The Architecture of Creativity: *Toward a Causal Theory of Creative Workspace Design*

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The question of how the physical work environment can affect creativity is gaining interest among companies and educational institutions. This paper introduces ten propositions outlining possible relationships between spatial characteristics and creative work. The propositions were developed following a grounded-theory approach based on nine expert interviews that provide insight on the topic from the perspective of different creative fields—namely, urban planning, architecture, interior design, office planning, furniture design, industrial design, design thinking, innovation, and fine arts. We focused on both educational and practice environments within the creative sector. For each proposition, we provide links to supporting literature. We present a summary of the main insights and visualize the developed propositions as a set of causal graphs. The propositions have implications for both research and practice: on the one hand, they can be regarded as the first step toward a theory of creativity-supporting work environments; on the other hand, they can serve as a reference when designing or adjusting creative workspaces.

Keywords – Architectural Design, Creative Space, Creativity, Grounded Theory, Workspaces for Design.

Relevance to Design Practice – The ten propositions presented in this paper can be of value for design practitioners and spatial planners because they provide insights on the possible impact of spatial design decisions on creativity and innovation efforts.

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Introduction

So-called creative spaces are being implemented in educational and corporate organizations worldwide with the intention of better facilitating creativity and innovation processes among co-workers. The design of such work and study environments is highly influenced by well-known examples, such as Google or WeWork—companies that were at the forefront of incorporating design elements like open-plan office spaces with lots of plants, games, and relaxation areas. The image conveyed by these companies can lead to the assumption that an organization could easily transform into a successful innovation game changer by simply installing beanbags and lounge areas. Unfortunately, it is not that simple. Creative space is a complex system with multiple interacting parts. Therefore, the possible impact of spatial design decisions on creativity and innovation needs to be understood and carefully considered when designing a creative work environment. However, as stated by Amabile et al. (1996), "there is almost no empirical research on the effects of work environments on creativity" (p. 210). Consequently, the following research question guided our study:

> *RQ: What are the spatial conditions that facilitate creativity and innovation, and how can these be supported through literature?*

Thus, in this paper, we aim to provide a structured investigation of how the built environment might be able to facilitate creative activities and outcomes. We begin by outlining the *theoretical foundations*, which include relevant creativity concepts and related literature about creative space theories. We continue by describing our *methodology* for developing a causal theory based on a grounded theory approach with nine expert interviews. We then proceed by describing the *propositions* developed to suggest a possible impact of space on creativity. We conclude by *discussing* the main findings of this paper, as well as its limitations, and provide an outlook for future work.

Theoretical Foundations

In this section we establish the theoretical foundations that guide our theory development. We first dwell on various creativity concepts, then we offer a definition of creative workspaces, and finally, we take a closer look at existing studies and related theories about creative workspace design.

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Creativity Concepts

Numerous definitions of creativity exist. Most authors distinguish between creativity as an outcome (a creative solution) and creativity as a process. A creativity outcome should be novel (both original and unique), meaningful, and useful at the same time (Amabile et al., 1996; Boden, 1996; Sääksjärvi & Gonçalves, 2018; Sarkar & Chakrabarti, 2007; Sawyer, 2006; Stein, 1953; Sternberg, 1988; Weisberg, 2006). Gero (1996) added *unexpectedness* as a further aspect to this definition of creativity, and Simonton (2012) added *surprise*, which is similar to unexpectedness. The most widely accepted definition of creativity as a process is still the one developed by Wallas (1926), who proposed a four-step creative problem-solving process. These steps are *preparation* (investigation of the problem in all directions), *incubation* (unconscious processing), *illumination* (sudden insight and creation of a solution), and *verification* (critical elaboration and validation of the idea). Several authors suggested that elaboration needs to be separated from validation, because early critique would kill creativity (Osborn, 1953).

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In order to select relevant creativity concepts that shall guide our theory development, we have taken two different lenses: a process lens and a cognitive lens. Both perspectives will help us to tell a more complete story regarding how an external factor (the space) impacts creativity.

First, we consider creativity not as a singular activity happening in a vacuum but rather as a sequence of different activities which leads to the creation of ideas and insights. Our research focuses on the ability of the built environment to facilitate such *creative activities*. Hence, the definitions of creativity as a process are more relevant for our study. Accordingly, our research question centers on the questions if and, if yes, how the environment can facilitate (1) *preparation*, (2) *incubation*, (3) *illumination*, (4) *elaboration*, and (5) *verification*.

Besides Wallas's (1926) four-stage model of creativity, other concepts are equally relevant to our theory development. Building on Wallas's definition, Guilford (1950) introduced the concept of (6) *divergent thinking* and (7) *convergent thinking* as modes of thought to explain creativity. Divergent thinking means producing a large quantity and variety of ideas, whereas convergent thinking describes the process of narrowing down to one solution—concepts that are also popular in current design thinking (Brown, 2009).

Later, Guilford (1967) differentiated divergent thinking further into (8) *flexibility* (the variety of ideas diverging into different directions) and (9) *fluency* (the quantity of ideas produced), which are seen as important elements of a creative process. These concepts were considered in our theory development as well.

Wallas's model of the creative process did not, however, suggest any deliberate synthesizing and structuring of research insights—a concept known as *synthesis* and *point of view* in design thinking (Brown, 2009). Hence, we add (10) *synthesis* to our list of relevant creativity concepts.

Secondly, to explore these creativity-related concepts from a cognitive perspective, we take a look at related concepts from cognitive theory. Therefore, adding to the aforementioned concepts, other creativity-related concepts will guide our theory-development process, such as (11) *fixation*—the inappropriate repetition of existing solutions (Cardoso & Badke-Schaub, 2011a; Jansson & Smith, 1991; Purcell & Gero, 1996), (12) *priming*—the activation of a specific, for example creative, mindset (Sassenberg et al., 2017), and (13) *serendipity*—the unexpected finding of valuable ideas, persons, and things (Goldschmidt, 2015; Meusburger et al., 2009).

The brain switches frequently between two cognitive modes: *focused mode* and *diffused mode* of thinking (Immordino-Yang et al., 2012; Moussa et al., 2012; Oakley, 2014; Raichle & Snyder, 2007). The focused mode (also called highly attentive state) is "a direct approach to solving problems using rational, sequential, analytical approaches" (Oakley, 2014, p. 12) and is mostly linked to the prefrontal cortex. In the diffused mode (also called resting state network or default mode network), the mind wanders and connects different areas of the brain in a more relaxed manner (Oakley, 2014). The focused and diffused modes

are similar to De Bono's (2009) concepts of vertical and lateral thinking and Guilford's (1950) concepts of *convergent thinking* and *divergent thinking* (as outlined earlier). The diffused mode is associated with higher creativity, especially when divergent thinking is involved (Takeuchi et al., 2012).

Table 1 summarizes the 13 creativity-related concepts that were considered for our theory development. We will refer to these concepts throughout the paper to illustrate the anticipated impact of our propositions.

Our goal is to offer an overview of relevant creativity concepts, rather than focusing on one creativity theory, only. These different dimensions of creativity could each be affected through the spatial environment and, hence, will be included in our proposition formation.

Creative Space

Thoring et al. (2020) define creative spaces as physical structures and elements at different scales that are able to support creative work processes and to facilitate creativity. The scales of the physical structures and elements can vary—for example, from pieces of furniture, the room's layout and interior design, the architectural building, to the location within a specific urban context. The concept of creative space covers environments in both educational and corporate contexts, as well as special forms such as incubators, makerspaces, co-working spaces, and innovation labs (Thoring et al., 2020).

Related Literature

There is a long history of research that investigates the effects of space on work productivity (Oseland, 1999). In the last few decades, creativity and innovation have become a bigger part of work, being considered essential 21st century skills for the future of the workplace (World Economic Forum, 2016). Therefore, interest in the connection between workspace and creativity has grown. Several studies have investigated creative spaces of practitioners (e.g., Kristensen, 2004; Moultrie et al., 2007). Simultaneously, an increased interest in creative learning environments has emerged in the area of elementary schools and kindergartens (e.g., Boys, 2010; Dudek, 2000; Ehmann et al., 2012; Kaup et al., 2013). Some authors have looked particularly at creative learning spaces in design-focused educational contexts (Cannon & Utriainen, 2013; Jankowska & Atlay, 2008; Jones & Lloyd, 2013; Leurs et al., 2013; Setola & Leurs, 2014; Weinberg et al., 2014), but most of them addressed only specific topics, such as virtual creative spaces or environments for media studies.

A systematic literature review on creative spaces by Thoring et al. (2020) yielded only five sources that presented a causal theory of creative spaces that would explain any possible relationships between spatial designs and creativity: Martens (2008), McCoy (2005), Meinel et al. (2017), Paoli et al. (2017), and Thoring et al. (2017).

Martens (2008) presented a hypothetical framework based on a case study, outlining how the physical work environment contributes to creativity and creative work processes. The framework positions creativity, creative work, and an appropriate work environment. The identified critical factors were layout, furniture, color, finishing, and light. More specifically, he identified several aspects as conducive to creativity: open space, spaciousness, unconventional architecture, interim showcases, indoor climate, an adequate noise level, bright colors, and haptic textures.

McCoy (2005) looked into the literature on team creativity in organizations that linked creative team characteristics and social influences to properties and attributes of the physical

Table 1. Relevant creativity-related concepts utilized for theory development.

#	Concept	Explanation	Source
1	Preparation	Investigation of the problem in all directions	Wallas (1926)
2	Incubation	Unconscious processing	Wallas (1926)
3	Illumination	Sudden insight	Wallas (1926)
4	Elaboration	Adding detail; narrowing down toward fewer solutions (part of convergent thinking)	Osborn (1953)
5	Verification	Critical validation and selection	Wallas (1926)
6	Divergent Thinking / Diffused Mode	The process of expanding the problem and solution space in order to explore a large variety of design directions	Guilford (1950) Oakley (2014)
7	Convergent Thinking / Focused Mode	The process of narrowing down the problem and solution space towards a smaller set of solutions	Guilford (1950) Oakley (2014)
8	Flexibility	Variety of ideas (part of divergent thinking)	Guilford (1967)
9	Fluency	Quantity of ideas (part of divergent thinking)	Simonton (1999) Guilford (1967)
10	Synthesis	Conscious, deliberate processing	Brown (2008)
11	Fixation	Inappropriate repetition of existing ideas	Purcell & Gero (1996)
12	Priming	Activation of a specific mindset	Sassenberg et al. (2017)
13	Serendipity	Unexpected finding of ideas, persons, and things	Goldschmidt (2015)

office environment. Five categories that influence the physical environment and social behavior emerged from this literature review: spatial organization, architectonic detail, view, resources, and ambient conditions. She identified several aspects as positive for creativity: remoteness from the daily work, spaciousness, proximity and short distances, vistas in between and across rooms, face-to-face meeting spaces, informal lounge areas, personalized space, writeable surfaces like whiteboards, and technical infrastructure.

Based on a literature review of 17 articles, Meinel et al. (2017) identified several categories of interest regarding creativity-supporting physical work environments: They defined five aspects regarding spatial layout (privacy, flexibility, office layout, office size, complexity), four space types (relaxing space, disengaged space, doodle space, unusual/fun space), and several tangible office elements (furniture, plants, equipment, window/view, decorative elements, materials) as well as intangible office elements (sound, colors, light, temperature, smell). They summarized the results in a framework. They identified several aspects as supportive for creativity, such as available materials and tools, a good indoor climate, positive smells and sounds, complex shapes and ornaments, decoration and art, and greenery.

Paoli et al. (2017) presented a set of design characteristics that would be able to facilitate creativity, clustered into five different themes (home, sports and play, technology, nature, and symbolism). Among the aspects they identified as conducive to creativity were: field access, open space, spaciousness, greenery, cozy capsules, toys and games, sports facilities, communal tables, style and atmosphere, ambient light, bright colors, pale colors, and natural materials.

Thoring et al. (2017) investigated the possible impact of the physical environment on creativity in educational contexts. Based on eight semi-structured interviews, the authors presented a set of 12 propositions that tried to explain a positive impact of specific spatial designs on creativity. These propositions were: surprising space, space as a platform for ideas, creative chaos, visual stimuli, reduced stimulation, tactile/olfactory/acoustic stimuli, making spaces, open views, bodily activity and movement, playful and experimental atmosphere, creative labelling, and social interaction. The 12 propositions were supported by relevant literature. However, the results were limited to educational environments, only.

The analyzed literature has shown that although there have been a few attempts to explain the possible causal relationship between workspace and creativity, most sources did not provide a sound theoretical underpinning of existing creativity theories, and others were limited to specific (e.g., educational) contexts. Consequently, a comprehensive overview of the influence of a creative space in relation to general theories of creativity still needs to be developed (Thoring et al., 2020). With this study, we are attempting to provide a first step toward this endeavor.

There exist numerous further sources that address the concept of creative workspace designs from various angles. However, as this is outside of the goal of this paper, we refrain from discussing these sources in detail and, instead, refer the reader to the conclusive systematic literature review provided by Thoring et al. (2020).

Methodology

Proposition Development

According to Jaccard and Jacoby (2010) a causal theory can be developed either based on a grounded theory approach (Corbin & Strauss, 2014) or based on a confirmative approach involving experimental testing or some other form of theory validation. We pursue the first approach—grounded theory, which means that we constructed our propositions through the collection and analysis of qualitative data. More specifically, we conducted nine expert interviews and substantiated the resulting insights with related literature. A validation of the developed propositions is not part of this paper but dedicated to future work.

It is noteworthy that our developed propositions are probabilistic, not deterministic, which means that we searched for factors that make the outcome in general more likely (Jaccard & Jacoby, 2010). We do not claim that these propositions are valid for everybody in all circumstances. Instead, we are interested in the rich insights related to possible contingencies. Therefore, our main sources for the propositions, besides literature, are qualitative interviews. This set of propositions leads us toward a qualitative probabilistic causal theory (Pearl, 2000) of creative workspace design.

Expert Interviews

We conducted nine semi-structured interviews with experts from the fields of design education, innovation, product design, art, workplace furniture, office planning, urban planning, architecture, and interior design. We chose these experts in order to include corner cases that cover a wide variety of different perspectives on the topic of creative environments. The term *corner case* (Langer et al., 2007; Meck, 2013) originates from the engineering discipline and refers to the approach to study extreme cases rather than averages. We pick-up on this concept and include interviewees as cases that could provide broad perspectives on creative work and behavior. The selected interviews provided insights into the topic from nine different angles:

1. Urban planning (URB): This expert is a design professor for social and communication design. Her research focus is on the relevance of public and urban spaces for designers.
2. Architecture (ARC): This expert is an architect with Henning Larsen Architects—an architectural firm specializing in cultural buildings. He was leading architect for the design of several architectural projects, including the planning, design, and building of a design school in Umeå, Sweden.
3. Interior design (INT): This expert is an architect and interior designer who was responsible for the redesign of the interior of the Hasso-Plattner-Institute (HPI) School of Design Thinking in Potsdam, as well as several spatial design projects in industry (e.g., with Google).
4. Furniture manufacturing (FUR): This expert is a workplace consultant for higher education at Steelcase Furniture Manufacturing who is responsible for the German-speaking European market.

5. Industrial Design Practice (ID): This expert is a design manager at a leading design consultancy, IDEO. He provides insights from his 15+ years of work experience in IDEO's different design offices around the world.
6. Office planning (OFP): This expert was part of the *Quickborner Team* office planning consultancy—a company that introduced open-plan offices in Germany in the late 1950s and then influenced the rise of the cubicle in the U.S. (Duffy & Hannay, 1992; Saval, 2014).
7. Innovation (INN): This expert is a renowned writer who has published several books about creativity and innovation. He provides insights into the innovator's mindset.
8. Design Thinking (DT): This expert is a professor for strategic design and design thinking, as well as a design thinking consultant for several start-ups and global companies.
9. Artistic spatial design (ART): This expert works as an artist and spatial designer. Among her broad professional experience is, for example, the design of the Berlin *grund_schule der künste*—a school of art education for children that is associated with the Berlin University of the Arts' Teacher Training Programs for Fine Arts. She provides a perspective on creative spaces that addresses the peculiarities of art education, design, and elementary schools.

Figure 1 illustrates the different experts' perspectives on creative space.

The selected experts also represent cultural diversity in terms of their countries of origin and their places of work. The covered nationalities include German, American, Venezuelan, and Swedish, and their places of work include the U.S., Germany, Denmark, Switzerland, and Austria. Table 2 shows an overview of the included interviewees.

A set of open questions guided the semi-structured interviews. We structured the interviews according to three categories. First, we asked about experiences or thoughts related to five spatial qualities (i.e., organizational culture, knowledge processing, social dimension, stimulation, and process enabler) as suggested by Thoring et al. (2018). The second set of questions is related to a space's general characteristics (materials, colors, furniture, etc.) and what impact these might have on creativity, and how important these characteristics are. Finally, we asked the interviewees about

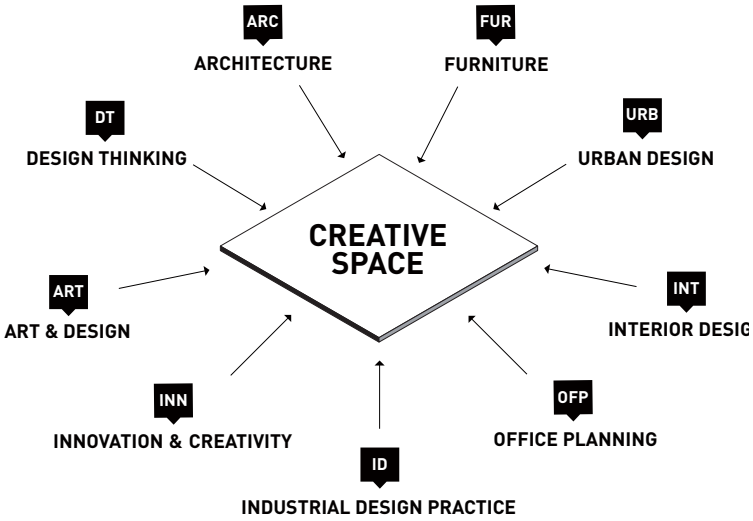

Figure 1. Nine expert interviews as corner case perspectives for creative space.

Table 2. Overview of expert interviewees.

#	ID	Experience (years)	Main Expertise
1	URB	20+	Professor for Urban and Social Design, Germany
2	ARC	10+	Architect for Umeå Design School, Sweden
3	INT	10+	Interior Architect for HPI D-School, Potsdam, Germany
4	FUR	15+	Manager for Educational Furniture at Steelcase, Germany, Austria, Switzerland
5	ID	15+	Design Manager at IDEO in the U.S. and Germany
6	DT	20+	Professor for Strategic Design and Design Thinking, Venezuela
7	INN	30+	Writer and Professor for Innovation, the U.S.
8	OFP	45+	Sociologist, Office Planner for Office Landscapes, Quickborner Team, Germany
9	ART	10+	Spatial and Furniture Designer, Germany

their personal experiences in and preferences for their own work environments. All questions were open and allowed for the sharing of personal insights and stories beyond the prepared questions. The interviews were audio recorded and later transcribed (non-verbatim). The final nine interviews totaled 11.4 hours of audio data—an average of 86 minutes per interview. We transcribed and imported the interviews into Atlas.ti for further analysis.

Data Analysis and Proposition Formation

To analyze the data, we iteratively developed a code structure based on the five spatial qualities (organizational culture, knowledge processing, social dimension, stimulation, and process enabler), as suggested by Thoring et al. (2018). Further code groups were added to identify the addressed impact of space on creativity, the prioritization (how important a certain characteristic was for the interviewees), and concrete characteristics of spatial designs (such as atmosphere, colors, or light).

Two of this paper's authors coded the interview data. We calculated an interrater agreement coefficient (Cohen's Kappa) of 0.70 by analyzing and comparing the codes from one jointly coded interview. For any identified disagreements, both raters discussed their ratings until they came to an agreement.

The first step of the analysis process was to filter all data against the code *creativity* because this study's main objective is to investigate the space's possible impact on creativity. We coded the data with this term in cases where the experts mentioned the term *creativity* either autonomously or after prompts from the interviewer and where quotes mentioned closely associated aspects such as *innovation* or *idea generation*. Thus, we coded 86 text segments where *creativity* was mentioned, which served as the basis for developing the propositions. In a second step, we checked these identified segments against other codes that appeared in close proximity because these aspects might also influence creativity. We ranked the resulting 161 adjacent codes according to the frequency with which they appeared in the interview texts. The most frequent occurrences were the sub-codes around *stimulation* and *atmosphere*. Because these aspects might also have an impact on creativity, we cross-checked all the data for these codes to gain new insights. Using this procedure, we identified additional quotes that appeared to be highly relevant to spatial impact on creativity. The quotes were clustered according to emerging categories. The two researchers grouped, regrouped, split, named, and renamed the emerging categories in several iteration rounds, in order to identify the underlying concepts. This procedure was repeated until no further categories emerged—that is, to the point of theoretical saturation (Corbin & Strauss, 2014). The resulting ten propositions are described in detail in the following section.

Ten Propositions About the Impact of Space on Creativity

In the following subsections, we present a set of ten propositions that suggest a possible influence of spatial characteristics on creativity, each of which is based on quotes from the interviews. The exemplary interview quotes constitute the main source for the development of each proposition. Where applicable, we provide relevant literature that supports (or possibly contradicts) the proposition. Figure 2 shows an abstracted graph that illustrates the possible cause-and-effect relationship between space and creativity. A spatial element or configuration could facilitate, enable, or activate a particular spatial construct (which gives name to the overall proposition) that might lead to a creativity-supporting event (the concepts described in Table 1). However, the space could also influence the construct in a negative way by reducing, limiting, or preventing the construct.

A spatial construct is influencing a creative aspect in an indirect (or *mediated*) causal relationship that includes a mediator (Jaccard & Jacoby, 2010). This mediator (in the diagram called *Explanation*) provides insights into the possible working mechanism of the proposition. Each proposition follows the same structure and is illustrated through such a graph. This abstracted *grammar* guided the further development of the ten propositions.

Proposition 1: *Sources*

P1: Space that provides visible sources is conducive to creativity.

Experts' Input

Designers often rely on visual stimulation for inspiration, which most of the interviews made evident. Such inspiring sources can be graphics and images, but also texts, books, models, materials, as well as toys and gadgets.

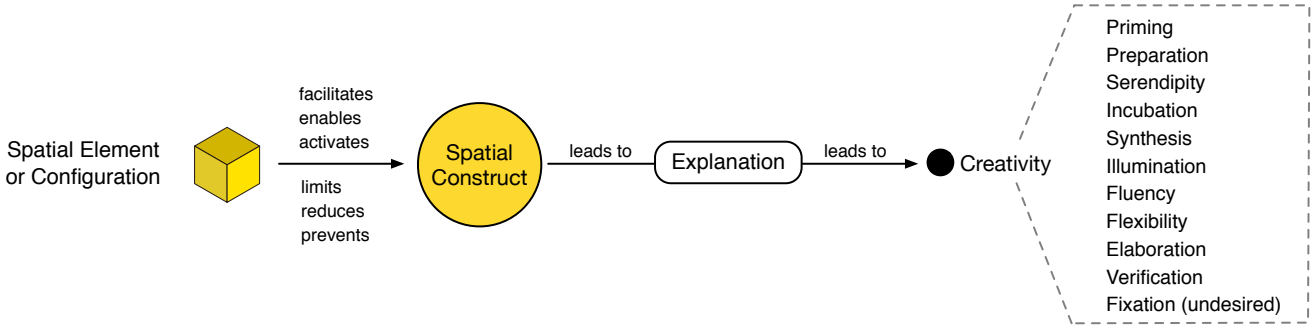

Figure 2. Abstracted *grammar* that describes the causal relationship between space and creativity.

> Quote 1: It is important to have those things that we find inspiring at hand. We have a collection of old projects to show to new clients. And a material library, books, and project reports. (ART) [translated by author].

> Quote 2: And if I start putting things or paintings on the walls and stuff, then I get a little bit distracted. […]. There are moments when distraction really pays off, and I think visual distraction creates ideas. (DT)

> Quote 3: Sometimes I bring them a box of materials with unusual stuff for prototyping (pasta, for example). It is always a surprise moment. (DT)

Evidence From Literature

This view is extensively supported by literature. Gonçalves et al. (2014) investigated the inspirational approaches of designers and identified a strong preference for visual material, mainly from the internet, but also from magazines and books. This preference seems to pay off at times, as there is a positive correlation between the presence of visual stimuli and the emergence of creativity (Goldschmidt & Smolkov, 2006). However, Goldschmidt and Sever (2011) and Gonçalves et al. (2013) also found that textual stimuli can be equally inspiring for creativity. Furthermore, the exhibition of sketches, either self-generated or created by colleagues, elicits *backtalk* (i.e., reinterpretation and reflection of visual material created; Schön, 1983). Backtalk from sketches can then elicit multiple reinterpretations and lead to creativity (Goldschmidt, 2003). Moreover, visible sources also contain knowledge that might be relevant to the creative process. However, an abundance of visible sources can be distracting or even result in creative chaos, which might hinder an effective workflow. At the same time, such *creative chaos* might lead to serendipity by providing unexpected findings (Baird et al., 2012). Clark (2007) described chaos and order as two interconnected elements of the creative process that must be in balance.

> Quote 4: For me, messy is really inspiring. Yeah. I make connections when things are really messy. […] What is messy? Messy is not knowing where things are at the moment when you need them. Instead, you are finding things you were not looking for. And that is inspiring. (DT)

The degree of acceptable chaos depends on the project status. Although one may consider an abundance of visual sources to be tolerable during a project (caused by the project's own materials), one may also consider chaos produced by old materials from previous projects to be a hindrance at the beginning of a new project. This could also result in fixation (Cardoso & Badke-Schaub, 2011b; Crilly & Cardoso, 2017) because the presence of visible material from earlier projects bears the risk of getting stuck in those old thought patterns. Thus, space should facilitate a good balance of chaos and order.

> Quote 5: I could not start a new project when the material from the previous one was still on my desk. No one would stick the new Post-it note on top of the old one. If you want to create something new, you need to start fresh, to create new associations. Otherwise, there's the risk of reproducing the same stuff again and again. During the project, however, it may be chaotic and messy [translated by author]. (INT)

Possible Spatial Facilitation

Books and other texts provide a resource for research, whereas materials and objects (such as work models) can help with understanding structural or other design principles. In that way, sources can facilitate exploration of the context in various directions (preparation). In an environment displaying an abundance of sources and materials, unexpected findings, coincidental combinations, or mistakes can occur (serendipity). Visible sources allow individuals to make new connections between them, which leads to faster and easier development of many ideas (fluency) and can result in a greater variety of ideas (flexibility). However, the presence of sources may also lead to a limitation of originality and the inappropriate copying of existing ideas. This possible fixation effect is undesired and needs to be considered carefully when providing sources within the workspace.

A space that offers an effective degree of visible sources might, for example, be structured through storage facilities to keep order and provide shelves and showcases to display and provide books, materials, work models, or other relevant material. Writeable walls and pin boards allow for the collection of inspirational materials and relevant information, that can be removed and reused according to the project at hand. Figure 3 illustrates Proposition 1 as a causal graph.

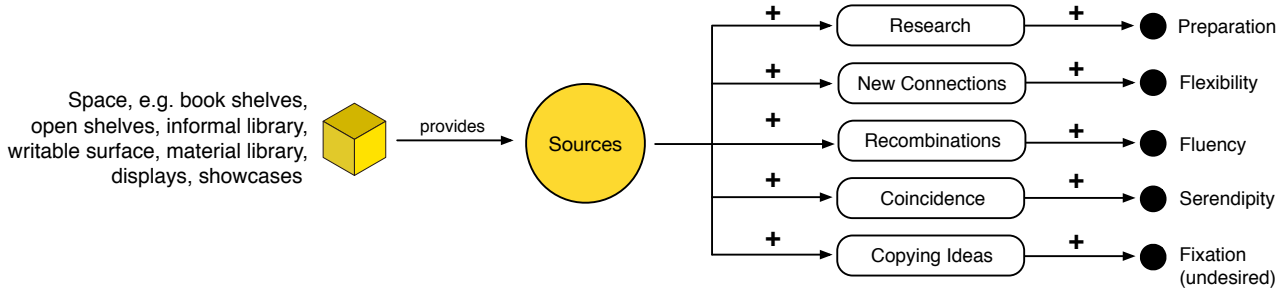

Figure 3. Components of Proposition 1—Sources.

Proposition 2: *Void*

P2: Space that provides a void is conducive to creativity.

Experts' Input

Although visual stimulation can act as a source of inspiration, the opposite—reduced stimulation and a lack of visible sources—might also be conducive to creativity, according to our interviewees.

> Quote 6: I prefer to have a white space, a white canvas, where I can spread out my thoughts. […] If you would fill everything with inspirational material, that would have to be removed later to leave empty space for the next project. (URB) [translated by author]

> Quote 7: A space should be like a stage to be filled by its users. A room that wants to be the main actor is always a bit bothersome. (ID) [translated by author]

Evidence From Literature

Empty space (conveyed by reduced stimulation or white walls) might help the mind to lose focus and to wander (Baird et al., 2012). Moreover, people often express a tendency to fill an empty space to make it look complete, a phenomenon known as the *Zeigarnik effect* in Gestalt psychology (Zeigarnik, 1938). Hence, a provided void might trigger people to fill it with their own ideas, as suggested in the following quote.

> Quote 8: I had this picture frame from my grandmother. I left it empty and I really like looking at it. I don't look at the frame; I look at the white space in the middle, and I project the ideas into it. (DT)

However, we see across our interviewees, that this is not a unanimous opinion. Some experts were skeptical about white spaces and expressed their wish for visual structures and stimuli.

> Quote 9: A totally white and empty room is awful! If I was a very contemplative person, this might work, but since I'm a communicative person I think this is terrible. It depends on your personality. Even as a contemplative person this would be disturbing, if you look at the wall and there is no visual feedback. (OFP) [translated by author]

This could be explained by designers' personal preferences: those that require visual stimulation could be considered *inspiration seekers*, while those that prefer to rely on their experience and to work in white spaces can be called *inspiration avoiders* (Gonçalves et al., 2016). Furthermore, the current state of the project might also determine different needs regarding the abundance of sources (or lack thereof). For example, during the research phase, a lot of sources might be conducive, whereas later during synthesis, a lack of sources could help to maintain focus. We will elaborate further on this discrepancy in the discussion section of this paper.

Possible Spatial Facilitation

White walls or empty rooms with reduced stimuli facilitate the diffused mode, which can trigger an incubation phase. The emptiness can also lead to people projecting their own ideas into the void—that is, to trigger an illumination effect. And finally, the reduced presence of visible sources might also be able to minimize fixation effects, especially in people who prefer to work creatively without stimulation and are wary of fixation effects (Gonçalves et al., 2016)

White walls or empty rooms with reduced stimuli facilitate the diffused mode and invite people to project their own ideas onto them. Dedicated empty areas, such as empty poster frames, might invite people to express their own ideas even more. Neutral colors and clean walls without decoration could also have the desired effect. A well-organized storage system with closed shelves and drawers might help to keep order and minimize chaos. Figure 4 illustrates Proposition 2 as a causal graph.

Proposition 3: *Encounters*

P3: Space that facilitates encounters and social interaction is conducive to creativity.

Experts' Input

Several experts stressed the importance of social interaction with creative people to share ideas and feedback. In fact, they suggested that the people are more important than the space. However, a well-designed creative space can facilitate and reinforce such encounters with co-workers, fellow students, or strangers.

> Quote 10: All innovations basically emerge in the smoking corners, these informal spaces where everybody passes by and conversations come up. (URB) [translated by author].

> Quote 11: We have designed those small extra stools that we place at each workstation. They indicate sort of an invitation… "Hey, come and sit next to me for a minute and see what I am working on." It encourages spontaneous feedback. (ART) [translated by author]

> Quote 12: Access to citizens is an important factor, for example to do user research and conduct interviews. That's why we set up our space in the city center. (URB) [translated by author].

> Quote 13: Our old office building was stretched over five floors. You literally would not meet some colleagues from the other floors for weeks. That's why we moved into this new building that is arranged more horizontally with lots of open-plan spaces. (ID) [translated by author]

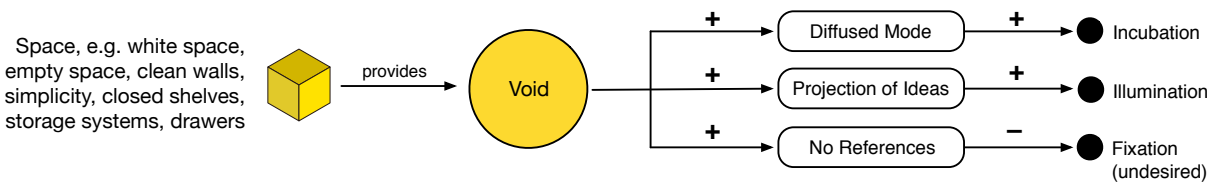

Figure 4. Components of Proposition 2—Void.

Evidence From Literature

McCoy and Evans (2002) found that spaces that promote social interaction have a positive effect on creativity. Amabile (1983), Zuo et al. (2010), Shaw (2010), and Le Dantec (2010) also supported this proposition. According to Moenaert and Caeldries (1996), spatial proximity can lead to a higher quality of communication.

Possible Spatial Facilitation

Relating *Encounters* to creativity concepts, several connections can be made. Chance encounters and related new input can lead to coincidences which might, in turn, lead to serendipity. Meeting people allows one to make new connections within existing knowledge, which can increase flexibility. And finally, field access to do user research can facilitate preparation.

Spatial instantiations that might support these effects are, among others, communal work areas or lounges that facilitate collaboration, proximity through reduced horizontal and vertical distance, open-plan office structures, as well as spare seats or high stools that provide better eye contact with passersby. Space can facilitate social interaction and chance encounters through several means, such as strategically positioned meeting points (e.g., copy machines), lounge furniture, or transparent walls, to name just a few examples. The location within the city determines access to user research. Figure 5 illustrates Proposition 3 as a causal graph.

Proposition 4: *Seclusion*

P4: Space that provides seclusion and reduced social interaction is conducive to creativity.

Experts' Input

Although creativity can strive from interactions and collaboration, there are phases in the creative process that require individual work (Paulus, 2000). In those occasions, the opposite of personal encounters—seclusion and privacy—seems to have a positive effect on creativity.

> Quote 14: If you need to think conceptually or be creative by yourself, you sometimes need this withdrawal space which is secluded—almost hermetically. You would have to exclude any distractions then. Maybe it could be with another person, but not more. (INT) [translated by author]
>
> Quote 15: You need a place where you could be alone with your ideas and that is one of the things a lot of people forget when they are building creative spaces, either at schools or agencies. (INN)

Evidence From Literature

The possibility to withdraw from frequent interruptions can help the mind to enter the focused mode (Immordino-Yang et al., 2012; Oakley, 2014). The focused mode (also called highly attentive state) is "a direct approach to solving problems using rational, sequential, analytical approaches" (Oakley, 2014, p. 12) and is mostly linked to the prefrontal cortex. Csikszentmihalyi (1990) introduced the term *flow*—a state of mind characterized by intense and focused concentration, which can be compared to the focused mode. The state of flow can also be conducive to creativity (Csikszentmihalyi, 1996).

Newport (2016) proposed privacy and reduced social interaction to allow efficient and focused work—a state of work that he called *deep work*. This view corroborates the concept of flow, although flow can also occur in social groups and does not necessarily require privacy. Both concepts do, however, propagate an elimination of distractions.

Possible Spatial Facilitation

This focused or high-attentive state of mind allows one to critically elaborate and flesh out ideas, which would support elaboration and verification of ideas. Moreover, an undistracted environment allows for preparing the creative tasks, for example by conducting desk research. Spatial instantiations that might support these effects are, among others, booths or other capsules, high-back furniture, shields, partition walls or curtains, and private rooms. Sometimes, other means of avoiding disturbances might also be useful, such as providing headphones or temporarily blocking one's availability in social media or disconnecting email and phones. Figure 6 illustrates Proposition 4 as a causal graph.

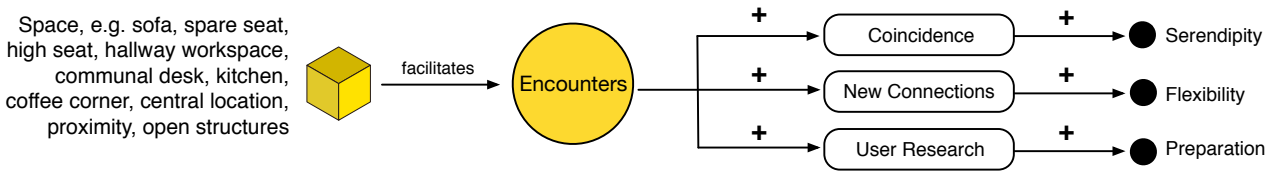

Figure 5. Components of Proposition 3—Encounters.

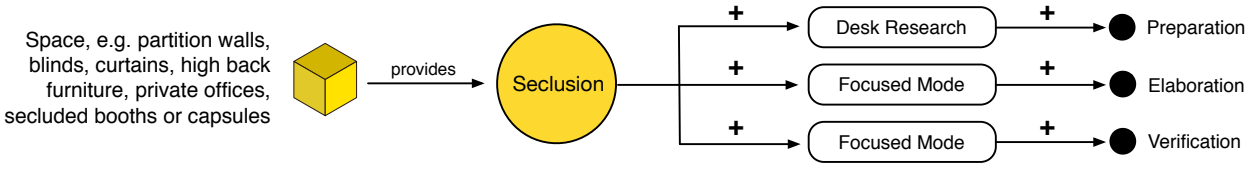

Figure 6. Components of Proposition 4—Seclusion.

Proposition 5: *Ambiance*

P5: Space that provides a balanced ambiance is conducive to creativity.

Experts' Input

In addition to visual stimuli, other senses can also be stimulated, which can influence creativity—for example, through sounds, smells, or tactility.

> Quote 16: I think materials are hugely important; I'm a very tactile person. And I think in terms of representing and promoting creativity; I think material surroundings are very important. It's stimulating. (INN)

> Quote 17: "Basically, every creative person is able to be creative anywhere. But sometimes the space does not allow that. Either I do not feel comfortable in there, or the light, the air, the atmosphere is not right […] in a way space can hinder creativity." (FUR) [translated by author]

Evidence From Literature

According to Sarkar and Chakrabarti (2008), a stimulation is a *trigger* that activates one or more senses and, hence, initiates the creative search and exploration process. Consequently, triggers can occur through visual, auditory, olfactory, tactile, or gustatory stimulation of the five senses (Ludden et al., 2012). Such stimuli create a certain ambiance in the workspace.

Mehta et al. (2012) suggested that "a moderate (vs. low) level of ambient noise is likely to induce processing disfluency or processing difficulty, which activates abstract cognition and consequently enhances creative performance" (p. 785). Other research showed that an ambient sound level can even increase creativity in highly creative individuals (Toplyn & Maguire, 1991). Olfactory cues might also be able to enhance creativity, as shown by Gonçalves et al. (2017). Furthermore, tactile structures might add to the creativity-facilitation capabilities of a space. McCoy and Evans (2002) demonstrated the importance of using materials in creativity. Natural materials, such as wood, were considered important to creativity. In addition, plants and flowers can be beneficial to the ambiance in the workspace (Ceylan et al., 2008; McCoy & Evans, 2005). According to Plambech and Konijnendijk van den Bosch (2015), a natural environment can enhance creativity by facilitating the two first phases of a creative process—preparation and incubation.

Possible Spatial Facilitation

Sensorial stimuli—such as textures, comfortable light, the smell of coffee, or certain material smells (such as from woodworking)—might lead to creativity. Other stimuli, like loud noises or unpleasant smells, can quickly become annoying or distracting, however. A well-balanced composition with appropriate incongruities between stimuli, can be crucial to the constitution of a creative space. If present to an appropriate degree, the stimuli creating the ambiance of a space might be able to facilitate the incubation phase by stimulating unconscious processing of prior information. For example, a moderate level of relaxing background music can direct the mind toward the diffused mode. Also, a close proximity of certain stimuli (e.g., workshops or coffee stations) can provide for pleasant smells in the workspace. The abundance of lights, in addition to natural daylight, can improve the ambiance of a space. Providing means to get fresh air, such as outdoor access (e.g., balconies) or dedicated outdoor work areas, can be beneficial as well. Moreover, the presence of indoor plants to provide stimulation might be considered. Figure 7 illustrates Proposition 5 as a causal graph.

Proposition 6: *Views*

P6: Space that provides views is conducive to creativity.

Experts' Input

Windows providing an open view of nature or an urban environment, as well as vistas within buildings seem to have a positive effect on creativity and inspiration.

> Quote 18: If I'm trying to write here and I'm trying to look for a creative idea, I always look outside the window. (DT)

> Quote 19: … people passing by outside the window might distract me, but also could provide new input at the same time. (FUR) [translated by author]

> Quote 20: There is a small couch near the [office] entrance. Sometimes I just go there for a 5 minutes break maybe just to look in the newspaper or just clear my mind. There you have this very nice overview; you don't see the whole thing but you see a lot of space there. You see the door where people go in and out which is fundamental that you can see who is coming in and leaving. That's one of my favorite spots. (ARC)

> Quote 21: Vistas and window views are extremely important for me. Even if that reduces my privacy. I like to be connected to the sky. It lets the mind expand. (ART) [translated by author]

Evidence From Literature

McCoy and Evans (2002) suggested that looking into a natural environment would foster creativity. The positive effect of window views is also suggested by several authors (Ceylan et al.,

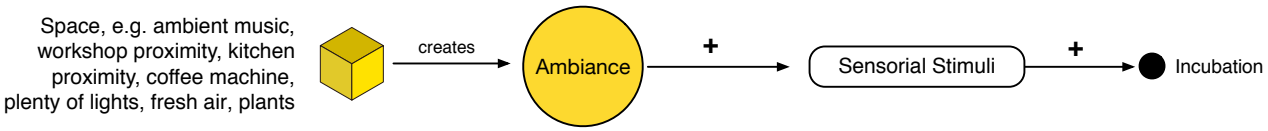

Figure 7. Components of Proposition 5—Ambiance.

2008; Dul et al., 2011; Dul & Ceylan, 2011, 2014). Conversely, Farley and Veitch (2001) could not confirm this hypothesis in their studies. Students in windowless rooms showed the same creative performance as those in rooms with a view. However, study participants confirmed a higher level of well-being when they were in rooms that provided a window view.

Possible Spatial Facilitation

The expansion of the mind into the outside world could activate a diffused mode of thinking and, hence, facilitate the incubation effect. Moreover, views across rooms can also provide visual stimuli and foster social interaction, which could lead to serendipity.

Large windows to the exterior, as well as window seats elevated to the sill, can enhance outdoor views. Vistas across rooms can be provided through nested open-plan offices with elevated platforms, transparent divider walls and glass doors, or other open structures, such as open shelves. Figure 8 illustrates Proposition 6 as a causal graph.

Proposition 7: *Visual Cues*

P7: Space that provides visual cues is conducive to creativity.

Experts' Input

According to some of the interviewed experts, space can invite people to experiment, play, and try things out.

> Quote 22: A design school needs to have a protected space, a safe space in which you can act as you want, say what you want, design what you want, and where you do not feel embarrassed. (INT) [translated by author].

Sometimes, just calling a space a *creative space* or an *innovation lab* can put someone in a mood that is receptive to creativity.

> Quote 23: And, of course, there is the Innovation Lab and it [just the name] worked — it spread really fast like everybody was talking about it. Suddenly, everybody wanted to use it […]. But now, all of a sudden, everything is about innovation. (DT)

The historic atmospheres of creative surroundings seem to have a similar effect. People can be inspired to mimic historic role models from art and design who are still omnipresent through stories and discussions.

> Quote 24: Well, the fact that Parsons is down in the Village, which has traditionally been the center of creativity in this city, is really important. I mean Jackson Pollock lived a block from here. The whole movement, abstract movement, they all lived here. (INN)

Evidence From Literature

Bhagwatwar et al. (2013) studied brainstorming performance in virtual environments. Their results indicated that people perform more creatively in spaces that are labeled for creative activities.

This effect is not exclusive to literal labeling; also objects and atmospheres that indicate that playful and experimental behaviors are valued by the organization can have a similar result.

> Quote 25: Especially when it is about creativity, it is important to get rid of pressure and high expectations. I would say 70% of our team plays table tennis. We also like to play soccer in the afternoon. […]. Frequently, some toys and gadgets show up here. We had a drone and such nonsense. It leads to a better collaboration. (INT) [translated by author]

Berretta and Privette (1990) studied the influence of play on creative performance and were able to confirm an outcome of significantly greater creative thinking skills in children who practiced flexible play. Furthermore, Lieberman (2014) suggested that the concept of play can instigate creativity by increasing spontaneity and supporting divergent thinking.

Possible Spatial Facilitation

The labeling of a space as specifically designated for creative activities can result in people being motivated for this type of task and adopting a creative mindset (priming). The encouragement of experimental behavior can increase the number of developed ideas (fluency) and might also facilitate experimentation and trial-and-error (verification).

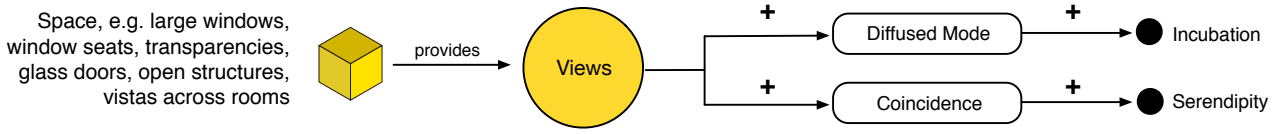

Figure 8. Components of Proposition 6—Views.

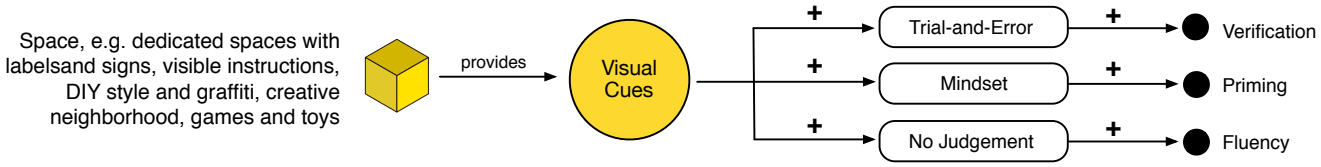

Figure 9. Components of Proposition 7—Visual cues.

Space can provide such encouragement through visual cues—for example, through providing labels and signs that visually represent mission statements and creative work ethics, or that suggest a specific creative behavior. Moreover, the playful or experimental design style of a space—for example, the presence of rough materials or graffiti wall paintings—can indicate that creativity would be appreciated there. Specific pieces of furniture, such as beanbags or hammocks, or a playful atmosphere with games and toys indicate that the organization values play and experimentation, and it also signals that an occasional break is invited. Figure 9 illustrates Proposition 7 as a causal graph.

Proposition 8: *Activator*

P8: Space that activates bodily movement and participation is conducive to creativity.

Experts' Input

Several experts mentioned the positive effect of bodily activities, such as walking or performing sports.

> Quote 26: Personally, I think the more you move the more you learn. There is a connection between your physical activity and your mind work, so to speak. There was always this old idea of when you walk, you think very well and you discuss very well when you walk. I don't know if it's fixed to everyone, but I can sense that importance of physical activity while thinking or doing some intellectual work. (ARC)

> Quote 27: I feel very much creative when I'm moving in the space; for example, my best ideas I have when I'm walking […]. Somehow, movement triggers me a lot. (DT)

However, not only sport-like activities can have an impact on creativity. Manual work with your hands and active participation in the creative process might also be helpful. Instead of thinking about a problem, manually working on something can be conducive to creativity.

> Quote 28: Somehow, you think differently when you touch things or when you try to build. You really come up with ideas that you cannot have come up by sketching or by looking out the window. You think different when you're making. (DT)

> Quote 29: Yes, changing position of work is part of this, definitely. […] I do believe that our brain works very well when we switch in between different thoughts like using your hands or your body doing something physically and using just your mind, so to speak, writing something or drawing; then, of course, you use your hands still, but it's in less extent than building something or doing something physically. This interplay in between activities is quite important. (ARC)

Evidence From Literature

In Ancient Greece, the Peripatetic School (Furley, 2003), founded by Aristotle, cultivated the habit that one should *think while walking* (Csikszentmihalyi, 1996). Since then, bodily movement has been believed to be conducive to creative or intellectual thinking.

Oppezzo and Schwartz (2014) experimentally demonstrated that walking boosts creative ideation. Also, Gondola (1986), Steinberg et al. (1997), and Colzato et al. (2013) provided evidence that physical exercise positively affects creative performance.

Active movement (e.g., when walking or exercising) can set the brain into the relaxed state of mind, or diffused mode, in which the mind wanders and connects different areas of the brain in more relaxed ways (Oakley, 2014).

Possible Spatial Facilitation

A space can induce the relaxed state of mind by providing, for example, transition spaces that require walking between buildings to get from A to B, thus facilitating the incubation phase. Furthermore, vertical distances, such as layered floor plans with stairs, could have a similar effect. General outdoor access that motivates people to get away from their computers could also be considered.

More deliberate inclusion of facilities for exercising and sports could be beneficial as well, for example, by providing a gym or other infrastructure for exercising and team sports (table tennis, climbing walls, etc.). Moveable (swivel) chairs or furniture that allows or enforces different work positions might have a similar effect. Figure 10 illustrates Proposition 8 as a causal graph.

Proposition 9: *Platform for Ideas*

P9: Space that provides a platform for ideas is conducive to creativity.

Experts' Input

When working creatively, one needs some space to manifest one's ideas. This space can range from a Post-it note or a whiteboard to a writeable wall or a large studio to build things in.

> Quote 30: The size of the space is extremely important. I had a smaller studio before and all my designs were smaller as well. A large space allows you to think bigger, create bigger ideas, and build bigger models. (ART) [translated by author]

> Quote 31: Ideas manifest creativity, and that manifestation must be part of the process, and you manifest in different ways: workshop, studio, even if you are acting things out, you need a sort of stage. (INN)

> Quote 32: One of my favorite pieces of furniture is this table with the integrated sheets of paper. It allows you to spontaneously capture ideas. (FUR) [translated by author]

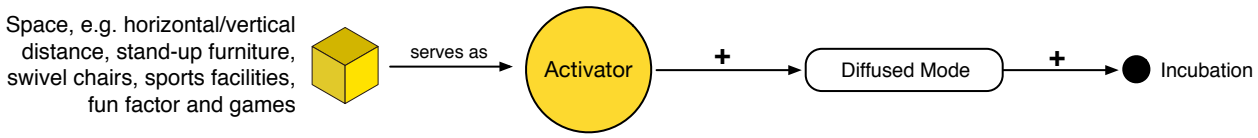

Figure 10. Components of Proposition 8—Activator.

Evidence From Literature

Typical examples of such platforms for idea generation are innovation templates. Helminen et al. (2016) presented three different toolkits and showed how altering the design of these toolkits also changed the creative performance of the users. Similarly, Sadler et al. (2017) presented evidence of the correlation between modularity of a prototyping toolkit and the quality and quantity of users' ideas. We argue that the concept of boundary objects can explain these phenomena. Boundary objects (Star & Griesemer, 1989), such as sketches, canvases, or prototypes, are plastic enough for different communities to adapt and interpret information differently but robust enough to maintain informational integrity. They support distributed cognition by eliciting and capturing tacit knowledge through interactions with the boundary objects (Henderson, 1991). Boundary objects support social and individual creativity in several ways: by moving from vague ideas to more concrete representations; by producing records of mental thought outside of the individual memory; by providing means for others to critique, interact with, and build upon the ideas; and by establishing a common language of understanding (Fischer et al., 2005). Space can establish a platform for these boundary objects and act as a boundary object itself—a sort of boundary space.

Moreover, space as a *platform for ideas* invites the manifestation of an idea—for example, as a prototype. Youmans (2011) investigated the influence of prototyping and material use on fixation. Although he did not necessarily relate prototyping to creativity, one can argue that if fixation is reduced when working with physical materials, then prototyping can potentially support creativity. Fonseca et al. (2009) established a connection between prototyping and creativity within the domain of human-computer interaction in a computer engineering course.

Possible Spatial Facilitation

A large (studio or workshop) space enables the creation of more or literally bigger ideas (e.g., building larger models). The larger the platform, the more possibilities one has for manifesting ideas, which can generate many solutions (fluency). When an idea appears suddenly during the incubation phase, it is helpful to have a platform available to represent the emerging idea (e.g., writeable surfaces throughout the workspace), which is useful to facilitate the possible occurrence of an illumination. Workshop facilities, tinker desks, and tools allow one to add details to ideas and develop them further (elaboration). The idea manifestations also allow one to visualize, discuss, and validate ideas—either together with others or as a testable prototype (verification). Moreover, empty spaces (as outlined in Proposition 2, the *Void*) can serve as a platform for new ideas. Figure 11 illustrates Proposition 9 as a causal graph.

Proposition 10: *Variation*

P10: Space that provides variation and change is conducive to creativity.

Experts' Input

Several experts mentioned positive effects through varying work environments, change, and the related possibility to get new input and new perspectives.

> Quote 33: Flex desks and room-sharing, where you have a new desk every morning, allows you to meet new people every day and gain new perspectives. (OFP) [translated by author]

> Quote 34: I like to look at an environment that is not static but constantly changing and provides visible movement. (OFP) [translated by author]

Several experts stressed the positive effects of a varying work environment.

> Quote 35: It is important to break proportions. The room itself can be rectangular, but this alone becomes boring; it needs some variations to loosen it up, such as small niches or parts with rounded shapes… this makes it livelier. (OFP) [translated by author]

While most experts stressed the positive effects of a changing, unusual, and even surprising work environment, also some negative thoughts were mentioned.

> Quote 36: When I was working in this Frank Gehry building, you would think round fosters creativity and so on, but it was quite the opposite. There was no way of placing the tables inside that room. And when your space is constantly invaded because it's round and you have people walking behind you and so on, it just doesn't help you connect with the space. (DT)

Consequently, spaces that are too impractical for the intended activity might be impedimental to creativity.

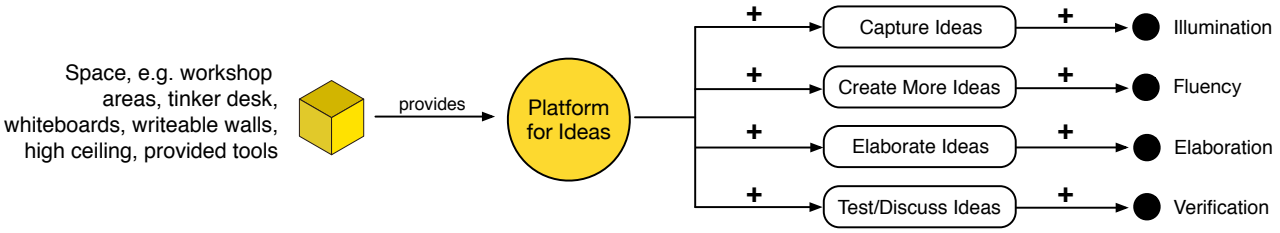

Figure 11. Components of Proposition 9—Platform for ideas.

Evidence From Literature

Csikszentmihalyi (1996) reports on various artists and poets who have traveled away from their homes (i.e., familiar surroundings) in order to see new perspectives and get new input. The possibility of gaining new perspectives by switching spaces and moving into new surroundings can have a positive effect on creativity.

Nicolai et al. (2016) found indications that students had breakthrough ideas when they moved out of their normal workspace. According to Flipowicz (2006), surprise can cause a cognitive shift which very likely fosters creativity. This view is also supported by Grace and Maher (2015) and Becattini et al. (2017).

Possible Spatial Facilitation

Strange or unexpected spaces that have unusual shapes resulting in *dead* or unused corners or that reveal surprising interiors or views can have a positive effect on creativity. Such surprising, unfamiliar, unexpected, or changing spaces trigger curiosity, provide new perspectives, and, hence, allow people to make new connections. This effect can result in an increased variety of ideas by establishing connections between different concepts (flexibility), or it can provide coincidences (serendipity).

Space might be able to provide variation and new perspectives—for example, through so-called flex desks, where people would choose a new work desk and thus meet new neighbors every day. Varying sizes of windows or views of busy and changing environments might also be conducive to creativity. Moreover, frequently updating exhibitions, as well as affording the possibility of changing the workspace (e.g., by providing outdoor work areas) can provide new insights. Figure 12 illustrates Proposition 10 as a causal graph.

Discussion

Discussing the propositions in relation to the creative process, to related literature, and to each other, allows us to draw additional conclusions about how they can best be applied and what potential impact they might have. Subsequently, we offer a critical discussion of our approach and provide an outlook to future work.

Propositions in Relation to the Creative Process

Mapping the propositions to the relevant creativity concepts allows us to identify at which stage of the creative process a particular work environment might be beneficial. Figure 13 summarizes the suggested relations of propositions to creativity concepts in a diagram.

The overview presented in Figure 13 also resembles the creative process, with roughly ordered steps proceeding from left to right. Although this is not supposed to be a rigid, linear process but could be passed iteratively, it becomes evident that certain phases require different approaches. The psychological priming effect, which would put people in a mood receptive to creativity, is relevant throughout the entire process. Priming can mainly be addressed through visual cues (P7). In the preparation (or research) phase, sources (P1) are the most important aspect. Depending on the type of preparation, both encounters (P3) and seclusion (P4) can be beneficial—encounters during user research and seclusion during desk research. Serendipity occurs when unexpected insights show up during research. Those unexpected insights can be found either through sources (P1), encounters with people (P3), surprising views (P6), or variation (P10). Incubation requires a diffused mode, which is facilitated by unrelated tasks, such as sports or walking (P8), and a relaxing ambiance (P5) and views (P6). Reduced stimulation (P4) and lack of sources (void, P2) can also be beneficial. Synthesis requires a focused mode which can be supported by a void (P2) to eliminate distractions and a platform for ideas in order to structure thoughts and insights. Illumination requires similar environments as the incubation phase because the insight typically happens suddenly during incubation and, consequently, marks the end of this phase. We argue that illumination as such is difficult to trigger. Providing a void (P2) could be conducive to illumination because it might trigger people to project their ideas and to fill the void. Moreover, the environment can *prepare* for this moment of sudden insight, by providing an appropriate platform (P9) to capture this sudden idea (P9), such as writable walls or whiteboards. During idea development, encounters (P3) are useful to develop a greater number of ideas that are also more flexible. Sources (P1) can have the same positive effect on idea development, but these can also lead to fixation. This fixation effect could be reduced by providing a void (P2), instead. Variation (P10) can facilitate flexibility of ideas by providing varying input, whereas visual cues (P7), through deferring judgment and encouraging risk-taking, can increase the number of ideas.

The elaboration phase needs an environment that allows focused work. Seclusion (P4) is important, as well as a platform for ideas (P9) to flesh out concepts and add detail to the solution. Finally, during the verification phase, platform for ideas (P9) is again important in order to build, present, and discuss the idea. Here, it is also beneficial to provide encounters with others so as to obtain feedback.

We suggest that phases of focused mode and convergent thinking—such as synthesis, elaboration, and verification—would require a work environment with reduced stimulation and fewer distractions, as well as appropriate infrastructure to capture and

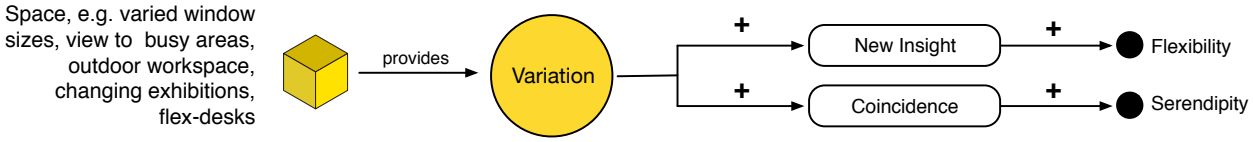

Figure 12. Components of Proposition 10—Variation.

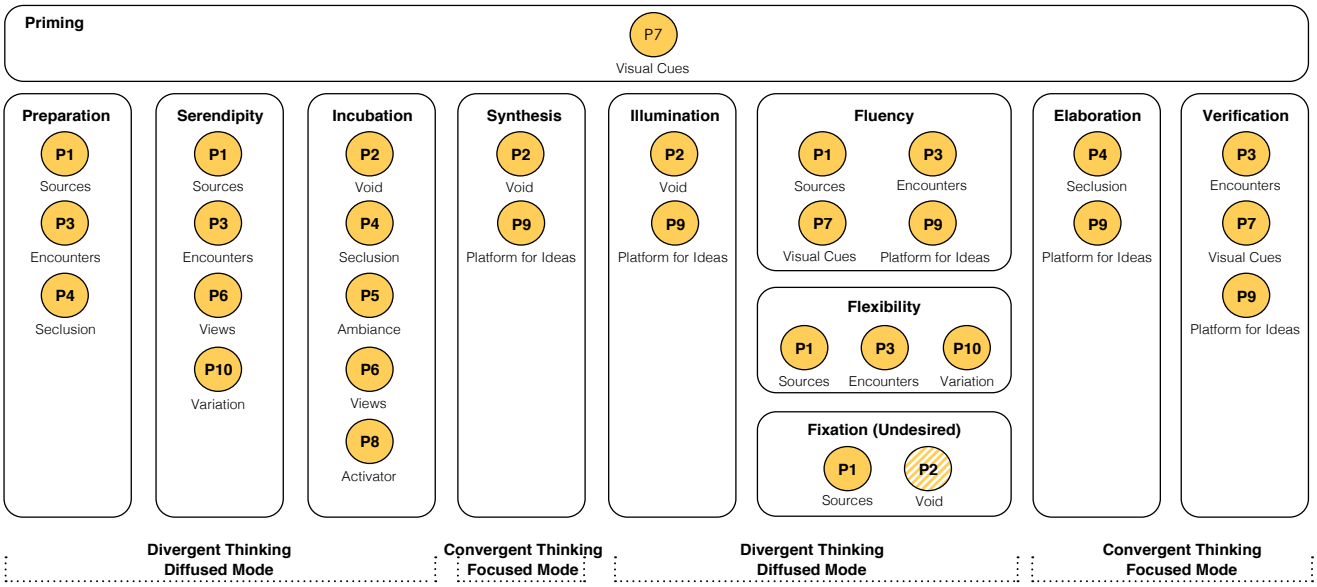

Figure 13. Propositions relevant to the creativity concepts.
Fixation is negative for creativity; striped means a decreasing effect.

manifest ideas. In contrast, phases of diffused mode and divergent thinking—such as preparation and incubation—as well as the process of idea development would require more stimulation (through visible sources, variation, and activation), ambiance, and social interaction.

Fixation effects have to be considered carefully, because they can become a hindrance to creativity, by inducing people to repeat existing ideas or by not being able to break away from recurrent approaches to a problem. The striped proposition (P2, Void) indicates an impact of decreasing the strength of fixation, which, in turn, might be beneficial for creativity.

Csikszentmihalyi (1996) expressed some thoughts about the appropriate environment for facilitating creativity in relation to the phase of the creative process. He suggested that familiar or even humdrum environments would be better suited to the phase of preparation, while a different environment with novel stimuli and views might be more conducive to making new connections during incubation. Toward the end of the process, for elaboration and evaluation, one would need the familiar, ordered environment again to be able to finish the idea in a focused manner (Csikszentmihalyi, 1996).

Csikszentmihalyi's position partly corroborates our suggested theory. We also acknowledge that focused and diffused modes of thinking alternate in the creative process and that both require different environments. We agree that elaboration and verification require a focused mode of thinking and, hence, an undisturbed environment. However, we consider the preparation phase as the process of collecting insights and information on the topic, for which stimulating sources (and possibly encounters) are crucial. Although we agree that preparation is focused and should not be interrupted by distractions from real life, as suggested by Csikszentmihalyi (1996), we advocate the presence of sources and social interaction during this stage of the creative process. One possible explanation for this apparent mismatch between Csikszentmihalyi's view and our own might be that he is mainly focusing on traditional artistic fields (such as music, poetry, or fine arts) that consider the creative person as a lone genius, whereas we focus more on contemporary design and innovation processes that usually involve user research and team collaboration. Moreover, we added more detail to our model, both in terms of the creative process and the suggested environments, which allows us to be more specific with our suggested propositions.

Proposition Relationships and Contradictions

Some propositions appear to be contradictory. P1 (sources) and P2 (void) address opposite scenarios—that is, the presence or absence of visual sources. We argue that both concepts are relevant for creativity in different situations. The stimulation and knowledge provided through visual and other sources (P1) can facilitate research, provide new connections, allow recombination, and lead to coincidence. These aspects might be conducive to creativity for preparation, increase flexibility and fluency of ideas, and result in serendipity. The opposite—reduced stimulation and a lack of sources (P2)—can also be conducive to creativity by setting the mind to a diffused mode. Moreover, the lack of references could lead to more original ideas. Hence, this proposition can facilitate incubation and illumination, and it reduces the risk of fixation. Consequently, both constructs can have a positive impact on creativity, but at different process steps and using different mechanisms. In a similar vein, P3 (encounters) describes spatially initiated social interactions, whereas P4 (seclusion) refers to the opposite—the spatial separation from such interactions.

For these instances, we decided not to use one single construct with different degrees, but rather to define two different propositions with unique names for each construct. In this way, it was possible to also distinguish between different working mechanisms, creativity concepts, and design suggestions for each construct.

There are several interrelationships between propositions. For example, a void (P2), such as a dead corner or an empty wall, can become a platform for ideas (P9) where people can install their own work. Furthermore, an activator (P8), such as an outdoor workspace or a sports facility, can lead to encounters (P3) and provide variation (P10).

We argue that these relations and interdependencies between propositions facilitate a better understanding of and the ability to impact the complex system of creativity-supporting work environments.

Conclusion

In this paper, we presented a collection of ten propositions that constitute the first step toward a theory of the impact of spatial design on creativity. We developed the propositions empirically through grounded theory. Relevant quotes from nine expert interviews were clustered and analyzed in order to form the propositions. Relevant literature was added to provide theoretical underpinning.

The ten propositions are presented and discussed according to their possible impact on relevant creativity concepts related to the creative process, and in relation to existing literature.

However, the propositions still need to be validated in order to be considered a mature causal theory of creative space. Further research will have to provide practical evidence for the applicability and actual impact of the propositions. Hence, future work will include a search for real-life instantiations of creative spaces in order to map them against the ten propositions, as well as conducting experimental studies in order to validate them.

In conclusion, we argue that the ten propositions for creative workspace design presented in this paper can be of relevance to design practitioners because they may contribute to a better understanding of the possible influence of spatial design on creativity.

Critical Reflection and Limitations

The work presented in this paper is subject to several limitations. First, the propositions were developed emerging from grounded theory and are not yet validated. Hence, the suggested impact of spatial design decisions on creativity needs to be considered with caution since there is no guarantee for their actual impact.

Secondly, the propositions are at this stage not operationalized. They are abstract and general and, hence, require people to invest additional effort to adapt them to their respective requirements and situations. While this allows the propositions to be applied in various contexts, they require the users to carefully consider any possible advantage and disadvantage. However, we argue that the work presented in this paper can facilitate this process by providing the theoretical underpinning of possible working mechanisms for each proposition.

Finally, despite our careful and systematic proposition development, the grounded theory approach cannot guarantee that the ten propositions show the full picture of possible impact of workspace design on creativity. There may be other influential factors in this context that were not mentioned by the experts.

Future Work

The ten propositions presented in this paper are considered a starting point for further research. The next step would involve an empirical validation of the propositions. We envision the following strategies for validating the propositions in order to turn them into a mature theory of creative workspace design: (1) Conducting an additional case study in different creative organizations to explore patterns of physical workspace design. These identified patterns should then be mapped to the 10 developed propositions. (2) Conducting an additional study using the experience sampling method (Hektner et al., 2007) to enquire how people perform creative activities and how these activities are affected through spatial designs. (3) Conducting controlled experiments to question popular assumptions, such as *open space increases communication* or *chaos is creative*, that are actually myths in the layperson's understanding of creative space. Empirically testing such assumptions in a specific context may add to a broader understanding of the impact of the physical environment on the creative process and on design output. Researchers might find our propositions a valuable resource to investigate these questions further.

Contribution

Notwithstanding the limitations mentioned above, we argue that the ten propositions presented in this paper constitute the nucleus of a theoretical investigation about the impact of physical workspace design on creativity.

In this paper, we demonstrate that creative space is a multi-dimensional concept that is affected by various parameters, such as the stage of the creative process and the creative tasks at hand. Hence, it cannot be addressed through a *one-fits-all* formula but instead needs to carefully consider the potential impact and side-effects of particular design decisions. Simply copying a popular spatial design or designing the workspace based on intuition and taste bears the risk of unwanted effects. We offer an overview of the various dimensions of creativity and their possible relation to workspace design. The presented ten propositions offer additional theoretical underpinning about the working mechanisms of each proposition (labeled as a mediating *Explanation* within each causal graph). In that sense, they provide a generalizable understanding of how workspaces function and how they could be improved.

As a consequence, we argue that the ten propositions can support designers, educators, architects, spatial planners, and managers with taking deliberate design decisions. Architects and spatial planners can use the propositions as some sort of checklist and adapt them to their individual requirements when designing intended creative workspaces.

As Gabriela Goldschmidt outlined in an extended editorial in the *International Journal of Design Creativity and Innovation*, the need for a fundamental theory of design creativity persists (IJDCI Editorial Board, 2013). We argue that, with the ten presented propositions, we offer a small piece that might help to complete the bigger picture of a fundamental theory of design creativity.

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