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Spaces for Creativity: Unconventional Workspaces and Divergent Thinking

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In recent years, companies have been experimenting with unconventional workspace designs to promote creativity among their employees. However, empirical evidence on the effect of unconventional workspaces on creativity has been lacking. We study this effect by examining the causal relationship between unconventional workspaces and individual divergent thinking performance in a controlled experiment setting. Across three studies with 855 participants, we found, contrary to our initial expectation, that unconventional workspaces did not always facilitate divergent thinking and were even harmful to it under certain conditions. In particular, we found that solving a creative challenge in an unconventional workspace was detrimental to divergent thinking when salient features of the workspace were related to the creative task at hand, which otherwise would anchor the respondents into solution paths that would limit their divergent thinking. Hence, the positive effect of unconventional workspaces on divergent thinking was significant only when the creative task was unrelated to features of the workspace. We also found that the unfamiliar and atypical nature of the space (relative to the usual workspaces the respondents worked in) mediated the positive effect of unconventional workspaces on divergent thinking. Importantly, we were able to replicate the effect of physical workspaces in an online setting, which implies that divergent thinking can be facilitated in virtual work environments as well. This study contributes to the behavioral operations and organization design literatures by not only empirically establishing the causal effect of unconventional workspaces on divergent thinking, but also offering important boundary conditions to such an effect.

Keywords: Creativity; Divergent Thinking; Behavioral Operations; Workspace Design; Organization Design

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1. Introduction

Individuals' divergent thinking, or the process of generating many and distinct ideas to solve a task at hand, has been argued to play a critical role in the production of creative outcomes (e.g., Amabile 1996, Acar and Runco 2011, Girotra, Terwiesch, and Ulrich 2010, Kavadias and Sommer 2009, Sommer, Bendoly, and Kavadias 2020). Accordingly, management scholars have been trying to understand the factors that enable individuals to become more effective in divergent thinking. A growing stream of research examines the behavioral aspects of innovation processes including the generation of creative ideas (Katok, Leider, and Donohue 2018), especially within the field of behavioral operations, which concerns the people side of operations and processes.

Prior studies have investigated a diverse set of topics related to creativity and innovation management from a behavioral operations viewpoint, for example, studies examining how different team structures (e.g., nominal vs. collaborative) and features (e.g., diversity) impact teams' creative performance in idea generation sessions (Girotra et al. 2010, Kavadias and Sommer 2009). Another study used experiments to investigate how problem complexity plays a moderating role when individuals generate solutions to a problem (e.g., Sommer et al. 2020). Also in an experiment setting, researchers examined how to best transition from ideation to implementation in innovation projects (Kagan, Leider, and Lovejoy 2018). Moreover, other studies have considered various ways of collaboration among inventors to understand aspects such as the impact of collaboration on breakthrough creation (Singh and Fleming 2010), the role of the problem structure (e.g., modular vs. integral) when deciding whether or not to collaborate for creating breakthroughs (Chan, Mihm, and Sosa 2021), and the best ways to collaborate with star innovators (Liu, Mihm, and Sosa 2018). Finally, studies have examined behavioral factors on innovation contests (e.g., Boudreau, Lacetera, and Lakhani 2011). Despite all these advances from a behavioral operations perspective on how to better manage innovation processes, the field still lacks understanding on how the *workspace* in which creative tasks take place influences the performance of participants in creative endeavors. Our paper aims to fill this important gap in the literature.

Notably, in practice, many firms have been already actively experimenting with the design of workspaces to facilitate employees' divergent thinking and creativity (Bacevice, Burow, and Tribner 2016, Cohen 2019, Waber, Magnolfi, and Lindsay 2014). As seen in Figures 1a and 1b, for instance, companies such as Google and Facebook have been adopting unique workspace designs in their corporate buildings, with the belief that *unconventional workspaces*—spaces with unusual office design features to occupants—will play a positive role in a firm's creativity by facilitating the divergent thinking of employees (see Creative Bloq Staff 2021).

– Figure 1 about here –

Indeed, there are several theoretical reasons to believe that unconventional workspaces will have a positive effect on individuals' divergent thinking performance. In particular, unconventional workspaces could help individuals to recombine ideas (e.g., Savino, Petruzzelli, and Albino 2017, Singh and Fleming 2010), trigger distractions that are positive for divergent thinking (e.g., Baird et al. 2012, Dijksterhuis and Meurs 2006, Lu et al. 2017a), motivate individuals to become more creative (e.g., Amabile 1997), and/or put individuals in moods that are conducive to divergent thinking (e.g., De Dreu, Baas, and Nijstad 2008, Hirt, Devers, and McCrea 2008, Murray et al. 1990). Nonetheless, no academic research to date has examined whether this causal relationship actually holds.

It is important to note that the creativity literature has examined the role that some individual elements of workspaces such as lights, plants, colors, natural materials, and views of natural environments may have on creativity (e.g., Ceylan, Dul, and Aytac 2008, Kallio, Kallio, and Blomberg 2015, McCoy and Evans 2002; see also Elsbach and Pratt 2007). However, these elements do not necessarily make workspaces unconventional, and, more importantly, the relationships found in these studies are correlational at best. In the field of ergonomics and workplace design, Lee (2016) went as far as investigating common characteristics of physical work environments that are known and used in practice to facilitate creativity for innovative start-up workplaces. However, this study was also based on a limited sample and interview data, which did not allow for causal inference. In sum, despite the growing adoption of unconventional workspaces in practice and plausible theoretical arguments why such workspaces would have positive effects on the divergent thinking performance of individuals working within them, this causal relationship remains to be investigated.

Uncovering such a causal relationship poses significant challenges, however, especially in real-life organization settings. For instance, the relationship cannot be examined by simply comparing the divergent thinking performance of individuals who currently work in unconventional versus conventional workspaces, because other unobserved factors could be associated with both an organization's decision to have an unconventional workspace or not and individuals' divergent thinking performance; organizational culture is one such factor (Stallworth and Kleiner 1996, Turner and Myerson 1998). Another possibility is that unconventional workspaces attract certain employees, especially those who are inherently more creative and better at divergent thinking (Stegmeier 2008). Such a scenario would demonstrate the selection effect of the workspace, instead of the treatment effect of it. Finally, it would be extremely challenging, if not impossible, to randomly assign some individuals into unconventional workspaces and others into conventional workspaces in real organization settings, due to fairness and operational issues.

For these reasons, in this study, we investigate the causal relationship between unconventional workspaces and divergent thinking performance, and its boundary conditions, using three controlled experiments in physical and online settings. Specifically, Study 1 took advantage of a rare opportunity in which we had access to two physical spaces that had identical floor plans but contrasting interior designs; one space was designed as an "unconventional space" and the other one was designed as a "conventional space." Experiment participants were then randomly assigned into these spaces to solve a divergent thinking task. Contrary to our expectations, we found that individuals assigned to the unconventional space in this study had lower divergent thinking performance than those assigned to the conventional space. Additional analyses suggested that the *relatedness* between possible solutions for the divergent task and some salient features of the unconventional space drove this negative relationship. Based on this finding and further scrutiny of the creativity literature, we developed a revised hypothesis, which we tested in a virtual workspace setting.

The revised hypothesis predicted that unconventional workspaces will have a positive impact on divergent thinking only when possible solutions for a divergent thinking task *cannot* be readily inspired by features of an unconventional workspace. To test this hypothesis, we ran two additional studies (i.e., Studies 2 and 3). These studies were conducted using Amazon's Mechanical Turk (MTurk) online platform with 400 participants for each study. The virtual workspaces were manipulated by showing participants detailed videos of the workspaces, in which they were ask to perform the task as if they were doing it in-person. Study 2 first replicated the results from Study 1, allowing us to verify that the effect of physical workspaces can be replicated online in virtual workspaces. Then in Study 3, we changed the divergent task to one for which the possible solutions could *not* be readily inspired by features of an unconventional workspace. We found support for our revised hypothesis: the effect of the unconventional workspace on participants' divergent thinking performance was positive in the absence of potential relatedness between the features of the unconventional space and the divergent thinking task at hand.

All in all, our paper uncovers an often assumed but never tested, nuanced causal relationship between unconventional workspaces and divergent thinking performance. Importantly, we find that the features of an unconventional workspace need to be unrelated to potential solutions of a divergent thinking task for the workspace to have a positive influence on divergent thinking performance. Our results also show that virtual (online) workspaces can be designed to improve the divergent thinking performance of individuals. This has important implications for managers who need to manage employees in virtual work environments, especially in situations such as the COVID-19 pandemic. Taken together, this work contributes to the literature on individual creativity from a behavioral operations perspective (e.g., Girotra et al. 2010, Kagan et al. 2018, Kavadias and Sommer 2009, Sommer et al. 2020). It also contributes to the organization design literature on workspaces, by providing insights into how physical spaces of organizations can be configured to promote individual-level creativity (e.g., Lee 2019). Finally, it opens up novel research opportunities for understanding the micro-processes of innovation in organizations.

2. Development of Baseline Hypothesis

Unconventional Workspaces and Divergent Thinking

For individuals to generate creative ideas, divergent thinking is essential. Divergent thinking is a thought process or method used to generate many ideas by exploring possible solutions in diverse directions; therefore, it becomes the basis for producing creative outcomes (Acar and Runco 2011, Runco 2011). However, any kind of idea generation task (i.e., divergent thinking task) ultimately occurs within a space, and it is likely that certain workspaces are more conducive to individuals' divergent thinking performance compared to others.

Several plausible theoretical arguments might explain why unconventional workspaces would enhance individuals' divergent thinking performance. Most importantly, we expect that, compared to conventionally designed workspaces, unconventionally designed workspaces welcome or trigger a mindset that encourages non-typical thinking and actions, because such workspaces are significantly different from those which individuals are familiar with or usually work in (Kobe and Lehman 2021). This would trigger several sub-mechanisms that can positively influence individuals' divergent thinking ability.

First, prior research has suggested that creativity and innovation involve the mix and match of existing (familiar) and new (unfamiliar) ideas and concepts (Savino et al. 2017, Singh and Fleming 2010). Individuals bring in existing ideas from their past experiences and knowledge to workspaces. However, unconventional workspaces comprise features that individuals are not typically exposed to in a work setting (as depicted in Figures 1a and 1b). We expect those features to inspire new combinations of ideas, leading individuals to produce more creative solutions in those workspaces.

Second, unconventional workspaces could create (mental) distractions, especially those that are useful for improving creative thinking. In particular, a roadblock to creativity has been argued to be cognitive fixation—a situation where individuals become fixated on ineffective ideas or problem-solving strategies and thus fail to think in diverse directions. Distractions have been found to help individual break free from such fixations and explore multiple paths of ideation. For example, Lu et al. (2017a) found that switching between different tasks improved individual creativity because it helped individuals break free from cognitive fixation. Similarly, Baird et al. (2012) found that individuals' creative performance increased when they temporarily set aside the focal creative task to work on a simple unrelated task. Moreover, Dijksterhuis and Meurs (2006) found in a laboratory student that participants who were distracted for a few minutes generated more names that diverged from the examples given than did participants who consciously thought about the task for an equal duration, when participants were asked to generate new names for products. As such, unconventional workspace designs could create distractions that allow the minds of individuals to wander (e.g., Baird et al. 2012), and therefore facilitate their creativity.

Finally, unconventional workspace designs could motivate individuals to think more creatively or put them in mental states conducive to creativity. For example, Amabile (1997) argued that intrinsic motivation is important for creativity, such that motivation driven by interest and involvement in the work, by curiosity, or by enjoyment can enhance creativity. The novelty associated with an unconventional workspace design could trigger interest and curiosity in the task, which could lead to individuals producing more creative outcomes. In addition, it has been found that positive mood is related to cognitive flexibility and creativity (Amabile et al. 2005, De Dreu et al. 2008, Hirt et al. 2008, Murray et al. 1990). Unconventional workspace designs could create positive moods by providing a task environment that is novel and stimulating.

Taken together, we predict, in the baseline hypothesis below, that unconventional workspace designs, compared to conventional workspace designs, will facilitate higher divergent thinking performance in individuals:

> ***Baseline Hypothesis****: Individuals will have higher divergent thinking performance in an unconventional workspace than in a conventional workspace.*

3. Study 1: Experimental Evidence for the Effect of Unconventional (Physical) Workspaces on Individuals' Divergent Thinking Performance

We test our baseline hypothesis using a quasi-field experiment that involved participants being randomly assigned to two different physical spaces and completing a divergent thinking task. Participants in the treatment condition were assigned to an "unconventional" workspace, and those in the control condition were assigned to a “conventional” workspace. After experiencing their workspaces, participants engaged in a divergent thinking task, on which their creative performance was scored.

3.1. Methods

Unconventional vs. Conventional Workspaces

For our experiment, we exploited a unique, yet temporary, opportunity that involved using two large flatrooms in one of the campuses of a global business school. The two flatrooms were on the same floor, were located side-by-side, and had the same floor plan (in terms of size and structure). One of the rooms was designed to look like an unconventional workspace (denoted as "Unconventional Space" hereafter), whereas the other room was kept to look like a conventional workspace (denoted as "Conventional Space" hereafter). Specifically, the former room included several unusual workspace features, such as unfinished ceilings, colorful beanbags, high-top tables and stools, and various drawings and posters on the walls, as illustrated in Figure 2a. The design elements for this workspace were inspired by and adopted from the radical workspace designs of some modern technology firms (such as the ones depicted in Figures 1a and 1b) and industrial design schools. On the contrary, the latter room (Figure 2b) maintained a conventional design, resembling a classic business workspace with clean mono-colored walls, carpeted floors, and equipment related only to work (e.g., computer, projector, white board, etc.). A general example of this type of workspace is illustrated in Figure 1c.

– Figure 2 about here –

Participants

A total of 55 individuals participated in the study. These participants were either MBA students or executive education program participants at the business school where we conducted our study. Only *new*, incoming students were recruited for the study to ensure that the participants had never been exposed to the physical spaces we designed nor knew about the existence of these spaces on campus. The participants were volunteers who were interested in understanding how individuals engage in problem solving tasks and did not receive any (monetary or non-monetary) incentives for participating in the study.

Five participants did not follow instructions (i.e., they did not solve the task as instructed) and thus were removed from the analysis. The remaining 50 participants (11 females, M_{age} = 39.74, *SD* = 8.56) were included in the analysis.

Design

Participants gathered in front of the entrances of the two spaces prior to the experiment. The room doors were closed and the door windows were covered from the inside, preventing the participants from noticing that the two rooms looked different inside (see Figure 3). The participants were then randomly assigned to one of the spaces by drawing lots.

– Figure 3 about here –

Once the participants entered the rooms, they were asked to wander around the room and get accustomed to the workspace for two minutes. Subsequently, they were randomly assigned to a table, where they sat in a designated stool/chair that faced the front of the room. There was a maximum of nine tables in each room for each batch of participants, enabling a maximum of nine subjects to participate simultaneously in the study. Table 1 shows the *t*-test results of observable characteristics of participants assigned to the Unconventional Space versus the Conventional Space. The results of the *t*-tests show that the means of the observable characteristics of the participants (i.e., gender, age, education, and science/engineering training) did not differ between the two workspaces, indicating that the random assignment of participants to the two conditions was effective.

– Table 1 about here –

Procedure

Once seated in their assigned rooms, the participants received a booklet that included general instructions on the experiment and the divergent thinking task. Participants were given five minutes to complete the task. Participants remained seated and did not interact with each other during the task.

Divergent Thinking Task

The divergent thinking task we used was similar to Guilford's Alternative Uses Task (AUT: Guildford, 1967). Guilford's AUT requires participants to list as many creative uses for everyday objects, such as a brick or a toothpick, as possible (e.g., Lu et al. 2017a). In our divergent thinking task, 40 blank circles were printed out across two sheets of paper and participants were asked to draw as many real-world objects as possible, using those circles as an integral part of the objects. Figure 4 shows an example of the task completed by one of the participants.

– Figure 4 about here –

Performance Measures

To measure performance on the divergent thinking task, we examined two outcome variables. First, we counted the *total number* of objects that a participant drew (i.e., *ideational fluency*). Second, we counted the *unique* number of objects that a participant drew (i.e., *originality*) (see also Torrance 1981). To create this second measure, we compiled all the objects that the entire pool of participants of our study drew. Then we counted the number of objects that *only* the focal participant drew.

Econometric Model

Since our dependent variables were count variables that took only discrete, nonnegative integer values (i.e., number of drawings), we employed Poisson regression models.[1] The independent variable was *Unconventional Space*, which was coded as 1 if the participant completed her divergent thinking task in the Unconventional Space and coded as 0 if she completed the task in the Conventional Space.

We ran two models for each outcome variable. One model included only the independent variable (i.e., *Unconventional Space*), and the other model included controls for individual characteristics (i.e., gender, age, education, science/engineering training, and table dummy (indicating where the participant sat in the room).

3.2. Results

Manipulation Check

We checked whether our manipulation was effective by asking open-ended questions about the rooms to the participants. In their answers, participants of the Unconventional Space often explained that their room

[1] Results were similar when using negative binomial regression models (an alternative model for count dependent variables). However, negative binomial regression models have been advised against for smaller sample sizes because overdispersion cannot be reliably measured (e.g., https://stats.oarc.ucla.edu/stata/dae/negative-binomial-regression/). The results were also similar when testing mean differences using *t*-tests or non-parametric tests such as the Wilcoxon rank-sum test. Notwithstanding, using a Poisson regression model would be most suitable for our analyses since we use a count dependent variable and have a relatively small sample set.

had unusual features such as bean bags, unfinished ceilings, high-top tables and stools, and images drawn on the wall, whereas the participants of the Conventional Space rarely commented on the physical features of the room. Consistent with these answers, participants assigned to the Unconventional Space reported the physical environment of the room to be more different from their usual work environments ($M = 5.46$, $SD = 1.77$) than the participants assigned to the Conventional Space did ($M = 4.27$, $SD = 1.66$), $t(48) = -2.45$, $p = 0.02$ in a follow-up question. Overall, the participants' responses indicated that our manipulation was effective.

Effect of the unconventional space on divergent thinking performance

The results of the Poisson regression analysis that tested the effect of the unconventional space on divergent creative thinking performance in terms of *ideational fluency* (measured as the total number of drawings) are presented in Table 2. Model 1 included only the independent variable, *Unconventional Space*. Unexpectedly, and in contrast to our baseline hypothesis, the result in this model showed that divergent thinking performance was *lower* for participants who completed the task in the Unconventional Space compared to those who completed it in the Conventional Space ($p < 0.05$). Specifically, participants in the Conventional Space had an incidence rate that was 1.21 times greater than that of participants in the Unconventional Space, for the total number of answers they drew. Model 2 included the control variables. The results were consistent.

– Table 2 about here –

Next, we tested the effect of unconventional space on divergent thinking performance in terms of *originality* (measured as the number of *unique* drawings). The results of this analysis are presented in Table 3. Consistent with the results presented in Table 2, the results in Model 1 of Table 3 show that divergent thinking performance in terms of *originality* was significantly lower for participants in the Unconventional Space compared to those in the Conventional Space ($p < 0.05$). Specifically, participants in the Conventional Space had an incidence rate that was 1.52 times greater than that of participants in the Unconventional Space, for the number of unique answers they drew. Model 2 included the control variables and shows consistent results.

– Table 3 about here –

In sum, the results of Study 1 did not support the baseline hypothesis. Instead, the analyses showed statistically significant results in the opposite direction: individuals had higher divergent thinking performance in the Conventional Space than in the Unconventional Space. To better understand these results, we ran additional analyses, which we discuss next.

3.3. Did the Features of the Unconventional Space Produce Cognitive Fixation?

An explanation for why participants in the Unconventional Space had lower divergent thinking performance than those in the Conventional Space could be that the Unconventional Space also created countervailing forces that went against the sub-mechanisms (i.e., recombination of ideas, distraction/mind-wandering, and increased intrinsic motivation) we originally proposed to be conducive to creativity. One of those forces could be, in fact, *cognitive fixation*, which leads individuals to narrowly focus on cues that are in their immediate environment (Acar 2021, Crilly and Cardoso 2017). Especially, because the divergent thinking task in our study was to draw as many real-world objects as possible using circles as an integral part of them, it is possible that the participants searched for circular objects in their assigned workspaces to gain inspiration for their answers. On the one hand, a workspace that contains more circular objects could be useful for a participant's divergent thinking performance because it would give the participant more clues to complete the task. However, on the other hand, the literature on individual creativity and brainstorming suggests that cues that give out potential solutions to idea generation tasks could *hinder* divergent thinking performance because those cues will cognitively fixate individuals' minds on a narrow set of ideas that are closely related to the cue and thus limit their ability to come up with unique solutions.

For instance, in Smith and colleagues' (1993) study in which participants were asked to draw as many different toys or imaginary creatures as they could, as a part of an idea generation task, individuals generated fewer and less novel ideas when the task instruction included a pictorial example, as they became fixated on that example and generated ideas that were close variations of it (see also Chrysikou and Weisberg 2005 and Jansson and Smith 1991). Similarly, in the brainstorming literature, Kohn and Smith (2011) found that individuals generated fewer unique ideas when they brainstormed in a group compared to when they brainstormed individually, because group brainstorming led individuals to become fixated on the ideas generated by others (Diehl and Stroebe 1987,1991, Girotra et al. 2010). Consistent with these findings, we posit that the Unconventional Space could have made individuals cognitively fixated because the features of the room were related to the potential solutions for the divergent thinking task in Study 1.

To test this possibility, we conducted an additional analysis that exploited the existence of some salient drawings on the wall of the Unconventional Space that could have driven the cognitive fixation of participants in that workspace, if such a force existed. Specifically, we examined whether individuals became cognitively fixated on some Disney and Pixar cartoon characters (e.g., Mickey Mouse, Woody, Lightning McQueen, etc.) that were drawn on the front wall of the Unconventional Space, as seen in Figure 5.

– Figure 5 about here –

These drawings were visible to all participants who completed their divergent thinking task in the Unconventional Space, because participants were required to sit at tables facing the front wall. If cognitive fixation was the countervailing mechanism that drove lower performance in the divergent thinking task for participants in the Unconventional Space, we expect those who *explicitly* drew Disney or Pixar characters earlier in the task (such as the participant who drew Mickey Mouse as the first answer in Figure 4) to have been the most susceptible to the stimuli and thus be the ones whose cognitive fixation levels were the highest. We therefore expect these individuals to have *even lower* performance than their counterparts in the Unconventional Space on their divergent thinking tasks. To test this, we created a binary variable, *Early Disney or Pixar character drawing*, which took the value of 1 if participants drew a Disney or Pixar character as one of their first five drawings (and 0 otherwise), and interacted it with the main independent variable, *Unconventional Space*, to see whether the relationship between *Unconventional Space* and *Divergent Thinking Performance* was negatively moderated. The results of this analysis are presented in Table 4.

– Table 4 about here –

Model 1 of Table 4 replicates our main results in Model 1 of Table 2 (i.e., the negative effect of the unconventional space on ideational fluency). Model 2 included *Early Disney or Pixar character drawing*, and the interaction term, *Unconventional Space* x *Early Disney or Pixar character drawing*. Consistent with our prediction, the results of this analysis showed that those who explicitly drew Disney or Pixar characters earlier in the divergent thinking task had even lower ideational fluency than their counterparts in the Unconventional Space ($p < 0.05$), providing support for the cognitive fixation mechanism.[2] Motivated by these results, in the next section, we develop a revised hypothesis.

4. Revised Hypothesis

Even though the results from Study 1 contradicted our original theory, it may not be that our original theory is invalid. Rather, there may be boundary conditions to the theory, such that the *type* of divergent thinking task matters for whether unconventional workspace designs have positive versus negative effects on creativity. Specifically, based on the results of the additional analyses of Study 1, we suspect that the *relatedness* of the potential solutions for the idea generation task and the features of an unconventional space will determine whether the unconventional space will have positive versus negative effects on individuals' divergent thinking performance.[3]

On the one hand, as we found in Study 1, when solutions to a divergent thinking task could be readily inspired by features of an unconventional workspace (e.g., the existence of salient circular objects in the unconventional space when individuals are generating ideas for circular objects), an unconventional space could lead to worse performance due to cognitive fixation (e.g., Chrysikou and Weisberg 2005, Jansson and Smith 1991, Kohn and Smith 2011, Smith et al. 1993). On the other hand, when solutions to a divergent thinking task *cannot* be readily inspired by features of an unconventional workspace, we argue

[2] Results including the controls showed consistent results. For the *originality* variable, there was too little variation to run this analysis. However, in our follow-up online study, which replicates the results of Study 1 with a sample of 375 participants, results were consistent for the *originality* variable ($p < 0.15$).
[3] The main assumption here is that the notion of "relatedness" is not relevant in conventional spaces. That is, relatedness is associated with salient and unconventional features of the space, which is undefined for conventional spaces.

that unconventional workspaces are likely to help individuals to recombine ideas (e.g., Savino et al. 2017, Singh and Fleming 2010), trigger distractions that are positive for divergent thinking (e.g., Baird et al. 2012, Dijksterhuis and Meurs 2006, Lu et al. 2017a), motivate individuals to become more creative (e.g., Amabile 1997), and/or put individuals in moods that are conducive to divergent thinking (e.g., De Dreu et al. 2008, Hirt et al. 2008, Murray et al. 1990). Accordingly, we develop a *revised hypothesis* that considers circumstances when solutions for a given divergent thinking task cannot be readily inspired by features of an unconventional workspace:

> ***Revised Hypothesis****: Individuals will have <u>higher</u> divergent thinking performance in an unconventional workspace than in a conventional workspace when solutions for a given divergent thinking task <u>cannot</u> be readily inspired by features of the unconventional workspace.*

5. Study 2: Online Replication of Study 1

In this study, we first aim to replicate the results of Study 1 online, using Amazon's Mechanical Turk (MTurk) online platform. We turned to an online setting to continue our research, for several important reasons. First, we lost access to the Conventional Space used in Study 1, because the room was renovated into a set of small offices soon after we completed Study 1. Because there was no other set of rooms in the building that could be used simultaneously, were on the same floor, and had the same size and floor plan, it was challenging for us to create a controlled setting for our experiment. Second, due to building security issues, we were limited to recruiting participants from the school's MBA and executive education programs. This resulted in a non-inclusive and non-representative participant pool. Third, and relatedly, it was difficult to run the experiment at a large scale (to increase the generalizability of the results) because only small batches of participants (e.g., maximum nine participants) could participate in each study due to the space constraints of the rooms. Last, but not least, the COVID-19 pandemic hit in early 2020 when we were planning to conduct additional studies, making it impractical to conduct in-person experimental studies for two years. Interestingly, we found this last constraint to be a valuable opportunity, because during the pandemic, employees started to work from home, and understanding how to facilitate employee creativity in virtual settings became an important challenge for companies relying on innovation for survival (e.g., Brucks and Levav 2022).

Admittedly, studying the effect of unconventional workspaces in a virtual setting has some challenges compared to a physical setting. Particularly, the treatment effect of the workspace is bound to be weaker and participants are likely to have lower attention levels than in physical spaces. However, these limitations, in fact, would make any results we found in a virtual setting conservative. In addition, a virtual setting not only resolved most of the aforementioned limitations we faced in a physical setting, but also had benefits for conducting additional experiments, if needed. In particular, it gave us flexibility in which workspace we showed our participants and controlled their experience by having them watch videos of the workspaces that had identical content structure and runtime (see Figure 6 for details).

Importantly, to validate that the online format was a reliable alternative to the physical format of the experiment conducted in Study 1, we replicated Study 1's experiment online.[4] Because the task in Study 1 (i.e., drawing real-world objects that have circles as an integral part) was one for which solutions could be easily inspired by features of the unconventional workspace, we expected to see the same results we saw in Study 1 for Study 2.[5]

5.1. Methods

(Virtual) Unconventional vs. Conventional Workspaces

We created two virtual workspaces for online participants by videotaping the original Unconventional Space we used for Study 1 (with changes to the drawings on the wall; see last photo in Figure 6a) and a conventional flatroom in the same building that had the same table and seating configuration as the Unconventional Space.[6] Each video was two minutes and thirty seconds long. For each workspace, we first

[4] One difference, other than switching to online, was that the online participants of this study received a fixed monetary incentive that was approved by the Institutional Review Board (IRB). However, the incentive did not change the results.
[5] To ensure the credibility of the results, we registered the data collection and analysis plan for Study 2 on a public online platform ***prior*** to running the experiment: https://aspredicted.org/mp7wi.pdf.
[6] Since the original flatroom we used for Study 1 was converted into smaller offices, we used another flatroom in the building that had similar dimensions but was on a different floor.

filmed the entrance to the room and then the entire room—showing the tables, chairs, walls, and the ceiling in detail. Each video ended at a table in the back of the room with the camera facing the front of the room. This last scene remained in the background of the task screen while participants engaged in their divergent thinking tasks. Figure 6 shows scenes from the Unconventional and Conventional Space videos.

– Figure 6 about here –

Participants

We recruited 400 participants from Amazon Mechanical Turk (MTurk) to complete the study. Participants qualified for the experiment only if they were at least 18 years old, fluent in English, and were not using a mobile device for the task (e.g., phones, tablets, etc.), to ensure that they could properly view the videos. All participants identified the United States as their home country. Prior to engaging in the task, participants were promised to be paid a fixed monetary incentive amount that was approved by the Institutional Review Board (IRB), as long as they completed both the task and survey questions.

We excluded five participants who failed to complete both the task and the survey questions, three participants who did not follow the task instructions, and 17 participants who indicated at the end of the experiment that they received help on the task (from the internet or other people), leaving 375 participants (233 females, M_{age} = 43.91, SD = 14.02) for the final analysis.

Design and Procedure

Participants were randomly assigned to the treatment (Unconventional Space) and control (Conventional Space) conditions in the order they joined the online study. Participants were told that they would be engaging in a simple problem-solving task in a "virtual workspace" due to the COVID-19 pandemic. Then they were asked to watch a video of their assigned workspace, so that they could become familiarized with the workspace before solving the task. The participants watched the aforementioned two-minute-thirty-second-long video of their assigned space. Importantly, they were told to watch the entire video and to not skip or fast-forward any parts of it.

Table 5 shows the *t*-test results of observable characteristics of participants assigned to the Unconventional Space versus the Conventional Space. The results of the *t*-tests show that the means of the observable characteristics of the participants (i.e., gender, age, education, and science/engineering training) did not differ between the two spaces except for age, which was weakly different (45.14 vs. 42.67, $p = 0.09$). To account for this modest difference, we control for age (along with the other observable characteristics of the participants) in our analyses that check for robustness.

– Table 5 about here –

After watching the video, the participants saw the following message on their screen: "Loading question and sending you to your virtual workspace." Shortly after, the divergent thinking task appeared on the screen, with the last scene of the video being the background image. The participants were given three minutes to complete the task.

Task and Measures

The divergent thinking task we used in this online study was identical to the "circle task" used in Study 1. Participants were asked to brainstorm real-life objects that include a circle as their main component. The only difference between this version of the task and the one given to participants in Study 1 was that the participants of this study did not have to draw the objects and only had to name them in the answer boxes that were given on the screen.

As in Study 1, we examined the same two performance outcomes—*ideational fluency* and *originality*—of the divergent thinking task examined in Study 1. Similar to Study 1, we estimated a Poisson regression model for each outcome variable without and with controls, respectively.

To check whether our manipulation was effective, we asked participants to report the extent to which they found the virtual workspace to have unconventional features (1 = strongly disagree; 7 = strongly agree) at the end of the study. A *t*-test was used to compare the mean scores of responses between the rooms.

5.2. Results

Manipulation check

Participants assigned to the Unconventional Space reported that the virtual workspace had more unconventional features ($M = 5.67$, $SD = 1.48$) than the participants assigned to the Conventional Space reported ($M = 2.31$, $SD = 1.35$), $t(373) = -23.01$, $p = 0.00$, indicating that the manipulation was effective.

Effect of the unconventional space on divergent thinking performance

The results of the Poisson regression analysis that tested the effect of the Unconventional Space on divergent thinking performance in terms of *ideational fluency* (i.e., the total number of solutions) are presented in Table 6. Model 1 included only the independent variable, *Unconventional Space*. Consistent with the results of Study 1 and with Hypothesis 1, the result showed that divergent thinking performance was *lower* for participants who were assigned to the Unconventional Space compared to those who were assigned to the Conventional Space ($p < 0.01$). Specifically, participants in the Conventional Space were expected to have an incidence rate that was 1.08 times greater for the total number of solutions than participants in the Unconventional Space. Model 2 included the control variables. The results were consistent.

– Table 6 about here –

Next, we tested the effect of the Unconventional Space on divergent thinking performance in terms of *originality* (i.e., number of unique solutions). The results of this analysis are presented in Table 7. Corroborating the results produced in Study 1, the results in Model 1 of Table 7 showed that divergent thinking performance in terms of *originality* was significantly lower for participants in the Unconventional Space compared to those in the Conventional Space ($p < 0.01$). Specifically, participants assigned to the Conventional Space were expected to have an incidence rate that was 1.38 times greater for the number of unique answers than participants assigned to the Unconventional Space. Model 2, which included the control variables, showed similar results.

– Table 7 about here –

Finally, we re-ran the additional analysis we ran for Study 1, which examined whether participants whose solutions included salient drawings on the wall (i.e., planet/globe/Earth, steering wheel, Ferris wheel, stop sign, pumpkin/tomato for this study) as one of their first five answers had even lower divergent thinking performance (ideational fluency) in the Unconventional Space. The results of this analysis, presented in Table 8, aligned with those of Table 4 from Study 1, suggesting that cognitive fixation also occurred in the virtual unconventional setting for this task.

– Table 8 about here –

Study 2 provided important evidence that virtual workspaces can be used as effective alternatives to physical workspaces when manipulating unconventional versus conventional work environments. Based on the findings of Study 2, we continue to use the virtual workplace setting to test the *Revised Hypothesis* in Study 3.

6. Study 3: Online Study for Testing of the *Revised Hypothesis*

In this study, we tested the *Revised Hypothesis* using Amazon's Mechanical Turk (MTurk) platform. As in Studies 1 and 2, participants were randomly assigned to the unconventional and conventional workspace conditions. However, unlike those studies, the participants in Study 3 solved a different divergent thinking task, which involved brainstorming solutions for a problematic situation, for which the features of the workspace were unlikely to provide direct clues to potential solutions.[7]

6.1. Methods

To maintain consistency between Studies 2 and 3, we used the same two-minute-and-thirty-second-long videos we used in Study 2 for Study 3 to manipulate the unconventional and conventional workspaces in our virtual experiment setting. We recruited 400 participants from Amazon Mechanical Turk (MTurk) to complete the study. We applied the same participation qualification rules from Study 2, leaving 375 participants (189 females, M_{age} = 42.83, *SD* = 13.00) for the final analysis. In the same way as in Study 2, participants were randomly assigned to the treatment (Unconventional Space) and control (Conventional Space) conditions in the order they joined the online study. The fixed monetary incentive for completing the study also remained the same.

Table 9 shows the *t*-test results of observable characteristics of participants assigned to the Unconventional Space versus the Conventional Space in Study 3. The results of the *t*-tests show that the means of the observable characteristics of the participants (i.e., gender, age, education, and

[7] We still followed the same pre-registered data collection and analysis plan used for Study 2 (https://aspredicted.org/mp7wi.pdf).

science/engineering training) did not differ between the two spaces, indicating that random assignment of participants to the rooms was effective.

– Table 9 about here –

Task and Measures

For this study, participants were given an open-ended divergent thinking task which required them to provide solutions to a problematic situation (Acar and Runco 2011, Runco 2011). Specifically, they were given the following task:

> *Imagine that you have arrived at a store that requires you to wear a mask due to the pandemic situation. However, you forgot to bring one. How will you deal with this situation? The store does not sell masks and returning home without the item you needed is not an option. Your goal is to type in as many answers as possible.*

We chose this task because deriving solutions for this task would require creative thinking but the features of the virtual workspaces (Figure 6) were unlikely to inspire those solutions. Participants were given 20 answer boxes that they could fill for three minutes.

As done in Studies 1 and 2, we examined the same two performance outcomes of the divergent thinking task. First, we counted the *total number* of solutions that a participant came up with (i.e., *ideational fluency*). Second, we counted the number of objects that *only* the focal participant answered (i.e., *originality*). We estimated Poisson regression models for each outcome variable, without and with controls. To check if our manipulation was effective, we asked participants to report the extent to which they found the virtual workspace to have unconventional features (1 = strongly disagree; 7 = strongly agree) at the end of the study. A *t*-test was used to compare the mean scores of responses between the rooms.

6.2. Results

Participants assigned to the Unconventional Space reported that the virtual workspace had more unconventional features ($M = 5.71$, $SD = 1.44$) than the participants assigned to the Conventional Space did ($M = 2.42$, $SD = 1.54$), $t(373) = -21.36$, $p = 0.00$, indicating that the manipulation was effective.

The results of the Poisson regression analysis that tested the effect of the Unconventional Space on divergent creative thinking performance in terms of *ideational fluency* (i.e., the total number of solutions) are presented in Table 10. Model 1 included only the independent variable, *Unconventional Space*. Supporting our Revised Hypothesis, the result showed that divergent thinking performance was *higher* for participants who were assigned to the Unconventional Space compared to those who were assigned to the Conventional Space ($p < 0.01$). Specifically, participants in the Unconventional Space had an incidence rate that was 1.14 times greater for the total number of solutions than participants in the Conventional Space. Model 2 included the control variables. The results were consistent.

– Table 10 about here –

Next, we tested the effect of unconventional space on divergent thinking performance in terms of *originality* (i.e., number of unique solutions). The results of this analysis are presented in Table 11.

– Table 11 about here –

Consistent with the results for *ideational fluency* and with the *Revised Hypothesis*, the results in Model 1 of Table 11 show that divergent thinking performance in terms of *originality* was higher for participants in the Unconventional Space compared to those in the Conventional Space ($p < 0.15$). Specifically, participants assigned to the Unconventional Space had an incidence rate that was 2.77 times greater for the number of unique solutions than participants assigned to the Conventional Space. Model 2 included the control variables and the results were consistent. Notably, the results of this analysis were statistically significant only at the 15% level. This was probably because the task was very familiar to all the participants and was completed by a significantly larger number of participants than in Study 1 (i.e., 400), increasing the number of redundant ideas across participants (and reducing the number of unique ideas across them) (see Kornish and Ulrich 2011 and Silvia et al. 2008). To adjust for this, we ran another analysis that coded unique answers as the solutions that were provided by less than 10% of the participants (i.e., fewer than 37 participants out of 375).[8] Thus, the alternative dependent variable for this analysis, *top*

[8] Some solutions were expressed differently but were qualitatively the same (e.g., "let your hair swing over your face and keep your head down" vs. "wrap my hair around my mouth and nose"). In our coding scheme, these solutions were *not* coded as two different solutions but as a duplicate solution (i.e., uniqueness was coded in a conservative way). Following this coding scheme, three coders independently evaluated the uniqueness of the solutions and created clusters of solutions. When there was disagreement between the coders, they reassessed the uniqueness of the solution until they came to an agreement on which cluster the solution should be included in. A total of 41 clusters were

10% originality, was the count of these top 10% unique solutions for each participant. The results of this analysis are presented in Table 12.

– Table 12 about here –

Model 1 included only the independent variable, *Unconventional Space*. As expected, the results of this model showed stronger statistical support for the *Revised Hypothesis*: divergent thinking performance in terms of *top 10% originality* was higher at the 1% level for participants who were assigned to the Unconventional Space compared to those who were assigned to the Conventional Space. The results also showed that participants in the Unconventional Space had an incidence rate that was 1.68 times greater for the total number of top 10% unique solutions than participants in the Conventional Space. Model 2 included the control variables. The results were consistent. In sum, the results of Study 3 (i.e., Tables 10, 11, and 12) showed consistent support for the *Revised Hypothesis*.

6.3. Mediation Analysis

Next, we examine whether the perceived difference between the unconventional workspace and the work environment that the participant was familiar with or typically worked in mediated the positive relationship between the Unconventional Space and divergent thinking performance, using the results from Tables 10 and 12. We argued in our theory that unconventional workspaces, compared to conventional workspaces, would be more conducive to individuals' divergent thinking performance because unconventional workspaces trigger sub-mechanisms that facilitate divergent thinking. The first and most important step to the activation of these sub-mechanisms, however, would be the difference between an unconventional workspace and workspaces that individuals were familiar with or usually worked in. This difference is what would attract individuals' attention to the workspace and thus trigger the sub-mechanisms that facilitate divergent thinking (i.e., idea recombination, distraction/mind-wandering, intrinsic motivation, positive mood, etc.). Therefore, as a mechanism test, we tested whether the perceived difference between the

identified, and among these, 28 were ones that less than 10% of the whole sample of participants (375) provided as a solution to the divergent thinking task. Among the 28 clusters, 11 clusters were singletons, which comprised a truly unique solution that was provided by only one participant.

Unconventional Space and the work environments that participants were familiar with or typically worked in mediated the positive relationship between the Unconventional Space and divergent thinking performance in this study. For this analysis, we created a composite measure that averaged participants' responses to the following two questions measuring mediators on a 7-point scale (1 = strongly disagree; 7 = strongly agree):

- *The virtual workspace looked different from the environment that I am familiar with.*
- *The virtual workspace looked different from the environment that I normally work in.*

The responses to these two questions had a reliable Cronbach's alpha of 0.69 (van Griethuijsen et al. 2014). Using the composite mediator, we tested for mediation following the test of Hayes and Preacher (2014) and Preacher and Hayes (2004), based on bootstrapping with 10,000 iterations. We analyzed mediation for two of the strong main results we found above (i.e., the result with *ideational fluency* and with *top 10% originality* as dependent variables, respectively). The mediation results for the relationship between the Unconventional Space and *ideational fluency* are presented in Figure 7.

– Figures 7 about here –

We found support for the mediation. The indirect effect through the *perceived difference from familiar/normal environment* was significant at the 5% level (*coefficient* = 0.3, *SE* = 0.14, 95% *CI* [0.03, 0.57]. 45.75% of the total effect was mediated. Next, the mediation results for the relationship between the Unconventional Space and *top 10% originality* are presented in Figure 8.

– Figure 8 about here –

Again, we found support for the mediation. The indirect effect through the *perceived difference from familiar/normal environment* was significant at the 5% level (*coefficient* = 0.1, *SE* = 0.05, 95% *CI* [0.01, 0.19]. 34.32% of the total effect was mediated.

Overall, in Study 3 we found support for a positive relationship between the Unconventional Space and divergent thinking performance, and found that this relationship was mediated by the perceived difference between the Unconventional Space and workspaces that individuals were familiar with or normally worked in.

7. Summary of the Results of Studies 1-3

Figure 9 summarizes the incident rates for the dependent variables (i.e., ideational fluency and originality) in the Unconventional Space calculated based on the Poisson models for Studies 1-3.

– Figure 9 about here –

Keeping the reference as the incidence rate (=1) in the Conventional Space (dotted horizontal line), Figure 9 shows that for Studies 1 and 2, in which the solutions for the given divergent thinking task could be inspired by salient features of the unconventional workspace (and in particular the drawings on the wall that participants were facing when solving their task), participants' incidence rates for ideational fluency and originality in the Unconventional Space were significantly lower than the incidence rates in the Conventional Space. However, for Study 3, in which the solutions for the given divergent thinking task could *not* be readily inspired by features of the unconventional workspace, participants' incidence rates for ideational fluency and originality in the Unconventional Space finally became significantly *higher* than the incidence rates in the Conventional Space.

All in all, our three controlled experiments tested the causal relationship between unconventional workspaces and individuals' divergent thinking performance and showed the condition under which unconventional workspaces could lead to higher divergent thinking performance for individuals.

8. Discussion and Conclusions

Understanding people-related factors that influence the performance of innovation processes is an important topic for both academics and practitioners (e.g., Bacevice et al. 2016, Cohen 2019, Girotra et al. 2010, Kagan et al. 2018, Kavadias and Sommer 2009, Sommer et al. 2020, Waber et al. 2014). In this study, we set out to examine a factor that influence individual performance in creative tasks: the *workspaces* where such activities take place. More specifically, we studied the causal relationship between unconventional workspaces and individuals' divergent thinking performance. Through three controlled experiments, we found that the effect of unconventional workspaces on divergent thinking performance is much more nuanced than it has been widely believed to be. In the technology industry in particular, the trend of redesigning workspaces in unconventional ways has been growing, with the belief that such workspace designs will enhance employees' creativity (Creative Bloq Staff 2021, Lee 2016). Our study shows that this belief may not always hold true, and that unconventional workspaces could, in fact, inhibit individuals' creativity under certain conditions. Interestingly, we also found that the effect of unconventional *physical* workspaces on individual divergent thinking can be replicated in *online* settings, which has important implications given the increasing demands for online creative problem solving.

Specifically, our experiment results showed that the effect of unconventional workspaces (both physical and online) on divergent thinking performance depended on the *relatedness* between the potential solutions for the idea generation task and the features of the unconventional workspace. When solutions to an idea generation task could be readily inspired by salient features of the unconventional workspace, working in such an unconventional space had a negative effect on individual divergent thinking performance. On the contrary, when solutions to an idea generation task could *not* be readily inspired by features of an unconventional workspace, working in such a space had a positive effect on divergent thinking performance, suggesting that the unconventional ambience of the space triggered processes that were conducive for divergent thinking without causing cognitive fixation. Especially, our mediation analyses showed that the perceived difference between the unconventional space and the work environments that individuals were familiar with or normally worked in mediated the positive relationship between the unconventional space and divergent thinking performance, suggesting that such a difference was what triggered the theorized sub-mechanisms facilitating individuals' divergent thinking.

Our results have important managerial implications. First, our results suggest that managers should not think of unconventional workspace designs as silver bullets for fostering creativity but should be aware of the dual effects that unconventional workspace designs may have on individuals' divergent thinking performance. Unconventional workspace designs that work for one firm to promote creativity may not work for another, since employees engage in different types of idea generation tasks at different companies; a particular workspace design could be the source of creative inspiration for one idea generation task but a source of cognitive fixation for another. Therefore, managers should not blindly copy the workspace designs of other organizations, just because such organizations are generating innovative outcomes. Our results show that unconventional workspace designs have positive effects on creative thinking, but only when the salient elements of the space do not provide related solutions to the idea generation task at hand. Understanding these nuances will help to create better physical environments for organizations striving for creative outcomes. Having said this, we contend that most tasks that require divergent thinking in real world problem solving are not trivial, nor can their solutions be merely directly inspired by visual cues (such as the task featured in our Study 3); therefore, unconventional spaces are unlikely to be detrimental to individuals' divergent thinking performance through the relatedness mechanism we found in our studies.

Second, our results had unexpected and important implications for fostering creativity in virtual online settings. The COVID-19 pandemic has changed the way we work and has made virtual work a common practice. The literature on creativity has lacked evidence on how creativity can be fostered virtually, if at all possible. Although not originally planned, due to several critical constraints we were only able to conduct Study 1 in an actual physical environment and had to conduct Study 2 and Study 3 in a virtual (online) environment. To our advantage, this alternative virtual test bed proved to be useful for examining whether the effects of unconventional workspace designs on divergent thinking performance could be replicated virtually and for testing our revised hypothesis. Beyond mere replication, the implications of these online studies are increasingly relevant as collaborative problem solving is increasingly moving online. For instance, our results may have important implications for managers who need to host live online sessions that demand creative thinking from remote participants. In these situations, it is possible that the workspace in which the host conducts the session (which will be displayed to the participants through the video background of the host) influences the divergent thinking capability of the participants. In other words, if the host of a problem-solving session conducts an online session from an unconventional space, participants may be able to boost their divergent thinking performance. We encourage hosts of these sessions to experiment with these possibilities.

Importantly, like any empirical study, our research has some limitations worth discussing. First, given the constraints related to conducting the study in physical workspaces, we were able to include only one study of that sort (Study 1). However, perhaps for the same reasons, our study, as far as we know, is the first to conduct a controlled experiment on the effect of unconventional workspace designs on individual-level divergent thinking performance, allowing for causal inferences and providing baseline results for future studies. In particular, to check the robustness of our results, we ran various supplementary tests, including tests to ensure the random assignment of participants to the physical spaces, bootstrapping analyses to check whether our results were driven by outliers, and alternative regression models that included control variables. The results were robust to these additional analyses. We also were able to replicate the results virtually, enabling us to verify the original results and examine their boundary conditions. Nevertheless, we encourage future studies to replicate and extend our findings in physical spaces when feasible, as the effect of unconventional spaces should be strongest in such settings.

Second, this study took a holistic approach to conceptualizing conventional versus unconventional workspace designs, in which we did not specify which features made a workspace feel conventional versus unconventional. This is consistent with the literature from design of spaces and experience design, which suggest that it is the holistic nature of the space what influences how people feel in such spaces (Kobe and Lehman 2021). Yet, in our studies, it could have been the unfinished ceilings, the colorful beanbags, the high-top tables and stools, or the various drawings and posters on the wall that made the experiment participants perceive the space to be unconventional. Thus, our study cannot provide specific guidelines on how to create an unconventionally designed workspace. However, we believe that any manager with sufficient organizational and industry experience would be able to imagine the kinds of workspace designs that would be perceived as unconventional by employees and would not be directly related to the tasks that employees carry out; such designs should be good starting points for creating unconventional workspaces that inspire creative thinking. It would be interesting, however, to see future studies that examine this topic in more depth and identify types of workspace features that make workspaces feel unconventional.

Third, although our study theorized about sub-mechanisms that could be driving the positive effect of unconventional workspaces on individuals' divergent thinking performance (e.g., recombination of ideas, distraction/mind-wandering, increased motivation, etc.), we do not go as far as to test those mechanisms as mediators, as the main focus of this study is to establish a causal link between unconventional workspaces and divergent thinking performance. However, we encourage future studies to dig deeper into our findings and examine which micro-mechanism plays the biggest role in enhancing divergent thinking performance in these settings. This will be also important to extending our findings to the team level of analysis. We found that individual creative problem solving will benefit by being done in an unconventional (and unrelated) workspaces. Would such effects multiply when teams were working in such spaces? We encourage future work to extend our findings at the individual level and study the impact of unconventional workspaces on creative problem solving in teams; the existing behavioral operation literature on creative problem solving at the team level will be helpful for such pursuits (e.g., Girotra et al. 2010, Kagan et al. 2018, Sommer et al. 2020).

Finally, our study examines only the immediate effects of an unconventional workspace on individuals' divergent thinking performance. However, it is possible that the stimulation from the workspace design wears off over time as individuals adjust to their environments. Further research is needed to understand how long these effects last and what can be done to mitigate their maturation. However, even assuming that the effect of unconventional spaces decays over time with usage, their usefulness can still be significant in organizations. For instance, imagine someone who has designed an unconventional office space for her own use. Over time, such an office space might not feel unconventional to her after daily use. However, it could still be unconventional to others who visit this office for a creative problem-solving session; in these cases, the workspace will positively contribute these individuals' creative thinking processes.

Despite these limitations, we believe this study makes several important contributions to the literatures on behavioral operations focused on how to improve innovation processes (e.g., Girotra et al. 2010, Kagan et al. 2018, Kavadias and Sommer 2009, Sommer et al. 2020), organization design focused on how workspaces influence organizational individuals' behaviors and performance (Bernstein and Turban 2018, Catalini 2017, Chown and Liu 2015, Khazanchi et al. 2018, Lee 2019), and creativity (Acar and Runco 2011, Amabile 1996, Lu et al. 2017a, Lu et al. 2017b, Zhou and Hoever 2014). We especially hope that our paper sheds new light on the relationship between workspace designs and employee creativity and opens exciting opportunities for understanding the micro-processes of innovation.

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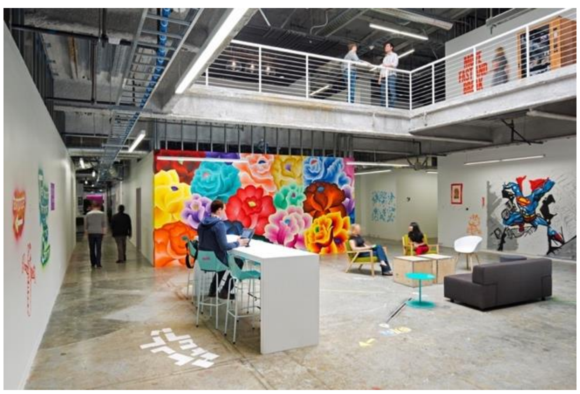
Figures and Tables

Figure 1. Examples of “unconventional” vs. “conventional” workspace designs

a. Unconventional workspace design: Google office in Dublin, Ireland (Source: Google search)

b. Unconventional workspace design: Facebook office in California, USA (Source: Google search)



c. General example of conventional workspace design (Source: Google search)

Figure 2. Panoramic view of the (a) Unconventional Space and the (b) Conventional Space (Study 1)

a. Unconventional Space

b. Conventional Space

Figure 3. View of the entrances to the two spaces (Study 1)

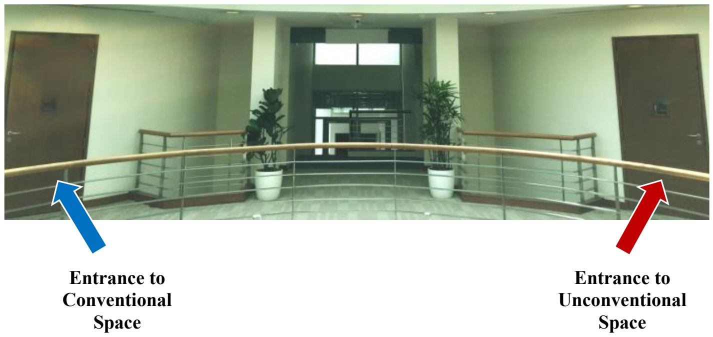


Figure 4. Divergent thinking task completed by a participant (Study 1)

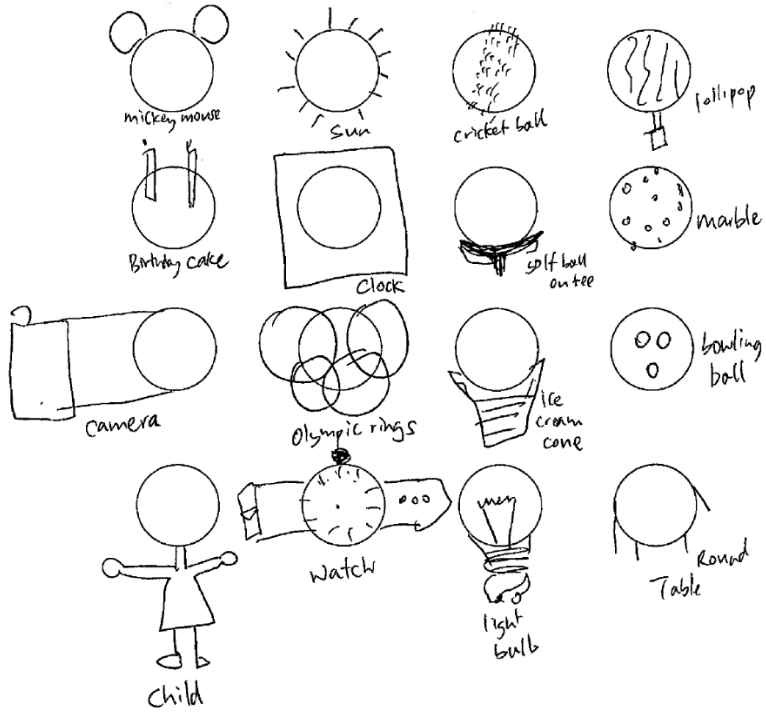


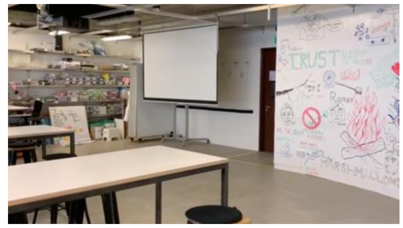
Figure 5. Close-up view of the front wall of the Unconventional Space (Study 1)

Figure 6. Screenshots of the Virtual Workspace Videos

a. Unconventional Space

Entrance

Left Wall

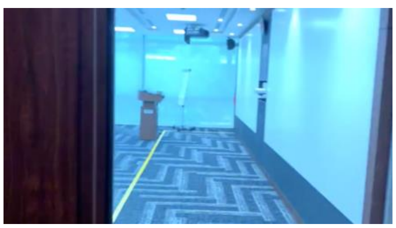


Front / Right Wall

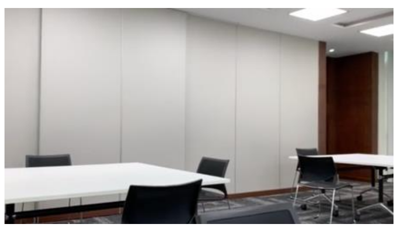
Ceiling

Last Scene with View of Front of Room

b. Conventional Space

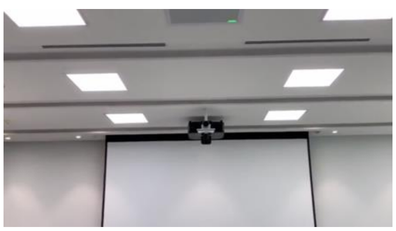


Entrance



Left Wall

Front / Right Wall



Ceiling

Last Scene with View of Front of Room

Table 1. Summary of observable characteristics of participants by space (Study 1)

Observable Characteristics of Participants	Unconventional Space Mean (Standard Deviation)	Conventional Space Mean (Standard Deviation)	*t*-test results	
			t-value	*p*-value
Gender (Male = 1)	0.71 (0.46)	0.85 (0.37)	1.17	0.25
Age	40.04 (9.53)	39.46 (7.75)	-0.24	0.81
Education (=5 if post-grad. degree)	3.63 (0.92)	3.46 (1.14)	-0.55	0.58
Science/Engineering training	0.42 (0.50)	0.38 (0.50)	-0.23	0.82
Number of participants	24	26		

Table 2. Poisson regression estimates for divergent thinking performance (*ideational fluency*) (Study 1)

DV: Divergent Thinking Performance (total number of all drawings)	Model 1	Model 2
INDEPENDENT VARIABLE		
Unconventional Space (=1 if Unconventional Space)	-0.190*	-0.183*
	(0.081)	(0.089)
CONTROL VARIABLES		
Gender (=1 if male)		-0.006
		(0.112)
Age		0.001
		(0.006)
Education dummy		Included
Science/Engineering training dummy		Included
Table dummy		Included
Observations	50	50

Standard errors in parentheses. ***p*<0.01, **p*<0.05, †*p*<0.1

Table 3. Poisson regression estimates for divergent thinking performance (*originality*) (Study 1)

DV: Divergent Thinking Performance (number of unique drawings)	Model 1	Model 2
INDEPENDENT VARIABLE		
Unconventional Space (=1 if Unconventional Space)	-0.419*	-0.468*
	(0.178)	(0.193)
CONTROL VARIABLES		
Gender (=1 if male)		0.198
		(0.258)
Age		0.014
		(0.014)
Education dummy (=5 if post-graduate degree)		Included
Science/Engineering training dummy (=1 if has a degree in these fields)		Included
Table dummy		Included
Observations	50	50

Standard errors in parentheses. ***p*<0.01, **p*<0.05, †*p*<0.1

Table 4. Additional Analysis: Did participants who drew Disney or Pixar characters as one of their first five drawings have even lower divergent thinking performance (*ideational fluency*) in the Unconventional Space? (Study 1)

DV: Divergent Thinking Performance (total number of drawings)	Model 1	Model 2
INDEPENDENT VARIABLES		
Unconventional Space (=1 if Unconventional Space)	-0.190*	-0.120
	(0.081)	(0.085)
Early Disney or Pixar character drawing (=1 if drew as one of the first five drawings)		0.241
		(0.249)
Unconventional Space x Early Disney or Pixar character drawing		-0.666*
		(0.314)
Observations	50	50

Standard errors in parentheses. ***p*<0.01, **p*<0.05, †*p*<0.1

Table 5. Summary of observable characteristics of participants by space (Study 2)

Observable Characteristics of Participants	Unconventional Space Mean (Standard Deviation)	Conventional Space Mean (Standard Deviation)	*t*-test results	
			t-value	*p*-value
Gender (Male = 1)	0.42 (0.49)	0.34 (0.47)	-1.58	0.11
Age	45.14 (14.05)	42.67 (13.92)	-1.71	0.09
Education	2.77 (1.25)	2.74 (1.23)	-0.20	0.84
Science/Engineering training	0.65 (0.82)	0.59 (0.80)	-0.71	0.48
Number of participants	189	186		

Table 6. Poisson regression estimates for divergent thinking performance (*ideational fluency*) (Study 2)

DV: Divergent Thinking Performance (total number of all solutions)	Model 1	Model 2
INDEPENDENT VARIABLE		
Unconventional Space (=1 if Unconventional Space)	-0.078**	-0.071*
	(0.028)	(0.029)
CONTROL VARIABLES		
Gender (=1 if male)		-0.028
		(0.030)
Age		-0.003**
		(0.001)
Education dummy		Included
Science/Engineering training dummy		Included
Observations	375	375

Standard errors in parentheses. ***p*<0.01, **p*<0.05, †*p*<0.1

Table 7. Poisson regression estimates for divergent thinking performance (*originality*) (Study 2)

DV: Divergent Thinking Performance (number of unique solutions)	Model 1	Model 2
INDEPENDENT VARIABLE		
Unconventional Space (=1 if Unconventional Space)	-0.321**	-0.323**
	(0.090)	(0.091)
CONTROL VARIABLES		
Gender (=1 if male)		0.165†
		(0.091)
Age		-0.001
		(0.003)
Education dummy		Included
Science/Engineering training dummy		Included
Observations	375	375

Standard errors in parentheses. ***p*<0.01, **p*<0.05, †*p*<0.1

Table 8. Additional Analysis: Did participants who provided a spaced-inspired answer as one of their first five answers have even lower divergent thinking performance (ideational fluency) in the Unconventional Space? (Study 2)

DV: Divergent Thinking Performance (total number of solutions)	Model 1	Model 2
INDEPENDENT VARIABLES		
Unconventional Space (=1 if Unconventional Space)	-0.078**	-0.021
	(0.028)	(0.034)
Early Spaced-inspired Answers (=1 if provided as one of the first five solutions)		0.033
		(0.052)
Unconventional Space x Space-inspired Answers		-0.158*
		(0.066)
Observations	375	375

Standard errors in parentheses. ***p*<0.01, **p*<0.05, †*p*<0.1

Table 9. Summary of observable characteristics of participants by space (Study 3)

Observable Characteristics of Participants	**Unconventional Space Mean (Standard Deviation)**	**Conventional Space Mean (Standard Deviation)**	***t*-test results**	
			***t*-value**	***p*-value**
Gender (Male = 1)	0.51 (0.50)	0.48 (0.50)	-0.56	0.57
Age	41.82 (12.92)	43.80 (13.03)	1.47	0.14
Education	2.92 (1.09)	2.97 (1.15)	0.43	0.66
Science/Engineering training	0.52 (0.72)	0.48 (0.72)	-0.61	0.54
Number of participants	184	191		

Table 10. Poisson regression estimates for divergent thinking performance (*ideational fluency*) (Study 3)

DV: Divergent Thinking Performance (total number of all solutions)	Model 1	Model 2
INDEPENDENT VARIABLE		
Unconventional Space (=1 if Unconventional Space)	0.133**	0.148**
	(0.047)	(0.047)
CONTROL VARIABLES		
Gender (=1 if male)		-0.070
		(0.048)
Age		-0.001
		(0.002)
Education dummy		Included
Science/Engineering training dummy		Included
Observations	375	375

Standard errors in parentheses. ***p*<0.01, **p*<0.05, †*p*<0.1

Table 11. Poisson regression estimates for divergent thinking performance (*originality*) (Study 3)

DV: Divergent Thinking Performance (number of unique solutions)	Model 1	Model 2
INDEPENDENT VARIABLE		
Unconventional Space (=1 if Unconventional Space)	1.018†	1.027†
	(0.677)	(0.683)
CONTROL VARIABLES		
Gender (=1 if male)		0.166
		(0.630)
Age		0.002
		(0.025)
Education dummy		Included
Science/Engineering training dummy		Included
Observations	375	375

Standard errors in parentheses. ***p*<0.01, **p*<0.05, ††*p*<0.1, †*p*<0.15

Table 12. Poisson regression estimates for divergent thinking performance (*top 10% originality*) (Study 3)

DV: Divergent Thinking Performance (number of top 10% unique solutions)	Model 1	Model 2
INDEPENDENT VARIABLE		
Unconventional Space (=1 if Unconventional Space)	0.520**	0.555**
	(0.143)	(0.144)
CONTROL VARIABLES		
Gender (=1 if male)		-0.001
		(0.142)
Age		-0.002
		(0.006)
Education dummy		Included
Science/Engineering training dummy		Included
Observations	375	375

Standard errors in parentheses. ***p*<0.01, **p*<0.05, †*p*<0.1

Figure 7. Results of Mediation Analysis (Study 3, *ideational fluency*)

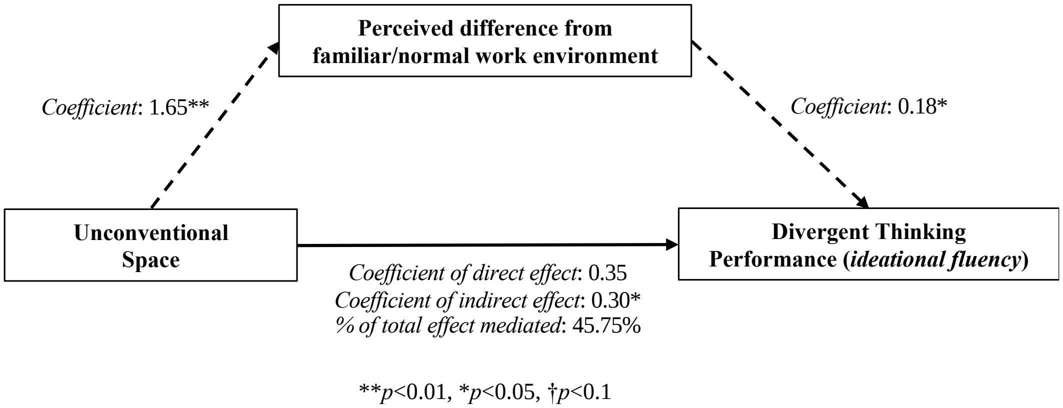


Figure 8. Results of Mediation Analysis (Study 3, *top 10% originality*)

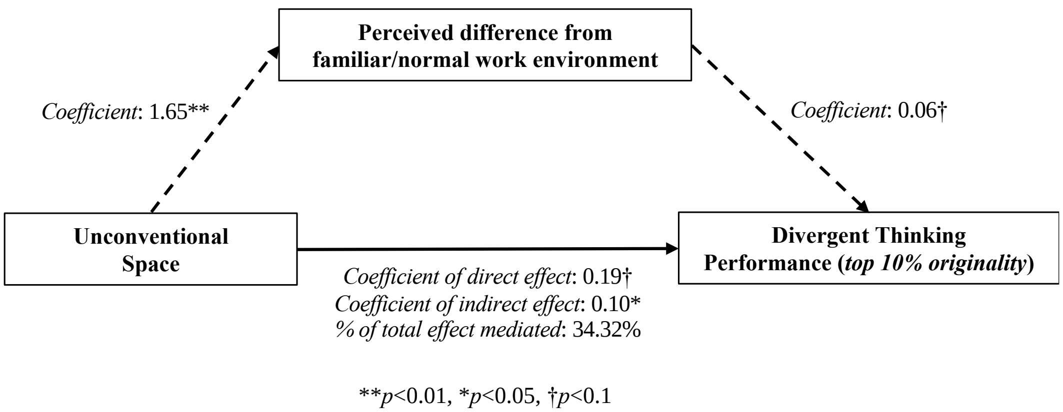


Figure 9. Summary of Results of Studies 1-3