychic development. It is not Goethe who creates Faust, but Faust which creates Goethe.”. In these cases sense of creative self extends beyond the body to materials of creative ideation.

**Theme 1: Tools and materials are ‘transparent equipment’ when people see through them to the task at hand, extending sense of the body during intuitive immersion in ideation activities.**

Widely accepted is that that body schema, somatosensory representation of the body, changes with tool use (Cardinali et al., 2009). Extended capabilities afforded by a tool are reflected in neural networks in the brain as corporeal awareness of the body changes (Maravita and Iriki, 2004). Body schema is highly plastic, rapidly adapting to new tool use (Carlson et al., 2010) and can persist for years, such as the case with phantom limb syndrome or prosthetic device usage (Mayer et al., 2008). Gallagher (2005) distinguishes between body image (a conscious sense of ownership) and body schema (an intuitive sense of sensorimotor capabilities involved in interacting with the environment). When a tool becomes part of the body schema, it acts as transparent equipment — the user sees through the tool to the task at hand (Clark, 2008b, p. 10) and when this tool is misplaced or fails to perform (such as when Kipling’s Waverly nib snapped,) a person may feel temporarily handicapped (e.g., “much disturbed”) over perceived loss of
creative capabilities. (Is a painter still a painter if you take away his brush?)

**Sense-Giving Spaces for Initiating and Sustaining Creative Flow**

Creative people are often as particular about their working spaces as they are with their tools. They personalize workspaces, populating them with meaningful objects or orienting furniture to favored views, to help them get into a creative mindset, incorporating environmental features and artifacts into rituals and sense of creative self. The role of inspirational objects in ritualistic creative behaviors is the subject of many narratives (Fig, 2009). Kipling (1937) wrote an entire chapter devoted to the significance of his “working tools.” His tools included meaningful objects from travels kept on his desk he felt were instrumental to his creativity. He explains how these items are essential for influencing his creative thoughts.

...I always kept certain gadgets on my work-table, which was ten feet long from North to South and badly congested. One was a long, lacquer, canoe-shaped pen-tray full of brushes and dead ‘fountains'; a wooden box held clips and bands; another, a tin one, pins; yet another, a bottle-slider, kept all manner of unneeded essentials from emery-paper to small screwdrivers; a paper-weight, said to have been Warren Hastings' a tiny, weighted fur-seal and a leather crocodile sat on some of the papers; an inky foot-rule and a Father of Penwipers which a much-loved housemaid of ours presented yearly, made up the main-guard of these little fetishes. Left and right of the table were two big globes, on one of which a great airman had once outlined in white paint those air-routes to the East and Australia which were well in use before my death — Kipling (1937)

Creative practitioners often develop routines to begin creative processes, such as cleaning up work surfaces or setting out favorite tools or meaningful artifacts (Csikszentmihalyi, 1996, pp 351–358; Fig, 2009). When productivity lags they change routines, alter features of their workspace, or move to a new setting (Fig, 2009). Although the white, empty art studio may be a figural representation of a creative space as a ‘blank slate’ where anything might happen, in reality the places artists be a figural representation of a creative space as a ‘blank slate’ where anything might happen, in reality the places artists have been Warren Hastings’ a tiny, weighted fur-seal and a leather crocodile sat on some of the papers; an inky foot-rule and a Father of Penwipers which a much-loved housemaid of ours presented yearly, made up the main-guard of these little fetishes. Left and right of the table were two big globes, on one of which a great airman had once outlined in white paint those air-routes to the East and Australia which were well in use before my death — Kipling (1937)...

...I always kept certain gadgets on my work-table, which was ten feet long from North to South and badly congested. One was a long, lacquer, canoe-shaped pen-tray full of brushes and dead ‘fountains'; a wooden box held clips and bands; another, a tin one, pins; yet another, a bottle-slider, kept all manner of unneeded essentials from emery-paper to small screwdrivers; a paper-weight, said to have been Warren Hastings’ a tiny, weighted fur-seal and a leather crocodile sat on some of the papers; an inky foot-rule and a Father of Penwipers which a much-loved housemaid of ours presented yearly, made up the main-guard of these little fetishes. Left and right of the table were two big globes, on one of which a great airman had once outlined in white paint those air-routes to the East and Australia which were well in use before my death — Kipling (1937)

Theme 2: People incorporate features and sensory attributes of settings into ritualistic behaviors to psychologically prepare for creative efforts, integrating them into concept of creative self over time.

The philosophical perspective of embodied cognition is supported when settings function as transparent equipment, part of a body’s sense-making process during creativity. Whether ambient sounds, motions, or inspirational views are truly embodied, to the extent they are incorporated into the body schema, cannot be determined from anecdotal description — although people feel they are. In personalizing their settings, people create their cognitive niche for creativity. Through “cognitive niche construction...[people] build physical structures that transform problem spaces in ways that aid thinking and reasoning” (Clark, 2008b, p. 62). Features and attributes of workplaces become resources in the cognitive niche improving creative abilities, whether or not they are incorporated into body schema. The concept of niche construction, however, fits more closely with the embedded thesis when people manipulate features and attributes of the environment in order to extend creative capabilities.

**Architectural Settings as Scaffolding for Embedded Cognition**

Embodied and embedded cognition often go hand-in-hand and are sometimes referred to collectively as embodied, embedded cognition (Clark, 2008a). Where embodied cognition considers how people use their bodies to help them think, embedded cognition theory considers how people use features of their environment to improve their cognitive abilities (Robbins and Aydede, 2009), including how they off-load cognitive work to their environments (Clark, 2001). Clark (2001, p. 46) refers to this as the “007 Principle” meaning “know only as much as you need to know to get the job done”. People will not store or process information they can easily off-load to the environment, a process of cognitive bootstrapping (Clark, 2008b). Stories describe how people exploit aspects of their environments as things to think with, helping them better understand, evaluate, and elaborate on ideas. They employ strategies of (a) seeing with different tools and materials to perceive hidden affordances in a situation through abstraction, (b) seeing as objects and qualities of their settings to redefine or reframe a problem or idea, and (c) seeking out new environments with different resources to feed their creativity.
Things to Think With: Seeing With and Seeing As

People use resources in their environments as cognitive strategies to simplify the complexity of creative problems through abstraction with different materials, or externalizing ideas in different ways, by seeing with a variety of tools and materials or to identify new opportunities in a situation or by seeing as another situation (e.g., using precedents or analogy), helping to reframe an idea or problem. Reflecting on discovery of the structure of DNA with Watson (1968), Crick (1990) describes two essential factors for creative success — the ability to find (or define) an interesting problem and perseverance and skills required to consider it from multiple perspectives, using all available resources.

The major credit I think Jim and I deserve… is for selecting the right problem and sticking to it…. Both of us had decided, quite independently of each other, that the central problem in molecular biology was the chemical structure of the gene…. We could not see what the answer was, but we considered it so important that we were determined to think about it long and hard, from any relevant point of view. — Crick (1990, pp 74–75)

In their respective autobiographies, Watson (1968) and Crick (1990) describe myriad of different resources and perspectives they used in their work, including diagramming, writing, conversations with other scientists, and, most importantly, physical model building. It was through iterative manipulation of three-dimensional materials that they finally discovered the structure of DNA. Just as tools organize the creative imagination, so too are materials and methods used to simplify, externalize, and evaluate a creative idea when people ‘see with’ them to uncover previously unperceived opportunities or constraints in a situation. Diagrams are a visual method of abstracting and compressing information (Garcia, 2010, p. 18) used to understand or analyze relationships (e.g., structural relationships than meaning making (Allen and Agrest, 2009, pp 41–69; Eisenman, 2010). Diagrams generally focus more on describing structural relationships than meaning making (Allen and Agrest, 2009, p. 50), yet their abstracted nature may facilitate deeper understanding about a creative problem or idea through analogy and conceptual combinations (Kazmierczak, 2003). In architecture and engineering different types of drawings (plans, sections, elevations, perspectives) isolate select spatial relationships for examination (Allen and Agrest, 2009, pp 3–40; Evans, 2000). Models are used in many disciplines, including mathematics and science, to help people better understand three-dimensional relationships. Model making was instrumental in helping Watson (1968, pp 193–197) and Crick (1990) work through the structure of DNA as they manipulated and reconfigured various machined parts. Diagrams, drawings, and models facilitate epistemic actions, defined by Kirsh and Maglio (1994, p. 513) as “actions performed to uncover information that is hidden or hard to compute mentally.” When problems are particularly challenging, epistemic actions aid in the understanding of a problem, with incremental insights gleaned through feedback from environmental conditions.

People employ a method of seeing-as to focus on particular aspects of the creative situation, filtering out any detail that may obscure or confuse their ability to perceive affordances in the situation by seeing one case as another previously experienced case (i.e., precedents), or by comparing experiences in one situation with their experiences in a different, unrelated situation (i.e., analogy). Analogy is a frequently described cognitive process of creativity that involves transferring the cognitive structure from one context where it is well established to a new context where it had never been used. Dunbar (1995) describes three types of analogical thinking: selective comparison, local analogy, and regional analogy. These processes differ in the domain distance between the two contexts. Selective comparison uses different cognitive structures from within the same domain. Local analogy involves application of a cognitive structure from one domain to a related domain. Regional analogy involves transferring the cognitive structure between completely dissimilar domains.

Many acts of extraordinary creativity involve regional analogy and people often describe using aspects of their physical environments to help them make conceptual leaps. Le Corbusier’s design for the roof of Notre Dame du Haut was inspired by a crab shell he had picked up on the beach and noticed laying on his drawing board next to the building sketches (Groat and Wang, 2002, p. 102). The architects John Utzon used experiences in his environment to help him think about his design for the Sydney Opera House (Peltason and Ong-Yan, 2010, pp 91–97). He watched large ships being built with ribs in the shipyard outside his office building. He considered how the fruit of an orange is organized in sections. He imagined how space inside a building was like music. All of this information acquired from the environment changed the way he approached the design for the iconic building and influenced its form, organization, and structure. Philo Farnsworth was plowing a field when he came up with the idea to project moving images line-by-line — which led to the invention of the television (Thomas, 2004). George de Mestral found inspiration for Velcro as he picked burrs off of his dog after a walk in the woods (Hargroves and Smith, 2006). Creative practitioners seem particularly skillful at exploiting environmental resources to help them consider creative problems and ideas from many different perspectives, often leading to leaps in insight as they solve complex problems.

Theme 3: People use methods of seeing with tools and materials and seeing as objects to focus on particular aspects of the creative situation, filtering out any detail that may obscure or confuse their ability to perceive affordances in the environment by seeing one case as another previously experienced case (i.e., precedents), or by comparing experiences in one situation with their experiences in a different, unrelated situation (i.e., analogy). Analogy is a frequently described cognitive process of creativity that involves transferring the cognitive structure from one context where it is well established to a new context where it had never been used. Dunbar (1995) describes three types of analogical thinking: selective comparison, local analogy, and regional analogy. These processes differ in the domain distance between the two contexts. Selective comparison uses different cognitive structures from within the same domain. Local analogy involves application of a cognitive structure from one domain to a related domain. Regional analogy involves transferring the cognitive structure between completely dissimilar domains.

Creative practitioners shape their own creative situations by acting in and on their environments, but the situations they create, in turn, influence their experiences and affordances they are able to perceive. Some stories suggest they are attuned to search their environment for potentially relevant information, even when not explicitly working on a problem — for example, Farnsworth’s ability to perceive affordances in the way he plowed a field for his pioneering work in television or de Mestral’s idea...
Serendipity Favors the Embedded Mind

People are active agents, explorers of their environment who habitually scan the world for information that is relevant to them (Reed, 1996, pp 18–19). For the creative practitioner, the world is an endless supply of resources for creativity. In her autobiography, choreographer Twyla Tharp describes how she perceives her environment in terms of the affordances it provides to think in new ways about her choreography.

*Everything that happens in my day is transactional between the external world and my internal world. Everything is raw material. Everything is relevant. Everything is usable. Everything feeds my creativity. But without proper preparation, I cannot see it, retain it, use it* (Tharp and Reiter, 2003, p. 10).

By “proper preparation,” she likely refers to the necessary skills and expertise required for creativity within her domain. However, preparation also describes her mindset; the environmental scanning she conducts is goal-directed, focused by interest and concern for dance.

Anecdotes describe how people develop a breakthrough idea through what seems sheer good luck. These stories feed myths of creativity as divine inspiration: Archimedes in the bath as he solves a method for measuring the volume of irregular objects; Newton’s observation of a falling apple as inspiration for his universal theory of gravity (Epstein, 1979), and Flemings discovery of penicillin in a moldy petri dish (Bennett and Chung, 2001, p. 168), to name a few. Feynman recounts the fortunate day he was in a cafeteria when someone threw a plate in the air; he credits this serendipitous event as inciting a process that led to the Nobel Prize (Feynman and Leighton, 1997, pp 171–174).

...So I got this new attitude... I’m going to play with physics... Within a week I was in the cafeteria and some guy, fooling around, throws a plate in the air. As the plate went up in the air I saw it wobble, and I noticed the red medallion of Cornell on the plate going around. It was pretty obvious to me that the medallion went around faster than the wobbling... I had nothing to do, so I start figuring out the motion of the rotating plate. (Feynman and Leighton).

Feynman reached a point of frustration in his research program and decided to deal with his inability to make scientific progress by looking for opportunities to “play with physics.” In solving the spin to wobble ratio of the plate he developed a complex equation, which led to calculation of electron orbits and breakthrough in his research program. Anecdotes like Feynman’s may capture our imagination because, at first glance, they seem like the happy accident of good fortune. But, as Louis Pasteur is often quoted, “Dans les champs de l’observation le hasard ne favorise que les esprits préparés.” (Where observation is concerned, chance favors only the prepared mind.) Feynman was seeking affordances to help him play with physics, shaped by a general concern for his research program. Creative people may talk about being lucky, but luck, it has been said, “is the residue of design.”10 They become experts at perceiving the opportunities afforded by their resource-rich environments as they move within and between them.

Theme 4: People actively scan their environments, and seek out new environments, for opportunities to perceive problems or ideas in new ways.

Settings Shape Perceiving-in-Action: Creativity as Enactive Cognition

The foundational principle behind enactive cognition is that perception and cognition depend upon a person’s interactions with the world (Varela et al., 1991). People create their own experiences through their actions; perceptions are shaped by what they do, how they do it, and what they anticipate doing (Noë, 2004). Personal accounts describing embodied and embedded experiences during creativity also fit the enactive paradigm.

Evidence of embodied cognition was found in narratives about intuitive processes during stages categorized as generating modes of thinking when people think-in-action through activities like writing, drawing, or model making. Embedded cognition evidence was more typically found in stories of people explicitly using epistemic actions during elaborating modes of creativity when they change the context of a situation to perceive new affordances within a setting — such as through abstraction with tools and materials or analogy using artifacts — or by changing settings. The third mode of creative ideation, incubating, is generally understood to involve sub-conscious (or semi-conscious) mental processes, however, evidences suggests it is sensitive to environmental conditions (Dijksterhuis and Meurs, 2006; Sio and Ormerod, 2009; Leung et al., 2012). In this section, the enactive perspective is discussed in terms of how it may help shed light on relationships between different modes of creative ideation and the environmental conditions supporting them.

Role of Physical Conditions in Complementary Processes of Generating and Elaborating

People engage in complementary intuitive and explicit processes when working on a creative problem; breakthrough emerges over time, with incremental insights constituted by engagement with tools, materials, and features of the architectural environment. During flow, creative practitioners often describe feeling part of the product of their ideation (such as Berger’s drawing), however, during elaboration modes their relationship to creative work changes; it becomes an object of explicit and critical evaluation. Aleksakova, an architect, describes how through intuitive and dynamic process of perceiving and acting, she notices an unexpected outcome of cutting, altering her relationship with the product of creation; she no longer feels a part of it. The moment of surprise triggers a process change from intuitive generating to explicit elaborating.

You stop thinking.
You just look at the piece of foam and you try to make it beautiful,
You cut.
Sometimes you slice something.
And then another thing.
And ou-u-u-p-p-p something is there.

---

10Attributed to Branch Rickey, also John Milton.
And you think: ‘Oh, that’s interesting; it’s there.’ (Yaneva, 2009, p. 57)

During flow (which she explains happens when “you stop thinking”), knife and foam are transparent equipment allowing Aleksakova to externalize thinking about a creative problem; she describes actions and perceptions merging as an idea takes shape from the process. Each action, guided by intuitive response to a previous action, is in pursuit of the goal to “make it beautiful.” When goal-directed expectations of an action do not match perceived result of that action (“something is there”) flow processes break down and surprise triggers explicit processes of elaboration (“you think: ‘oh, that’s interesting’. . .”).

The enactive perspective reveals how physical conditions in a creative situation can curtail one mode of creativity and trigger another.

Although people can choose to stop intuitively working on a problem, and decide to critically consider the outcome of their work, first person accounts of creativity reveal how movement between modes of creativity is often not a conscious decision. This perspective is not evident in the creative stage models, yet it has relevance for design strategies intended to improve creative productivity. Complementary relationship between modes of intuitive immersion and explicit elaboration suggests that typical sequencing of creative stages (generating, incubating, and elaborating) may not reflect the iterative ways people transition between them. It also helps highlight differences in environmental conditions supporting each of the modes — and implications this might have for workplace designs.

**Theme 5: People’s perceptions of affordances in their environments depend (in part) on their activities and mode of creative thinking.**

Integration of the embodied, embedded, and enactive perspectives with respect to creative cognition reveals overlaps and disparities between person–environment relationships among different modes of ideation (see Table 2). Essential to the intuitive immersion of creative flow is tools and materials functioning as transparent equipment. Tools and materials may also be embodied during explicit elaboration, however, this is not critical, as it seems to be for flow. Failure of a tool (i.e., when a nib breaks) or unexpected outcome of working with a material (i.e., when cutting foam transforms the material in unanticipated ways) will often engender the elaboration mode. During elaboration modes tools and materials may be critically regarded as things to think with. For example, a musician may pick up an unfamiliar instrument to explore an idea for a composition.) Settings for intuitive flow must protect the creative practitioner from interruption or distraction11 and support the focused attention required through familiar and comfortable tools, furnishings, and environs. These conditions are not critical for elaboration, which instead benefits from unfamiliar environments and resources, helping the creative practitioner perceive an idea or product in new ways. How people perceive their environment is, in part, determined by their mode of creative thinking and, in turn, their mode of thinking may be influenced by conditions in their physical environment.

**AutoPoiesis, Niche Construction, and Creative Ideation**

Central to the enactive thesis is a systems approach to understanding human cognition. As developed by Varela et al. (1991) its core concepts are influenced by *autoPoiesis* (Varela et al., 1974), considering living organisms as “autonomous systems” who “regulate their interactions with the world in such a way that they transform the world into a place of salience, meaning, and value” (Thompson and Stapleton, 2009, pp 50–57) famous account of interruption while composing *Kubla Khan.*

---

11 Importance exemplified by Coleridge’s (1816, pp 50–57) famous account of interruption while composing *Kubla Khan.*

**TABLE 2 | The 3E’s and modes of creative ideation: summary of themes.**

| 3E Theories | Generating Intuitive immersion in creative flow | Elaborating Explicit evaluation and exploration of an idea | Incubating Semi-conscious rumination about an idea |
|---|---|---|---|
| **Embodied** | Theme 1: Tools and materials are ‘transparent equipment’ when people see through them to the task at hand, extending sense of the body. | Tools and materials may be embodied, but this is not critical to the process. | Tools and materials are likely embodied when working on mundane tasks unrelated to the creative problem. People describe rituals (like walking or riding a train) and favorite settings with similar sensory qualities to help them incubate; they do not, however, express integration of these places into concept of creative self. |
| | Theme 2: People incorporate features and sensory attributes of settings into ritualistic behaviors to psychologically prepare for creative efforts, integrating them into concept of creative self over time. | | |
| **Embedded** | Seeing with materials sustains complementary processes of acting and perceiving through continuous reciprocal causation. | Theme 3: People see with tools and materials and see as objects and features of their environment to understand complex problems and creative situations in new ways. | Environmental cues positively influence insight during incubation. |
| | Theme 4: People actively scan their environments, and seek out new environments, for opportunities to perceive different affordances in problems or ideas. | | |
| **Enactive** | Theme 5: People’s perceptions of affordances in their environments depend (in part) on their activities and mode of creative thinking. | Theme 6: People change conditions in their environments, or move to new environments, to help them transition between creative modes of ideation. | |
Incubation occurs when conscious work on a problem ceases, particularly during period of indecision (Cohen and Ferrari, 2010). Studies find insight improved when people work on unrelated mundane (low-cognitive load) tasks during incubation (Dijksterhuis and Meurs, 2006; Sio and Ormerod, 2009) or when environmental cues are encountered immediately before or during incubation (Sio and Ormerod, 2009). Incubation may involve embodied tools or materials when a creative practitioner uses them to engage in unrelated work, but this does not seem a necessary condition. It may be a form of embedded cognition when people have creative breakthroughs in response to environmental cues. Stories where people incorporate cues from their setting to yield insight (such as Farnsworth’s) suggest elaboration and incubation may be related modes of critical reflection during creativity – one involving explicit cognitive processes and the other sub-conscious (or semi-conscious) reflection on a creative problem or idea. A striking theme among personal and biographical accounts of creativity is similarity of settings and activities where people experienced creative insight during incubation.

Incubation stories overwhelmingly describe insight happening while walking or riding a bus, carriage or train. Von Helmholtz claimed incubation did not occur when he was tired or while at his worktable, but walking outside encouraged it (Wallas, 1926, p. 80). Poincaré (1954, p. 26) also described insight occurring during incubation when he took a break from work and went for a walk, rode the bus, or when involved in unrelated activities while serving in the military. The train is identified as a productive workplace in both Buttmer’s (1983) report on 45 creatives from diverse disciplines and in Törnqvist’s (2004) analysis of biographies written about Nobel Laureates. They are so often referenced in personal accounts that Harding and Nichols (1948) suggest the rhythm of transportation modes may induce in creative practitioners a hypnotic state conducive to ideation. Whether motion, background noise (as suggested by Mehta et al.’s (2012) study mentioned previously), or other environmental qualities, people seek out similar sense-giving spaces to invite incubation. Thus incubation may be affected by environmental conditions under which it takes place, however, these examples do not obviously fit the enactive paradigm described by Varela et al. (1991).

Anecdotes suggest settings may play a role in encouraging or sustaining incubation; given limited knowledge of the mechanisms behind the intuitive process, there is not enough evidence to determine if it may be a form of enactive cognition. For alternative explanation, Clark (1999) argues complex “representation-hungry” problems requiring abstraction or imagination may involve “off-line reasoning” (in other words, mental representation, which is antithetical to the enactive thesis). Ward et al. (2011, p. 375) suggests it is not “bodily activity itself but our practical knowledge (which need not be verbalized or in any way explicit) of our own possibilities for action” that constitutes understanding. In contrast, Bergen’s (2012) embodied simulation hypothesis proposes people do not rely on mental representations during off-line thinking, rather they imagine virtual experiences; abstract thinking may be grounded in action through metaphor (Lakoff and Johnson, 1980). Even if incubation does involve “off-line reasoning,” stories of creativity suggest certain environmental conditions might inhibit the process (such as by demanding too much attention) or provide qualities that people find support their ability to incubate (such as spatial configurations that invite walking)\(^2\).

### Theme 6: People change conditions in their environments, or move to new environments, to help them transition between creative modes of ideation.

\(^2\)For example, experimental studies by Leung et al. (2012) suggest spatial configurations and ways people move through them influences quality and quantity of ideas generated.
TOWARD AN ECOLOGICAL MODEL OF CREATIVITY

Analysis of first person and biographical accounts reveals several things of potential relevance to the design of settings to support creativity. First, there is evidence that creative processes are embodied and embedded in, and enacted by architectural settings. This suggests architectural designs have the potential to positively or negatively impact user creativity. Second, themes from 3E analysis, organized with respect to the creative modes in Table 2, illustrate how a single mode of creativity may involve multiple forms of physically situated cognition (e.g., the elaboration mode may be embodied, embedded, and enactive). Although it is useful from the perspective of analysis to separate the 3E’s, in reality they are often integrated during creativity in the world. Development of a theoretical framework to guide design strategies must account for this. Third, how people perceive features and attributes of their environments is shaped by their mode of creative thinking. Thus how and why people use settings must be examined with respect to each mode of creativity. Fourth, people change their environments to help them transition between modes of creativity. The analysis in the paper reveals how creative modes may be supported by different environmental conditions. This suggests the environments which support one mode of creativity may inhibit another. For example, workplaces designed to maximize impromptu social interaction may be effective for elaborating modes, but at the cost of inhibiting (or at least harming) generating modes. Finally, it should be noted that it is beyond the scope of this paper to theorize whether all creative processes are physically situated or if some processes (such as incubation) are always physically situated, however, evidence gathered thus far suggests dynamic relationships between person and environment are instrumental for creative practitioners during modes of creative ideation.

Linking Process and Place

The aim of analyzing creative processes through the lens of the 3E’s was to look for evidence of physical situatedness as a first step toward developing a theoretical framework useful for informing architectural design strategies. The remainder of this section describes how findings from the analysis are used toward this goal. First themes from analysis inform three propositions about person–environment relationships during creativity as follows:

Proposition 1
Creative cognition is embodied when people see through tools and materials while intuitively perceiving-in-action, deepening immersion in the creative process and extending sense of the body during creativity.

Proposition 2
Creative cognition is embedded when people see with or see as tools, materials, decorative objects, or other features of their settings as things to think with, thereby extending their capabilities to understand a complex problem.

Proposition 3
Creative cognition is enacted when people construct cognitive niches for creativity by interacting with, altering, and moving between settings to engender, sustain, and enhance different modes of creative thinking.

Second, modes of creative ideation are linked with environmental conditions (Figure 3). As mentioned in the beginning of this paper, (a) there has been little integration

![FIGURE 3 | Linking creative process and place.](image-url)
between creative process and press research streams, (b) press research has focused primarily on the social context of creativity, and (c) stage models describe purely mental processes with little incorporation of physically situated theories of cognition. Existing stage models of creativity are not useful for informing architectural design strategies because they neither adequately identify and describe physical activities involved in the sub-processes of creativity nor sufficiently explain the relationships between creative stages or how people move between them. Figure 3 illustrates through a conceptual diagram those process–place relationships described by creative practitioners as they engaged in modes of creative ideation. The diagram highlights how each mode is supported by different environmental conditions. (A few key setting qualities are provided to illustrate this point.) It also describes relationships between ideation modes. Although people may consciously choose to move between modes, analysis reveals how perceived outcomes of physically situated cognitive processes can curtail or engender modes. This diagram illustrates what creative practitioners have described in these situations. For example, the generating mode of intuitive immersion is curtailed by an unexpected outcome (e.g., Aleksakova’s surprise after cutting the foam) and this triggers the elaborating mode to explicitly explore and evaluate the surprising situation. If the creative practitioner is unable to garner new insight into the situation through exploration and evaluation, frustration may curtail the elaborating mode and trigger incubation (e.g., as Feynman described deciding to walk away from his research and ‘play’ with physics). During incubation the creative practitioner continues to work sub-consciously or semi-consciously on the problem until moment of insight. Insight engenders the elaborating mode to determine its merit and, if suitable, is used to inform a new plan or goal from which to initiate the generating mode. Poincaré (1954) describes this iterative process of moving between modes of generating, evaluating, and incubating as he worked to solve a mathematical problem.

Finally, drawing on compatibilities between enactive cognition and Gibson’s affordance theory from ecological psychology, and informed by the three propositions and process–place diagram (Figure 3), a preliminary framework for a dynamical systems model (Figure 4) illustrates person–environment interactions during creative ideation. Central to an ecological model of creativity is the transactional relationship between person and setting during creativity; people construct cognitive niches for creative modes through their actions within spaces, with artifacts and features of their setting, and by moving from one space to another. This framework intends to provide a starting point for organizing existing research and informing new studies to better understand the relationships between architectural design strategies and user creativity toward developing an ecological model of creativity.

Niche construction is a concept borrowed from evolutionary biology and ecology describing how organisms change environmental conditions to increase their chances of survival (O’Brien and Laland, 2012); they adapt to problematic conditions in their environment through modifications they make to it. In cognitive science the concept is commonly used to describe how people off-load mental work to their environments (e.g.,

---

FIGURE 4 | Framework for an ecological model of creativity.
through epistemic actions, externalizing ideas through model making or diagramming, etc.) to extend cognitive capabilities (Clark, 2008a). The framework presented here merges the ecological and cognitive perspectives to better understand (1) how architectural designs impact users' creative processes and (2) how users exploit, alter, and move between settings to increase creative productivity. It begins to define variables involved in creative niche construction: (1) factors in the architectural setting and their sense-giving qualities, (2) characteristics of the creative person and his/her mode of creative ideation, (3) affordances (i.e., opportunities for action) offered by qualities of the architectural setting with respect to the creative person and mode of ideation, and (4) actions of the creative person that change the architectural setting, thereby impacting affordances offered.

**Architectural setting**

An architectural design is an example of niche construction in the biological sense; a building protects inhabitants from extreme weather and other safety risks, provides comfort through furnishings, equipment to prepare and serve food, a place to bathe, etc. It is a milieu, exerting environmental pressures on users through spatial configurations and sense-giving qualities. Areas of concern for architectural design professionals define the different variables of the architectural setting in this framework. For example, designs to support the generating mode could be considered from the perspective of site (e.g., the site for the Salk Institute is in a low density, quiet area, and on a cliff overlooking the ocean), buildings, (e.g., Kahn oriented buildings to maximize views toward the ocean), rooms (e.g., he angled scientists offices to provide a window in each, framing the inspirational view), and so forth. People also exert pressures on the architectural settings they use (Brand, 1994); building and user engage in an ongoing reciprocal relationship. For example, Kahn expected users would reconfigure the laboratory spaces at the Salk Institute and designed them to facilitate flexible spatial configurations. However, users have constructed private offices in these buildings, a pressure on the space he did not anticipate. This framework could be used to examine user rationale for the changes they make in and to their settings and how these changes, in turn, impact creative processes. Architectural settings inspire and constrain behavior and cognition through the affordances they offer, and users, by actualizing affordances, change conditions in their environments thereby shaping affordances available to them.

**Affordances**

This framework describes affordances as relationships between sense-giving qualities of an architectural setting with respect to the personal skills and abilities of its user, providing opportunities for creative thinking-in-action. Affordances may invite behaviors (e.g., through spatial configurations encouraging social interaction) or aesthetic appreciation (e.g., through forms and materials). During creativity, room finishes or features afford protection from unwanted distraction (such as Proust's cork-lined walls) or inspirational views (like Kant's of the church tower). Decorative objects (for example, those on Kipling's desk) afford rituals initiating creative efforts, and familiar tools afford perceiving-in-action during flow. Affordances exist whether or not they are perceived or actualized (used). For example, a twig dipped in ink affords writing, even if not perceived as such. Conversely, a pen with a broken nib does not afford writing.

**Creative practitioner**

Creative people have unique expertise (including domain knowledge and personal experiences) and psychomotor abilities, which, in part, determine affordances offered by their environments and how these are perceived and actualized. For example, a musician perceives a conch shell affords playing and he actualizes that affordance when he sees through it in the process of composing music. A writer perceives the shell as something she collected as a child during walks with her mother and actualizes the affordance when she sees with it, evoking memories she documents in her story. An architect perceives the shell as an enclosure and actualizes the affordance when he sees as it to design the form of a new building. Seeing, used figuratively in the model, refers to all ways of perceiving (not exclusively visual), consciously and subconsciously, through the sensorimotor system. Affordances depend upon a person's goal or intention toward, or concern about, a creative situation, framed by the mode of creative thinking.

**Actions**

Finally, the model describes how people make sense of complex and ill-defined problems through their actions, which alter affordances perceived and actualized in the situation. People have autonomy (Thompson and Stapleton, 2009), or agency (Gibson, 1977; Reed, 1996), to seek out environments (like trains) that help them be creative, develop behaviors to fit their environment (such as ritualistic cleaning of work surfaces, setting out favorite tools, gazing at an inspirational view) and alter environments to suit their needs (to address 'poor fit' such as when Kant had his neighbor's tree cut down after it blocked his tower view, or through personalization to inspire creativity such as the meaningful objects on Kipling's desk.)

**An example**

Feynman's story of the spinning plate illustrates how the framework might be used to guide understanding and empirical examination of physically situated processes involved in creativity. He, as a creative practitioner, has domain expertise in physics. In a period of frustration, he stops working on his research problem and decides to 'play' with physics. He walks around the Cornell University campus (changing his environment by moving to a new setting) with an intention to play with physics. When he arrives in the cafeteria he perceives a plate tossed into the air by a student. Because of his domain expertise, he notes the rate at which it spins and wobbles are different. He perceives this as an opportunity to play with physics by figuring out the ratio. Significantly, he perceives the plate's affordance while he is in incubating mode, which was engendered when he stopped working on his research. Although the plate

---

1 For example, research suggests people's visual perception changes as they develop expertise in a domain.
might seem a new creative problem to pursue, it is a process through which he gains insight on his research program. He sees with the plate to develop a new perspective on his creative problem. Working out the ratio, he devises a plan allowing him to resume productive work on his research, eventually leading to a breakthrough and the Nobel Prize.

Stage models of creativity do not capture the iterative, physically situated nature of incremental breakthroughs on a creative problem that creative practitioners describe. Stories like Feynman’s, Poincaré’s, and others help to reveal the dynamical relationship between person and environment during creativity. Gibson’s affordance theory of visual perception provides a foundation upon which to develop understanding of this relationship. However, to empirically examine the creative process as a form of physically situated cognition, it must be extended to include key personal characteristics and environmental factors impacting creative processes and outcomes. The framework proposed in this paper aims to provide a first step toward that goal. By linking process, and place, it may provide a useful structure to bridge research in creativity, cognitive science, and architectural design toward developing an ecological model of creative processes.

LIMITATIONS AND FUTURE RESEARCH

Analysis presented in this paper was limited to examination of existing first-person and biographical accounts of creativity by creative practitioners and therefore excluded perspectives from creative practitioners who were not compelled to write about their processes. It is possible those who write about creativity may not adequately represent the entire creative practitioner population. Most narratives were written by people who had quite a bit of freedom to work where, when, and how they wished. This provided a wealth of data, but does not represent the typical corporate office employee.14 There are more personal accounts by authors, than, for example, musicians. Authors may be more inclined to write personal accounts or some creative practitioners may feel they have less to write about; there may be people who believe their creative processes are not dependent upon physical conditions and thus are not compelled to write about them. Although efforts were made to include a diversity of creative perspectives (e.g., from the arts, design, humanities, math, and science) not every creative field is represented in this analysis. This paper also aimed to identify domain general (independent)15 modes of creativity, thus disciplinary and individual process differences are not considered. Finally, it focused solely on narratives about ideation modes of the creative process; it did not consider other stages of creativity that might also be physically situated (such as problem finding or implementation).

Much more research is needed (and from multidisciplinary perspectives) to better understand how physical contexts impact — and ways architectural designs might support — human creativity. As a small step toward a rather lofty goal, this paper attempts to provide some evidence of how creativity is physically situated in architectural settings. It does so by (1) identifying common (domain-general) modes of creative thinking, (2) organizing first person and biographical accounts describing the things creative people do when engaged in these creative modes, (3) analyzing these through the lens of situated cognition with the embodied, embedded and enactive cognition theses, and (4) illustrating person-environment relationships they describe in a theoretical framework integrating complementary concepts from enactive cognition and ecological psychology. Next steps in this research program include:

1. Extending the framework to include problem-finding and implementing modes, through:
   a. Analysis of first-person and biographical accounts, to identify other physically situated processes.
   b. Testing explanatory power against documented impacts of architectural designs on creative productivity.
   c. Testing predictive power through case and quasi-experimental studies of creative practitioners in workplace settings (pre- and post-occupancy).

2. Identifying additional environmental mechanisms relevant to understanding potential impacts of architectural design strategies including:
   a. Other environmental factors involved in engendering, sustaining, and/or inhibiting modes of creativity and relationships between them.
   b. Design variables in architectural settings with respect to modes of creativity.
   c. Organizational factors impacting how people use settings.

3. Develop a dynamic systems model integrating person, cognitive, social and physical factors
   a. Including separating domain-general, domain-specific, and subject/personal processes involved in physically situated processes.

CONCLUSION

Anecdotes about creativity suggest people’s processes involve embodied, embedded, and enactive forms of cognition, with the intertwined nature of thinking and acting a common theme. The physical context of creativity, including architectural settings where people work, remains largely unexamined — in part because of the complexity involved in empirically studying it. Economic pressure on companies to capitalize not only on employee creative productivity by also on every square foot of floor space reveals the untapped potential of architectural designs to add creative value to organizations (De Paoli et al., 2013). Yet there is no theoretical framework appropriate for guiding design decisions or predicting post-occupancy impacts in spaces...
to support creativity. Roughly 30 years ago, Gibson (1976, p. 413) complained “architecture and design do not have a satisfactory theoretical basis” and many in the profession feel this statement holds true today (Hensel et al., 2009; Lang and Moleski, 2010). Complementary concepts from Gibson’s theory of affordances and the enactive thesis of human cognition may together begin to provide the framework for a functional theory linking cognition, behavior, and environmental design. The model proposed in this paper suggests the benefits such an integrative approach could have for architects and creativity researchers in guiding future scientific research and design practices.

ACKNOWLEDGMENTS

Thanks to my colleagues at the University of Colorado for inspiring early ideas developed in this paper — Raymond McCall for introducing me to design rationale and encouraging my transformation from architectural practitioner to researcher/theoretician, Louise Chawla for her expertise in ecological psychology and emotional support, Michael Eisenberg for conversations about artificial intelligence and learning, and Gerhard Fischer for facilitating inspirational colloquia on topics in creativity and design.

REFERENCES

Aalto, A. (1997). “Trout and the mountain stream,” in Alvar Aalto in His Own Words, ed. G. Schildt (New York, NY: Rizzoli).
Allen, S., and Agrest, D. (2009). Practice: Architecture, Technique Representation. New York, NY: Routledge.
Amabile, T. M. (1996). Creativity in Context. Boulder, CO: Westview Press.
Armbruster, B. B. (1989). “Metacognition in creativity,” in Handbook of Creativity, eds E. P. Torrance, J. A. Glover, R. R. Ronning, and C. R. Reynolds (New York, NY: Plenum Press).
Barron, F. (1988). “Putting creativity to work,” in Louder than Words: The New Science of How the Mind Makes Meaning. New York, NY: Basic Books.
Berger, J. (2005). How Buildings Learn: What Happens after They’re Built. Boulder, CO: Westview Press.
Brand, S. (1994). Frontiers in Psychology | www.frontiersin.org 17 January 2016 | Volume 6 | Article 1978
Clark, A. (1999). An embodied cognitive science? Trends Cogn. Sci. 3, 345–351. doi: 10.1016/S1364-6613(99)01361-3
Clark, A. (2001). Being There: Putting Brain, Body, and World Together Again. Cambridge, MA: MIT Press.
Clark, A. (2008a). Pressing the flesh: a tension in the study of the embodied, embedded mind? Philos. Phenomenol. Res. 76, 37–59. doi: 10.1111/j.1933-1592.2007.00114.x
Clark, A. (2008b). Supervising the Mind: Embodiment, Action, and Cognitive Extension. New York, NY: Oxford University Press.
Cohen, J. R., and Ferrari, J. R. (2010). Take some time to think this over: the relation between rumination, indecision, and creativity. Creat. Res. J. 22, 68–73. doi: 10.1080/10400410903579601
Coleridge, S. T. (1816). Christabel; Kubla Khan, a Vision; The Pains of Sleep. London: Printed for J. Murray by W. Bulmer and Co.
Crick, F. (1990). What Mad Pursuit: A Personal View of Scientific Discovery. New York, NY: Basic Books.
Cross, N. (2006). Designerly Ways of Knowing. London: Springer.
Csikszentmihalyi, M. (1990). Flow: The Psychology of Optimal Experience. New York, NY: Harper & Row.
Csikszentmihalyi, M. (1996). Creativity: Flow and the Psychology of Discovery and Invention. New York, NY: Harper Perennial.
Dart, P. (1989). “Bus-bath-bed: a rationale for irrational predicate identifications in the service of creativity,” in Proceeding of the 75th Annual Meeting of the Speech Communication Association, San Francisco, CA.
de Korte, E., Lottie K., and van der Kleij, R. (2011). “Effects of meeting room interior design on team performance in a creativity task,” in Ergonomics and Health Aspects of Work with Computers, ed. M. M. Robertson (Berlin: Lecture Notes in Computer Science), 59–67.
de Paoli, D., Arge, K., and Blakstad, S. H. (2013). Creating business value with open space flexible offices. J. Corp. Real Estate 15, 181–193. doi: 10.1108/JCRE-11-2012-0028
Diehl, M., and Stroebe, W. (1991). Productivity loss in idea-generating groups: tracking down the blocking effect. J. Pers. Soc. Psychol. 61, 392–403. doi: 10.1037/0022-3514.61.3.392
Diehl, M., and Stroebe, W. (1987). Productivity Loss in Idea-generating Groups: toward the Solution of a Riddle. J. Pers. Soc. Psychol. 53, 497–509. doi: 10.1037/0022-3514.53.3.497
Dijksterhuis, A. P., and Meurs, T. (2006) . Where creativity resides: the role of the physical work environment. Ext. Consc. Cogn. 9, R478–R479. doi: 10.1016/j.concog.2005.04.007
Dul, J., and Ceylan, C. (2011). Work environments for employee creativity. Ergonomics 54, 12–20. doi: 10.1080/00140139.2010.542833
Dul, J., Ceylan, C., and Jaspers, F. (2011). Knowledge workers’ creativity and the role of the physical work environment. Hum. Res. Manag. 50, 715–734. doi: 10.1002/hrm.20454
Eisenberg, P. (2010). “Diagram: an original scene of writing,” in The Diagrams of Architecture, ed. M. Garcia (Chichester: Wiley).
Ekvall, G., and Tangeberg-Andersson, Y. (1986). Working climate and creativity: a study of an innovative newspaper office. J. Creat. Behav. 20, 215–225. doi: 10.1002/j.2162-6057.1986.tb00438.x
Ekvall, G., and Tangeberg-Andersson, Y. (1986). Working climate and...
Kazmiernczak, E. T. (2003). Design as meaning making: from making things to the design of thinking. Des. Issues 19, 45–59. doi: 10.1102/074936036755770140
Kipling, R. (1937). “Working-Tools,” in Something of Myself: For My Friends Known and Unknown (Garden City, NY: Doubleday, Doran & Co).
Kirsh, D., and Maglio, P. (1994). On distinguishing epistemic from pragmatic action. Cogn. Sci. 18, 513–549. doi: 10.1207/S15516709cog1804_1
Kohn, N. W., and Smith, N. M. (2011). Collaborative fixation: effects of others’ ideas on brainstorming. Appl. Cogn. Psychol. 25, 359–371. doi: 10.1002/acp.1699
Lakoff, G., and Johnson, M. (1980). Metaphors We Live by. Chicago, IL: University of Chicago Press.
Lakoff, G., and Johnson, M. (1999). Philosophy in the Flesh: The Embodied Mind and Its Challenge to Western Thought. New York, NY: Basic Books.
Lang, J. T., and Molecki, W. (2010). Functionalism Revisited: Architectural Theory and Practice and the Behavioural Sciences. Farnham: Ashgate.
Leidlmair, K., (ed.) (2009). After Cognitivism: A Reassessment of Cognitive Science and Philosophy. Dordrecht: Springer. doi: 10.1007/978-1-4020-9992-2
Leslie, S. W. (2008). “A different kind of beauty”: scientific and architectural style in I. M. Pei’s Meso Laboratory and Louis Kahn’s Salk Institute. Hist. Stud. Nat. Sci. 38, 173–221. doi: 10.1525/hsns.2008.38.2.173
Leslie, S. W. (2010). Laboratory architecture: building for an uncertain future. Phys. Today 63:40. doi: 10.1063/1.3397042
Leung, A. K., Kim, S., Polman, E., Ong, L. S., Qiu, L., Gonzalo, J. A., et al. (2012). Embodied metaphors and creative ‘acts.’ Psychol. Sci. 23, 502–509. doi: 10.1177/0956797611422901
Lubart, T. I. (2001). Models of the creative process: past, present and future. Creat. Res. J. 13, 295–308. doi: 10.1207/S15326934CRJ1304_07
Mahon, B. Z., and Caramazza, A. (2008). A critical look at the embodied cognition hypothesis and a new proposal for grounding conceptual content. J. Physiol. 102, 59–70. doi: 10.1016/j.physletb.2008.03.004
Maier, J. R. A., Fadel, G. M., and Battisto, D. G. (2009). An affordance-based approach to architectural theory, design, and practice. Des. Stud. 30, 393–414. doi: 10.1016/j.destud.2009.01.002
Mallgrave, H. F. (2011). The Architect’s Brain: Neuroscience, Creativity, and Architecture (Phk. ed.), Malden, MA: Wiley-Blackwell.
Mallgrave, H. F. (2013). Architecture and Embodiment: The Implications of the New Sciences and Humanities for Design. New York, NY: Routledge.
Maravita, A., and Iriki, A. (2004). Tools for the body (schema). Trends Cogn. Sci. 8, 79–86. doi: 10.1016/j.tics.2003.12.008
Mayer, A., Kudar, K., Bretz, K., and Tihanyi, J. (2008). Body schema and body awareness of amputees. Prosthet. Orthot. Int. 32, 363–82. doi: 10.1093/prosthetics/306.0802024971
McCoy, J. M. (2005). Linking the physical work environment to creative context. J. Creat. Behav. 39, 169–191. doi: 10.1002/jcb.20162-6057.2005.tb01257
McCoy, J. M., and Evans, G. W. (2002). The potential role of the physical environment in fostering creativity. Creat. Res. J. 14, 409–426. doi: 10.1207/S15326934CRJ1434_11
Mehta, R. Z., and Cheema, A. (2012). Is noise always bad? Exploring the effects of ambient noise on creative cognition. J. Consum. Res. 39, 784–799. doi: 10.1086/665048
Mullen, B., Johnson, C., and Salas, E. (1991). Productivity loss in brainstorming groups: a meta-analytic integration. Basic Appl. Soc. Psychol. 12, 3–23. doi: 10.1207/s15324834bas1201_1
Mumford, M. D., Mobley, M. L., Reiter-Palmonc, R., Uhlman, C. E., and Doarase, L. M. (1991). Process analytic models of creative capacities. Creat. Res. J. 4, 91–122. doi: 10.1207/s15326934crj0401_11
Murray, H. A. (1938). Explorations in Personality: A Clinical and Experimental Study of Fifty Men of College Age. New York, NY: Oxford university press.
Noë, A. (2004). Action in Perception. Cambridge, MA: MIT Press.
Norman, D. A. (1998). The Design of Everyday Things. London: MIT Press.
O’Brien, M. J., and Laland, K. N. (2012). Genes, culture, and agriculture: an example of human niche construction. Curr. Anthropol. 53, 434–470. doi: 10.1086/666585
Osborn, A. F. (1953). Applied Imagination: Principles and Procedures of Creative Thinking. New York, NY: Scribner.
Pallasmaa, J. (2005). *The Eyes of the Skin: Architecture and the Senses*. Chichester: Wiley-Academy.

Pallasmaa, J. (2010). *The Thinking Hand: Existential and Embodied Wisdom in Architecture*. Chichester: Wiley.

Peltason, R. A., and Ong-Yan, G. (2010). *Architect: The Work of the Pritzker Prize Laureates in Their Own Words*. New York, NY: Black Dog & Leventhal.

Poincaré, H. (1954). “Mathematical creation,” in *The Creative Process*. New York, NY: Harcourt, Brace & Company.

Pulvermüller, F., Hauk, O., Nikulin, V. V., and Ilimoeniemi, R. J. (2005). Functional links between motor and language systems. *Eur. J. Neurosci.* 21, 793–97. doi: 10.1111/j.1460-9568.2005.03900.x

Reed, E. (1996). *Encountering the World: Toward an Ecological Psychology*. New York, NY: Oxford University Press.

Rhodes, M. (1961). An analysis of creativity. *Phi Delta Kappan* 42, 305–310.

Robbins, P., and Aydede, M. (2009). "A short primer on situated cognition," in *The Cambridge Handbook of Situated Cognition*, eds P. Robbins and M. Aydede (New York, NY: Cambridge University Press), 3–10.

Rossman, J. (1931). *The Psychology of the Inventor: A Study of the Patentee*. Washington, DC: The Inventors Publishing Co.

Runco, M. A. (2007). *Creativity: Theories and Themes: Research, Development, and Practice*. Amsterdam: Elsevier Academic Press.

Saifer, K. (2011). Creativity as social and spatial process. *Facilities* 29, 6–18. doi: 10.1080/02632771111101296

Sawyer, R. K. (2012). *Explaining Creativity: The Science of Human Innovation*. New York, NY: Oxford University Press.

Schön, D. (1983). *The Creativity Conundrum: A Symposium*, ed. B. Ghiselin (Berkeley, CA: University of California Press), 22–31.

Sternberg, R. J. (2006). *Creating a Vision of Creativity: The First 25 Years*. Chichester: Wiley.

Sternberg, R. J. (1999). *Handbook of Creativity*. New York, NY: Cambridge University Press.

Thompson, E., and Stapleton, M. (2009). *Making sense of sense-making: reflections on enactive and extended mind theories*. *Topoi* 28, 23–30. doi: 10.1007/s11245-008-9043-2

Tornqvist, G. (2004). Creativity in time and space. *Geogr. Ann. Ser. B Hum. Geogr.* 86, 227–243. doi: 10.2307/3554349

Van Gundy, A. B. (1987). *Creative Problem Solving: A Guide for Trainers and Managers*. New York, NY: Greenwood Press.

Varela, F. G., Maturana, H. R., and Uribe, R. (1974). *Autopoiesis: the organization of living systems, its characterization and a model*. *Biosystems* 5, 187–196. doi: 10.1016/0303-2647(74)90031-8

Varela, F. J., Thompson, E., and Rosch, E. (1991). *The Embodied Mind: Cognitive Science and Human Experience*. Cambridge, MA: MIT Press.

Vithayathawornwong, S., Danko, S., and Tolbert, P. (2003). The role of the physical environment in supporting organizational creativity. *J. Inter. Design* 29, 1–16. doi: 10.1111/j.1939-1668.2003.tb00381.x

Waber, B., Magnolli, J., and Lindsay, G. (2014). Workspaces that move people. *Harv. Bus. Rev.* 92, 68–77.

Wallas, G. (1926). *The Art of Thought*. New York, NY: Harcourt, Brace and Company.

Ward, D., Roberts, T., and Clark, A. (2011). Knowing what we can do: actions, intentions, and the construction of phenomenal experience. *Synthese* 181, 375–394. doi: 10.1007/s11229-010-9714-6

Ward, D., and Stapleton, M. (2012). "Es are good: cognition as enacted, embodied, embedded, affective, and extended," in *Consciousness in Interaction: the Role of the Natural and Social Context in Shaping Consciousness*, ed. F. Paglieri (Philadelphia, PA: John Benjamins Publishing).

Ward, T. B., and Kolomynyts, Y. (2010). “Cognition and creativity,” in *The Cambridge Handbook of Creativity*, eds J. C. Kaufman and R. J. Sternberg (New York, NY: Cambridge University Press).

Wasiński, E. A. C. (1902). “Immanuel kant in seinen letzten lebensjahren: ein beitrag zur kenntnis seines charakters und haushalens leben aus dem tâglichen umgang mit ihm. 1804,” in *Immanuel Kant, ein lebensbild. Nach Darstellungen der Zeitgenossen Jachmann, Borowski, Wasianski*, ed. A. Hoffmann (Halle: Hugo Peter), 288–432.

Watson, J. D. (1968). *The Double Helix: A Personal Account of the Discovery of the Structure of DNA*. New York, NY: Atheneum.

Wilson, M. (2002). *Six views of embodied cognition*. *Psychon. Bull. Rev.* 9, 625–636. doi: 10.3758/BF03196322

Yaneva, A. (2009). *Made by the Office for Metropolitan Architecture: An Ethnography of Design*. Rotterdam: 010Publishers.

Yaneva, A. (2010). "The atrium as more important than the lab? Designer intentions, and the construction of phenomenal experience. *Synthese* 181, 375–394. doi: 10.1007/s11229-010-9714-6

Conflict of Interest Statement: The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2016 Malinin. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.