

Constraining Ideas: How Seeing Ideas of Others Harms Creativity in Open Innovation

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Journal of Marketing Research
2021, Vol. 58(1) 95-114
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DOI: 10.1177/0022243720964429
journals.sagepub.com/home/mrj



Abstract

Open innovation contests that display all submitted ideas to participants are a popular way for firms to generate ideas. In such contest-based ideation, the authors show that seeing numerous competitive ideas of others harms, rather than stimulates, creative performance (Study 1). Others' competitive prior ideas interfere with idea generation, as new ideas need to be differentiated from the preceding ones to be original. Exposure to an increasing number of prior ideas thus heightens individuals' perceived constraints of expressing ideas and harms creative performance (Studies 2 and 3). Furthermore, creative performance monotonically reduces with an increasing number of prior ideas (Study 4). A final study demonstrates that showing only a limited number of ideas as well as grouping prior ideas offer actionable ways to reduce prior ideas' harmful influence (Study 5). These results illustrate viable ways to improve contest-based ideation outcomes merely by changing how competitive prior ideas are presented.

Keywords

creativity, crowdsourcing, open innovation, innovation contests, user-generated content

Online supplement: <https://doi.org/10.1177/0022243720964429>

Over the past decade, many organizations have democratized their innovation processes. Firms now involve consumers in the product development process in many ways, ranging from usability groups that test product prototypes to innovation contests (Chesbrough 2003; Terwiesch and Ulrich 2009). Our research focuses on “open” innovation contests—contests that allow anyone to participate, but also make all submissions transparent and accessible to participants. Popular examples of platforms enabling such contests include OpenIdeo.com, Crowdspring.com, 99designs.com, or Atizo.com (now Hyve crowd.com). Open contest platforms are the most common format of creative crowdsourcing utilized in the business context (Eyeka 2017). On each of these platforms, firms hosting contests typically receive large numbers of solutions at minimal cost. As a result, these platforms have experienced dramatic growth in recent years and are increasingly used by firms to take advantage of consumers' latent creative potential. In many of these contests, the numerous submissions are transparent and can be accessed by all participants during the contest.¹

Seeing the ideas of others is generally believed to stimulate innovation, as prior knowledge can be reused, recombined, and accumulated in novel ways to create new knowledge (Furman and Stern 2006; Murray and O'Mahony 2007). Indeed, many innovation examples illustrate how organizations can learn from and build on the discoveries of others. For instance, in the pharmaceutical industry, drugs such as insulin or penicillin have been improved as subsequent innovators have bettered previous technologies (Scotchmer 1991). In the software industry, open-source development such as the Linux operating system shows that open sharing of collective knowledge

on the platform as of March 26, 2020. This revealed that a majority of 432,408 (77.60%) of these contests were open and transparent.

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¹ On 99designs.com, firms can choose between blind (i.e., intransparent) or open (i.e., transparent) contests. To learn about the popularity of open contests, we counted the number of open/blind contests out of all 557,207 contests listed

can indeed spur ongoing innovation. In ideation, popular approaches such as brainstorming (Osborn 1953) or brainwriting (Paulus and Yang 2000) build on the concept of idea communication and sharing. Thus, seeing the ideas of others can be viewed as a main advantage of open innovation, as it can foster incremental and cumulative innovation (Dahlander and Gann 2010).

Little is known, however, about the role of competition in this context (Amabile 2018). Specific to contest-based ideation, it is unclear how seeing ideas of others (denoted as “prior ideas”) influences the creativity of a participant in a contest in which people compete against the manifest submissions of others. Although the contest literature has investigated contest format with an emphasis on the design of financial incentives (e.g., Boudreau, Lacetera, and Lakhani 2011; Terwiesch and Xu 2008), less is known about contest design in terms of the information presented via user interfaces (UIs). Prior innovation contest research has found that moving from a blind interface to an open and transparent one can change entries’ quality characteristics and contest outcomes (Wooten and Ulrich 2015). However, the specific mechanisms of how others’ ideas influence creative performance, independent of potentially confounding factors such as visible feedback from firms, participant experience, or entry timing, have not been studied. Luo and Toubia (2015) found that decomposing an uncompetitive ideation task into a sequence of separate tasks that focus on and display only one specific common category of prior solutions at a time can improve the creative performance of knowledgeable individuals. It is not clear if these results hold when individuals see prior ideas from different categories at the same time, compete against them, and have to think beyond them in order to be original.

We contribute to this literature by documenting the harmful influence of seeing numerous prior ideas in the context of an innovation contest and by showing how individuals’ creative performance can be improved simply by changing the number of displayed prior ideas, altering ideation instructions, or grouping competitive prior ideas. Importantly, we focus on contests in which innovators compete against prior ideas for exclusive financial rewards. We find that when prior ideas are competitively (vs. uncompetitively) presented, they will influence one’s perceptions of how constrained the ideation task will be. Indeed, being confronted with numerous prior ideas as competitors, rather than pure sources of information or inspiration, will heighten the perceived challenge of separating one’s ideas from the pack, even when many more solutions are still possible. Therefore, we find that seeing more competing ideas harms participants’ creative performance. This effect increases monotonically with higher numbers of prior ideas and is defined for both novices and expert participants.

From a managerial perspective, finding ways to reduce the negative effects of prior ideas while simultaneously leveraging their stimulating effects is crucial in ensuring the success of open innovation contests. We find that exposing participants to a limited number of prior ideas, framing instructions in a less competitive manner, or changing the prior ideas’ presentation

by visually grouping similar ideas together reduces participants’ felt constraints in expressing their ideas. The remainder of this article is structured as follows. We first review the literature addressing how others can influence individuals’ creativity in group brainstorming and ideation. Then, we present our conceptual framework and formal predictions specific to the context of contest-based ideation. We test these predictions in a series of five empirical studies. We conclude with a summary and a discussion of the implications and limitations of this research.

Conceptual Framework and Hypothesis Development

Ideation has a long tradition in business practice. In 1957, Osborn introduced brainstorming as an effective way to enhance the number and quality of ideas generated in groups. In a typical brainstorming session, individuals are instructed to generate and verbally express as many creative ideas as possible without criticizing them and to build on ideas others have already suggested. The internet has taken group ideation online, and other approaches have emerged, such as electronic brainstorming (Gallupe and Cooper 1993), online innovation communities (Bayus 2013; Stephen, Zubcsek, and Goldenberg 2016), and online innovation contests (Terwiesch and Xu 2008). In each of these approaches, other group members and their ideas may harm or help creative performance in different ways, as we discuss next (for an overview, see Table 1).

The Harmful and Helpful Influence of Others in Group Brainstorming and Ideation

Others can significantly harm the creative performance of individuals in group brainstorming and ideation. The mere presence of others can increase anxiety and excitement, causing a narrowing of attention and reduction in performance (social inhibition; Mullen, Johnson, and Salas 1991; Zajonc 1965). The need to verbally express ideas to the group is a major limiting factor that reduces the productivity of group members, who are unable to talk when others are talking and have to wait their turn to communicate their own ideas (production blocking; Diehl and Stroebe 1987, 1991). Individuals may withhold their ideas, fearing negative evaluations from others (evaluation apprehension; Camacho and Paulus 1995; Collaros and Anderson 1969) or match others’ lower performance (social matching; Paulus and Dzindolet 1993). When performance is evaluated at the group (vs. individual) level, social loafing may occur (Harkins 1987; Karau and Williams 1993). Similarly, individuals may reduce their efforts and free ride on others when the perceived dispensability of their work to the success of the group increases (Kerr and Bruhn 1983).

These harmful influences have given rise to alternative approaches, such as the nominal group technique, electronic brainstorming, or online innovation communities. These strategies eliminate brainstorming’s most vexing issues by letting participants generate ideas individually, increasing accountability through measuring individual performance, and by asking them to type ideas instead of verbally expressing them (DeRosa, Smith,

Table 1. Overview of Harmful and Helpful Influences of Others on Individual Creative Performance in Brainstorming and Ideation.

Literature	Direction	Context	Effect
Mullen, Johnson, and Salas (1991); Zajonc (1965)	Harmful	Group brainstorming	Social inhibition: The mere presence of others (as independent coactors) can be arousing, narrowing attention and reducing creative performance
Diehl and Stroebe (1987, 1991)	Harmful	Group brainstorming	Production blocking: Difficulties include not being able to talk while others are talking, forgetting ideas while one waits one's turn to talk, thinking an idea is less relevant after having to wait to talk, and trying to generate ideas while others are talking
Paulus and Dzindolet (1993)	Harmful	Group brainstorming	Social matching: Matching the ideas of low-performing individuals
Camacho and Paulus (1995)	Harmful	Group brainstorming	Evaluation apprehension: Fear of negative evaluation
Diehl and Stroebe (1987); Harkins (1987); Karau and Williams (1993)	Harmful	Group brainstorming	Social loafing: Pooling of ideas with others reduces accountability for one's own performance, reducing effort
Kerr and Bruun (1983)	Harmful	Group brainstorming	Free riding: Group members exert less effort as the perceived dispensability of their efforts for group success increases
Boudreau, Lacetera, and Lakhani (2011); Taylor (1995)	Harmful	Innovation contests	Incentive effect: Increasing the number of participants reduces winning chances
Bayus (2013); Duncker (1945); Jansson and Smith (1991); Smith, Ward, and Schumacher (1993); Kohn and Smith (2011)	Harmful	Design tasks; ideation tasks; innovation communities	Fixation: Individuals are shown to conform to a prior idea and produce creative solutions that include features seen in the template prior idea(s)
Stephen, Zubcsek, and Goldenberg (2016)	Harmful	Innovation communities	Network structure effect: Higher connectivity among ideators harms the innovativeness of ideas
Dennis and Valacich (1993); Dugosh et al. (2000); Nijstad and Stroebe (2006); Paulus and Yang (2000)	Helpful	Nominal groups (with exposure to ideas of others)	Cognitive stimulation: Cognitive stimulation occurs from seeing prior ideas because they activate concepts and topics (i.e., images) that otherwise would not have been activated, potentially leading to new ideas that contain or combine such activated elements in new ways
Gallupe et al. (1992); Paulus et al. (2013)	Helpful	Electronic brainstorming	Number of prior ideas: The number of ideas that members can build on increases as a function of the number of ideas exposed to
This article	Harmful	Innovation contests	Idea competition effect: Exposure to a larger (vs. smaller) number of competitive prior ideas increases the perceived constraints of expressing one's own ideas in the mind of the participants, harming creativity

and Hantula 2007). Yet others' ideas are still typically visible, which can result in fixation (Duncker 1945) when the template ideas or prior ideas share common concepts (e.g., Smith, Ward, and Schumacher 1993). In these situations, participants conform to the ideas of others and produce creative solutions that include features seen in the prior idea(s) (Jansson and Smith 1991; Kohn and Smith 2011). In innovation communities, friends tend to suggest similar ideas, thereby reducing the inspiration realized from seeing them (network structure effect; Stephen, Zubcsek, and Goldenberg 2016).

Despite these negative influences, seeing others' ideas may not always harm creative performance but may instead cognitively stimulate creativity (Dennis and Valacich 1993; Nijstad and Stroebe 2006). Greater stimulation is also achieved with exposure to more prior ideas, which has resulted in the observation of a positive number of prior ideas effect—in other words, the more ideas individuals are exposed to, the better their creativity (Gallupe et al. 1992; Paulus et al. 2013).

However, in these studies, individuals did not compete against the prior ideas they saw.

Contest-Based Idea Generation and Competing Prior Ideas' Harmful and Helpful Influences

Contest-based idea generation differs from the previously discussed group ideation approaches in one particular and major way: individuals' performance is evaluated relative to the performance of other group members instead of a group's overall performance (the sum of all performances), introducing competition into the ideation task. Importantly, this evaluation typically happens only after all ideas have been submitted and the contest has ended (Harvey and Kou 2013). Contest participants are rewarded by rank, and only the top-ranked individuals receive a financial reward, emphasizing the need to stand out from the competition (Lazear and Rosen 1981). In sports, for instance, this increase in the importance of good or improved

performance has been found to increase pressure among athletes, who may “choke” under pressure, resulting in performance decrements (Baumeister 1984; Otten 2009). Competition can also increase stress levels, which may impede performance on tasks that require undivided attention (Ellis 2006; LeBlanc 2009). In innovation contests, Boudreau, Lacerata, and Lakhani (2011; Taylor 1995) show that increasing the number of competitors lowers winning chances, thereby diluting individual incentive to exert effort (incentive effect). Thus, the typically large numbers of ideas in online ideation result in low probability of winning for an individual idea, which in turn reduces individuals’ motivation to exert sufficient effort toward the innovation task.

In our research, we add to these identified effects by proposing an additional negative outcome when contest participants are exposed to competitive prior ideas (i.e., an idea competition effect). Beyond the influence of a contest’s objective incentive properties, we propose that exposure to a larger (vs. smaller) number of competitive prior ideas increases the perceived constraints of expressing one’s own ideas in the mind of the participants, thus harming their creative performance. This effect occurs when telling participants that their performance will be compared with others (competition), which implies that they should not copy others’ ideas and differentiate their own ideas for them to be perceived as innovative (constraint).

Indeed, when prior ideas are competitively presented, they will directly influence the assessed challenge of proposing creative ideas. We define “creative” as being the first in proposing an idea and suggesting ideas that go beyond what others have already identified (i.e., proposing original ideas; Guilford 1967). Some contest platforms even explicitly state that contestants “must create their own unique implementations, and must not merely attempt to replicate the decisions made by [others]” and that “unique and original concepts must be respected and only developed by the designer that introduced them.” (see, e.g., 99designs 2018). Therefore, individuals are likely to experience external constraints on their idea expression due to the disallowance of copying, imitating, or utilizing elements of original concepts that have already been submitted (Hofstetter, Nair, and Misra 2020).

Being confronted with numerous prior ideas as competitors, rather than ideas as sources of information or inspiration, will heighten the perceived challenge of separating one’s ideas from the pack, even when there is enough room for additional ideas. Individuals will feel less able to express their own ideas and more constrained by the prior ideas (i.e., they will feel that they cannot freely express ideas when incentivized to care about the distinctiveness of those ideas. This in turn reduces the subjective probability of their being able to produce further ideas (i.e., the participant’s expectancy to do so) and thus the tendency to perform well and persist in ideation (Nijstad, Stroebe, and Lodewijkx 1999; Vroom 1964). Indeed, we contend that fewer ideas will be generated and the chances that high-quality ideas emerge will be reduced. This expectation is in line with prior research arguing that people who feel constrained in their environment (e.g., by having less

choice in how to do a task) are less creative (Amabile 2018). Importantly, externally imposed output constraints that harm motivation are different from input constraints, which can actually increase creative performance in uncompetitive ideation (i.e., they trigger a more constructive cognitive process; Moreau and Dahl 2005).

In summary, we posit that competition frames the prior ideas as a constraint to creative output, which in turn interferes with the free expression of ideas. Therefore, when prior ideas are competitively presented, exposure to a growing number of prior ideas will increase the individual’s perceived constraint of expression and will, in turn, lead to a reduction in creative performance (i.e., an idea competition effect). Importantly, we predict that these effects are independent of the objective chances of winning. More formally,

H_{1a}: In open innovation contests, where prior ideas are competitively presented, exposure to a larger (vs. smaller) number of prior ideas decreases the level of creative performance realized (i.e., a negative effect of prior ideas).

H_{1b}: The negative effect of prior ideas on creative performance is mediated by the perceived constraints of idea expression.

Prior ideas may also help creative performances. Nijstad, Stroebe, and Lodewijkx (2002) showed how example ideas stimulate the ideation process by presenting a series of such ideas prior to participants’ own idea generation. Individuals built on the examples by leveraging them in their own creations. Dugosh et al. (2000) showed that greater stimulation can be expected if more example ideas are shown. Increased activation of previously stored knowledge through exposure to prior ideas can thus increase individuals’ cognitive ability to generate numerous and original ideas (i.e., a number of prior ideas effect; Dennis and Valacich 1993; Nijstad and Stroebe 2006; Paulus and Yang 2000).

The cognitive stimulation benefits gained from exposure to prior ideas are more likely to be realized in uncompetitive settings when the context emphasizes the informational value of prior ideas and not their competitive nature. We argue that in open innovation contests, where the competitive nature of the prior ideas is salient, the heightened competition inherent in seeing more prior ideas draws attention away from their informational benefits. Increasing the saliency of competition in the presentation of prior ideas can cause a shift away from their informational aspects, thus reducing their positive influence (Deci and Ryan 1985). Therefore, we argue that seeing more prior ideas can increase cognitive stimulation but only when they are presented uncompetitively, without constraints. The outcome of this increased stimulation is improved creative performance (Figure 1 summarizes the hypotheses that form our conceptual model). Thus,

H_{2a}: In open innovation contests, when prior ideas are presented uncompetitively, exposure to a larger (vs. smaller) number of prior ideas increases the level of

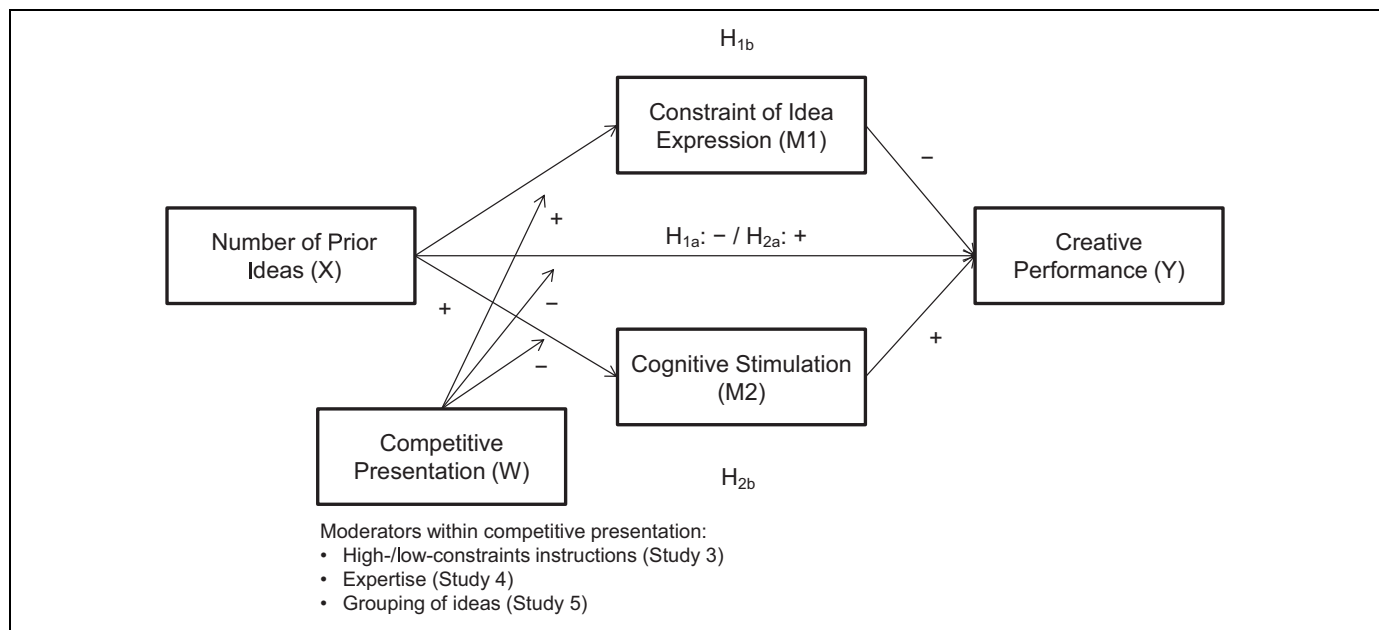


Figure 1. Conceptual framework of how competition affects the dual role of prior ideas in open innovation contests.

creative performance realized (i.e., a positive effect of prior ideas).

H_{2b}: The positive effect of prior ideas on creative performance is mediated by cognitive stimulation felt by the participant.

Constrained Ideation Tasks and Domain Expertise

There are considerable individual differences in how a constrained ideation task may undermine creativity. We explore how domain experts and novices cope with the constraints arising from competitive prior ideas. Participants in ideation contests are often novices (Terwiesch and Xu 2008), yet some participants may be considered experts due to prior knowledge specific to the ideation domain and their prior experience in related ideation tasks (Luo and Toubia 2015).

Although there is a wide agreement that a certain level of expertise is necessary for creativity, greater expertise may not always be better (Coursey et al. 2019; Dane 2010; Mumford et al. 2006; Stacey, Eckert, and Wiley 2002; Wiley 1998). By definition, experts possess a large body of domain knowledge and store substantial and meaningful chunks of domain-related information. This also involves methodological knowledge—including trained, habitual, and algorithmic ways to solve similar problems—and solutions that have worked in the past (Amabile 2018; Dane 2010; Murray and Häubl 2007). These knowledge structures can be quickly activated to produce solutions following a path of least resistance (Moreau and Dahl 2005; Ward 1994).

However, when confronted with external constraints from numerous competitive prior ideas, experts are required to flexibly integrate new information and deviate from their known solution paths. The higher the domain expertise, the less likely

this is to happen (Fiske and Taylor 1991; Lewandowsky, Little, and Kalish 2007). For example, expert accountants were found to be less capable of using a new tax law replacing an existing law (Marchant et al. 1991), and compared with novices, expert bridge players found it more difficult to adapt to a modified game with altered rules (Dane 2010; Frensch and Sternberg, 1989). Experts fixate on internal knowledge and known paths to solutions (different from fixation on external examples; Smith and Blankenship 1991; Youmans and Arciszewski 2014). Such fixation and inflexibility may be particularly harmful when developing maximally innovative (or radical) ideas that require flexible reorganization and combination of concepts in a way that departs from established patterns.

Therefore, we expect that domain expertise will increase the negative effect of seeing more prior ideas on creative performance. External constraints will reduce experts' subjective probability of producing creative ideas due to (1) less flexibility in integrating additional information and (2) a fixation on known paths to solution (which are likely less valid with more competing prior ideas being seen). Although our theorizing and conclusions specifically draw from domain expertise, similar results may be expected for the related constructs of anticipated success, self-efficacy, and ideation expertise.

H₃: High (vs. low) domain expertise increases the negative effect of prior ideas on creative performance.

Creative Performance in Open Innovation Contests

In open innovation contests, the frequently used winner-take-all prize structure suggests that managers typically care most about the quality of the top ideas they select for later processing and development (Hofstetter, Zhang, and Herrmann 2018). Managers often care about breakthrough or top ideas and the

maximum innovativeness that can be achieved (Fleming 2007). Therefore, we use the innovativeness of an individual's best idea out of all generated ideas (top-box innovativeness) as our key measure of performance. In previous research, creative performance often has been measured on two quality dimensions: an individual's ability to produce ideas that are original (or novel, unique; Gallupe et al. 1994) and useful (or appealing, valuable; Dahl, Chattopadhyay, and Gorn 1999). An increase in the level of originality achieved in the innovation process has been shown to have a direct positive effect on the success of a new product development effort (e.g., Dahl and Moreau 2002; Goldenberg, Lehmann, and Mazursky 2001; Lilien et al. 2002). However, originality alone may not guarantee market success; a successful outcome also requires that customers perceive products as useful (Dahl, Chattopadhyay, and Gorn 1999; Moldovan, Goldenberg, and Chattopadhyay 2011). Together, originality and usefulness define an idea's innovativeness. In addition, in innovation contests the number of ideas also indirectly matters (i.e., creative fluency; Guilford 1967), as greater numbers increase chances for top ideas (Girotra, Terwiesch, and Ulrich 2010; Terwiesch and Ulrich 2009).

In the open innovation contest context that we study, we acknowledge that individuals' creative performances can be measured in multiple ways, but we emphasize top-box innovativeness as the key metric. Nevertheless, in all studies we will also report results for the alternative measures of top-box originality, top-box usefulness, total innovativeness, and number of ideas generated. To integrate multiple elements of creative performance in a single measure, we follow the approach of Luo and Toubia (2015), who define creative performance as the individual-level sum of the average innovativeness ratings.² Throughout the studies, we focus on top-box innovativeness in our analyses but also report all four additional measures. For dependent variables, means, and results of all reported studies, see Table 2.

Overview of Studies and Controls

Five experiments test our predictions, with Studies 1 and 5 being field studies. Studies 2, 3, and 4 use a similar contest-based ideation paradigm, in which individuals perform an unusual uses task for a common household object (Guilford 1967) while seeing a sample of prior ideas at the same time, mimicking the UI of typical ideation platforms. With their own ideas, individuals compete for a financial reward that is granted to those who generate the best ideas (for details, see Study 2). All studies (except for Study 5) expose individuals to a random sampling of different prior ideas we provide in Web Appendix A, Tables 1 and 2. We vary the number of prior (smaller vs. larger) ideas in all studies, with differing numbers across studies.

In testing our hypotheses, we controlled for a range of alternative explanations for harmful or helpful influences of prior ideas mentioned by prior research (Table 1). Ideation was carried out electronically, individually, and anonymously, which controlled for the possibility of social matching, mere presence of others, or network structure effects, and eliminating production blocking. Evaluation of the ideas happened at the end of the contest, which controlled for evaluation apprehension and possible interplay between simultaneous ideation and evaluation (Harvey and Kou 2013). We incentivized individual as opposed to group efforts, controlling for the possibility of social loafing. Winning chances (i.e., the number of competing ideas) were fixed in the instructions across groups, and in Studies 2–4, we explicitly state a fixed total number of prior ideas (i.e., the total number of ideas already submitted to the contest). This number is identical across both smaller and larger prior ideas conditions. Beyond objective winning chances, the Study 3 follow-up also controls for perceived winning chances. Finally, participants were randomly assigned to conditions (and contests in Studies 1 and 5) and could not move between experimental conditions (or contests), thereby eliminating self-selection concerns.

Study 1: A Field Experiment on an Open Innovation Platform

In Study 1 we investigate the overall impact of the number of prior ideas on creative performance within a competitive frame. We used data from a field experiment across six actual open innovation contests hosted on the European open innovation platform Atizo (now HyveCrowd). Atizo was founded in Europe in 2007 and now has an online community of 98,000 registered participants (at November 2020). Participants are incentivized with financial rewards that are granted based on creative performance. Contests on average attract 135 participants and 357 ideas over the course of the typical contest duration of 25 days. The typical Atizo user is 39 years old, has been a member for 2.43 years, and is male (74%). Examples of innovation problems hosted by companies such as Nestlé (food and beverage) and BMW (car and motorcycle manufacturer) include new product and service ideas for yogurt, mobility services, or creative marketing slogans for consumer goods.

Method

The experiment varied the number of prior ideas participants were exposed to when entering the contest. We randomly displayed a list of either 2 or 10 different prior ideas (i.e., smaller vs. larger number; we used larger numbers in later studies) out of a set of at least 15 ideas per contest. These ideas were generated by a small subsample of five Atizo community members before the contest started (we invited Atizo members to suggest ideas by email; Web Appendix A shows the list of ideas used to sample from; Web Appendix A, Figure 1, shows how the ideas were displayed). Clickstream data of Atizo community members revealed that 90% of them view nine or fewer

² Specifically, let x_{ij} be the average innovativeness score an idea i of individual j received and N_j be the total number of ideas submitted by j ; then creative performance is calculated as $Y_j = \sum_{i=1}^{N_j} x_{ij}$.

Table 2. Means Across Experimental Conditions over All Studies.

Study	Experimental Group	N	Top-Box Innovativeness	Top-Box Originality	Top-Box Usefulness	No. of Ideas	Total Innovativeness	Guilford's Originality
1	2 prior ideas	263	3.533	2.627	4.549	1.662	5.423	—
	10 prior ideas	277	3.376*	2.379**	4.442 [†]	1.444**	4.683*	—
Main finding: Study 1 shows that seeing more prior ideas reduces creative performances of contestants across measures in actual ideation contests.								
2	5 prior ideas, competitive	98	3.054	3.382	3.603	4.592	12.719	24.89
	50 prior ideas, competitive	106	2.822***	3.048***	3.003***	2.906***	7.997***	18.71**
	5 prior ideas, uncompetitive	103	3.056	3.361	3.503	4.893	13.436	27.17
	50 prior ideas, uncompetitive	93	3.101	3.606*	3.487	5.720*	15.564*	32.60*
Moderator (manipulated): Competitive (vs. uncompetitive) presentation Main finding: Study 2 provides direct evidence for the proposed framework by showing that seeing prior ideas as competitors (competitive) rather than sources of inspiration (uncompetitive) introduces the prior ideas' harmful influence.								
3	5 prior ideas, high CE	254	2.672	2.855	3.360	4.339	9.277	—
	50 prior ideas, high CE	232	2.510**	2.711*	3.113**	3.233***	6.943***	—
	5 prior ideas, low CE	253	2.675	2.893	3.321	4.158	9.133	—
	50 prior ideas, low CE	245	2.791*	3.037*	3.224	4.155	9.099	—
Moderator (manipulated): High versus low CE within competitive presentation Main findings: Study 3 provides moderated mediation evidence for perceived constrained expression as mediator of the prior ideas' harmful influence. It supports the harmful influence of prior ideas after controlling for a depletion of the idea pool and the comparability of prior ideas between smaller and larger numbers.								
Study 3 follow-up	5 prior ideas	260	2.789	2.949	2.745	4.069	9.533	—
	50 prior ideas	240	2.664*	2.816*	2.629*	3.3***	7.703***	—
Mediators: Perceived constrained expression, perceived competence, perceived self-efficacy, perceived winning chances, perceived competitiveness Main finding: Exploratory mediation provides supporting evidence for constrained expression as mediator. It supports the harmful influence of prior ideas after controlling for a depletion of the idea pool, the comparability of prior ideas between smaller and larger numbers, and after controlling for functional fixedness (in two ways).								
4	3 prior ideas	347	3.631	3.609	3.793	2.870	13.036	—
	10 prior ideas	337	3.465**	3.493*	3.699*	2.325***	10.338***	—
	100 prior ideas	316	3.421***	3.415***	3.609***	2.193***	9.046***	—
Moderators (measured): Domain expertise, ideation expertise, creative self-efficacy, innovativeness, lead user, emergent consumerism, personal involvement, achievement orientation Main finding: First, Study 4 provides evidence that effect persists also for larger (compared with previous studies) numbers of ideas. Second, it shows that expertise moderates the prior ideas harmful influence such that the prior ideas more strongly negatively influence creative performance for those high in domain expertise (also ideation expertise, lead user-ness, creative self-efficacy, and involvement).								
5	Open	278	4.363	3.260	4.766	1.309	5.625	—
	Restricted	273	4.485*	3.775***	4.971*	1.729***	7.557***	—
	Grouped	277	4.616***	3.679***	4.935 [†]	1.744***	7.711***	—
Main finding: Study 5 validates the implications of prior studies on the design of a mock-up ideation platform's UI. Restricting and grouping competitive prior ideas increases creative performances of individuals.								
Total		4,252						

* $p < .05$.** $p < .01$.*** $p < .001$.[†] $p < .10$.

Notes: CE = constraint of idea expression. Statistical tests are always relative to the smaller number of prior ideas within condition or study. For Study 1, we ran linear regressions with project controls and clustered standard errors (at the project level). For all other studies, we used ANOVAs. We only calculated Guilford's originality for Study 2. In Study 4, the difference between 10 and 100 is significant for novices ($F(1, 994) = 5.00, p < .05$), but not for experts ($F(1, 994) = .01, p > .10$).

ideas prior to posting their own ideas, suggesting that ten prior ideas is appropriate for this platform.³

To control for potential confounds arising from selective entry, participants were randomly assigned to one of six similar ideation contests (e.g., ideas for novel pillows, ideas for viral videos featuring an eyeglasses brand) and they could only see and participate in the contest to which they had been assigned (the website was personalized accordingly). In the contest, we instructed participants about the specific innovation problem and provided a short background of the firm that elucidated the problem. We also told participants that original ideas would win 50 CHF (about US\$50), and that their ideas would compete with all other submitted ideas for these rewards. In all experimental conditions, we told them that 30% of all participants would win such a reward. Such high percentages of winners are not uncommon for contests on Atizo, with some contests rewarding more than 50% of the participants. We invited Atizo community members to participate in the contests by email. A total of 2,015 individuals registered for the contests and 540 decided to participate (26.80%), of which 263 (48.70%) were assigned into the two prior ideas condition and 277 (51.30%) in the ten prior ideas condition. These participants submitted 850 ideas in total. The average entrant submitted 1.57 ideas ($SD = 1.61$, $min = 1$, $max = 21$). We sent all submitted ideas to the firms, which then returned their evaluations to us (we do not have any information about the number of raters used or their demographics). Each firm only saw and evaluated the originality of ideas related to their own contest, using a seven-point Likert scale. The firms were blind to the experimental condition and the participant who generated the idea. One hundred sixty-one ideas that ranked highest in originality received a reward. We augment these data with information about usefulness; we had two marketing experts (doctoral students in marketing; one male, one female) evaluate the ideas on seven-point Likert scales and used the average as our measure ($\alpha = .89$). We then calculated an idea's innovativeness as $(originality + usefulness)/2$ (Argo and Tu 2013; results are comparable for the product of originality and usefulness). We utilized the five distinct dependent variables to test our hypotheses. Importantly, we included project fixed effects in all analyses to control for contest and evaluation differences across competitions.

Results

We pooled all data across contests to increase power, but we included project controls (and interactions of projects with the number of prior ideas, which are not significant in any of the analyses) to account for differing performance levels across projects. In support of H_{1a} , regression analysis shows a

significant negative effect of the prior ideas manipulation on top-box innovativeness ($M_2 = 3.53$, $SD = 1.18$ vs. $M_{10} = 3.38$, $SD = .97$; $\beta = -.24$, $p < .05$), top-box originality ($M_2 = 2.63$, $SD = 1.88$ vs. $M_{10} = 2.38$, $SD = 1.55$; $\beta = -.41$, $p < .01$), and marginally on top-box usefulness ($M_2 = 4.55$, $SD = 1.18$ vs. $M_{10} = 4.44$, $SD = 1.14$; $\beta = -.12$, $p < .10$) and the remaining two alternative measures (for additional Study 1 results, see Table 2 and Web Appendix A).

Discussion

In support of H_{1a} , the field experiment provides initial evidence that exposure to an increasing number of competitive prior ideas in an open innovation contest has a negative effect on creative performance. Importantly, the negative effect identified is not driven by objective winning chances, as they have been fixed across conditions. We find no evidence of a positive stimulation effect of prior ideas in Study 1. We believe that the absence of this effect is driven by the highly competitive nature of Atizo's innovation contests and the competitive presentation of prior ideas (e.g., the competitive nature of the task is made evident, contestants' profiles and contest rewards are prominently displayed). We test this further in a more controlled Study 2. Study 2 also addresses the small number of prior ideas in Study 1 (two vs. ten), which could be seen as a limitation given that contests often feature many more ideas.

Study 2: Constraints Implied by Competitive Presentation Trigger Ideas' Harmful Influence

In Study 2, we explicitly test the parallel processes outlined in H_1 and H_2 and the (in)dependence of these effects with respect to the competitive nature of the prior ideas' presentation in the open innovation contest. Consequently, we varied the number of prior ideas to which participants were exposed and investigate their influence on creative performance when the prior ideas were (vs. were not) competitively presented.

Method

The experiment had a 2×2 between-subjects design that varied the number of prior ideas (smaller: 5 out of 100 vs. larger: 50 out of 100) and the nature of the prior ideas' presentation (competitive vs. uncompetitive). We displayed more prior ideas in this study compared with Study 1 to test whether the negative influence of prior ideas also manifests within larger numbers of those ideas, and for comparability with previous experiments that exposed individuals with up to 60 ideas as part of the Guilford task (Nijstad, Stroebe, and Lodewijx 2002). Most participants (84%) correctly recalled the number of prior ideas they were confronted with in a recognition check question (n.s. between competitive conditions). We invited U.S. individuals from MTurk and offered them a fixed and a variable (bonus) amount for their participation in the study. We told them that by participating in the study they had entered into a competition for an 1

³ To further validate this manipulation, we conducted a pretest among 50 U.S. individuals from Amazon Mechanical Turk (MTurk). Individuals who were exposed to ten ideas (vs. two) indicated agreement toward the response "There are a lot of prior ideas" (7) relative to the response "There are few prior ideas" (1) on a seven-point semantic differential ($M_{10} = 5.00$, $M_2 = 2.96$, $diff = 2.04$; $t(48) = 4.04$, $p < .01$).

USD bonus payment that would be paid out depending on their creative performance (in addition to the fixed payment). We fixed the winning chances by telling them that typically 5% (5 out of 100 ideas) win the bonus in all experimental conditions. We told participants in all conditions that there are currently 100 ideas submitted and that we would show them a random sampling of either 5 or 50 different ideas out of these 100 prior ideas.

In the uncompetitive condition, we told study participants that the prior ideas were a sampling of example ideas generated by previous participants and that the winner would be determined by individually assessing the innovativeness of their new ideas, independent of the prior ideas displayed. Participants who generated innovative ideas would win the bonus. In the competitive condition, we told participants that their ideas were competing with the prior ideas and that we would compare their creative performance against other participants. Those who generated different and innovative ideas (compared with other competitors) would win the bonus.⁴

We also indicated that each prior idea was a randomly chosen idea of another competing participant, and that their own ideas would compete against the ideas we showed them (competitive condition) or that the ideas they would see were randomly chosen from previous participants (uncompetitive condition).⁵ In each condition, we told participants that prior ideas represented a sampling of different prior ideas of participants who may or may not have submitted more than one idea. Participants were then asked to submit as many innovative ideas as they could.

Before participants were asked to submit their ideas, we exposed them to the sampling of prior ideas. Participants either saw a smaller number of different prior ideas (5 different randomly picked ideas) or a larger number of different prior ideas (50 different randomly picked ideas). The ideas and their order were randomized between participants. The presented prior ideas were sampled out of 100 different ideas collected in a separate pretest with participants from the same population (for a list of these ideas and the presentation format, see Web Appendix A, Table 2).

After participants had seen these prior ideas, we asked them to report in random order their level of cognitive stimulation⁶ and perceived constraint of idea expression in the innovation

task. We measured cognitive stimulation using four items (e.g., “After having viewed the others’ ideas, I am aware of many different concepts and topics related to bricks”; $\alpha = .93$; see Web Appendix B). Factor analysis revealed that all items load onto the same factor and that only one factor was retained (eigenvalue = 2.35, proportion = 1.07, $\chi^2(3) = 950.68$, $p < .001$). We measured perceived constraint of idea expression with three items based on Ryan and Deci’s (2000) Basic Need Satisfaction Scale (Gagné 2003; e.g., “In this innovation task, I don’t feel free to express my ideas”; $\alpha = .91$; see Web Appendix B). Participants then completed the actual innovation task. We used a version of Guilford’s unusual uses task (Guilford 1967; Guilford, Merrifield, and Wilson 1958), a divergent thinking task, to measure the creative performance of participants. Divergent thinking tasks are frequently used to estimate the potential for creativity and have been found to be reliable and also predictive of real-world creative performance. Guilford’s task requires participants to produce varied responses to a question that has multiple alternatives within a limited time frame. In this study (and Studies 3 and 4), we asked participants to generate as many innovative ideas for unusual uses of a brick as possible.

A total of 400 U.S. respondents from MTurk participated in the study ($M_{\text{age}} = 36.82$ years, $SD = 11.95$; 46.50% female). Altogether, they submitted 1,794 ideas for uses for a brick. The mean respondent submitted 4.49 ideas ($SD = 2.84$, $\text{min} = 1$, $\text{max} = 16$). We calculated five different outcome measures as follows: we had MTurk raters evaluate the innovativeness, originality, and usefulness of each idea on five-point Likert scales (one separate item for each dimension; e.g., 1 = “Not at all innovative,” and 5 = “Extremely innovative”). We used ten raters for each dimension ($\alpha_{\text{innovativeness}} > .60$, $\alpha_{\text{originality}} > .70$, $\alpha_{\text{usefulness}} > .75$). These ratings allowed us to calculate the five creative performance measures. For the sake of comparability, we also calculated Guilford’s total originality measure, but only for this study (as described in Web Appendix C). Note that results are comparable if we calculate innovativeness as the sum or product of originality and usefulness.

Mean top-box innovativeness equaled 3.00 ($SD = .362$, $\text{min} = 1.24$, $\text{max} = 3.87$). Mean cognitive stimulation equaled 4.24 ($SD = 1.53$, $\text{min} = 1$, $\text{max} = 7$), and mean perceived constraint of expression equaled 2.38 ($SD = 1.50$, $\text{min} = 1$, $\text{max} = 7$). Note that cognitive stimulation and perceived constraint of expression are uncorrelated ($r = -.08$, $p > .10$) (we provide correlations across studies in Web Appendix D).

Finally, we checked for possible external fixation, which can harm creative performance beyond the perceived constraint of idea expression. Here, fixation may occur in the form of functional fixedness (Duncker 1945), which refers to the tendency to perceive an object only in terms of its most common use. Individuals may not be able to think beyond the prior ideas they see and accordingly may functionally fixate on them. When experiencing functional fixedness, individuals will likely restate prior ideas. Although fixation occurs typically when only very few common concepts are displayed and should vanish with increasing numbers of prior ideas (Jansson

⁴ Note that this manipulation of competition implies a constraint on idea expression.

⁵ We ran a pretest among 88 participants from MTurk. We randomly assigned individuals to one of the two task descriptions (45 to the uncompetitive and 43 to the competitive group) and then measured how they perceived competition using three items—“I think the task is very competitive,” “I think the competition in this task is very intense,” and “Competition is fierce in this task”—on seven-point Likert scales ($\alpha = .84$). The competitive description was perceived as significantly more competitive than the uncompetitive description ($M_{\text{high}} = 5.39$, $M_{\text{low}} = 4.67$; $d = .72$, $t(86) = 2.68$, $p < .01$). We also measured how well respondents understood what they would have to do in the task based on the description (“I understand what I would have to do in this task”) and found high levels of comprehension ($M_{\text{understand}} = 6.01$, $SD = 1.28$, $\text{min} = 1$, $\text{max} = 7$).

⁶ Asking about stimulation before the task may affect results. We omitted this measure in Studies 1, 3, and 5.

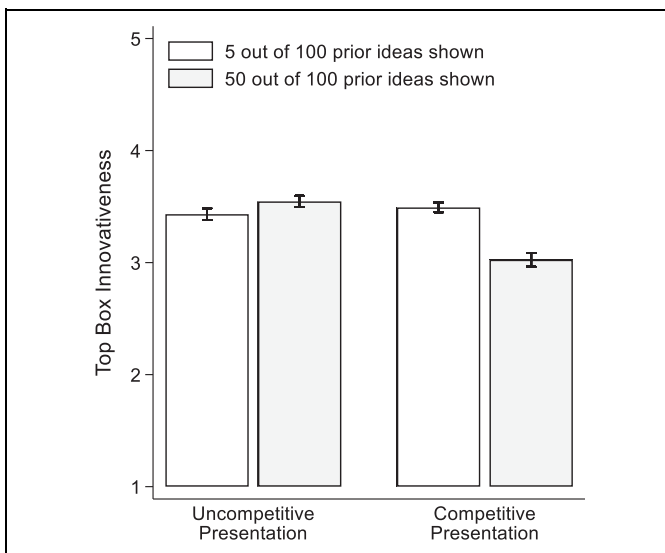


Figure 2. More prior ideas discourage creative performance when presented competitively (Study 2).

Notes: Error bars represent standard errors.

and Smith 1991), we found that 34 (1.90%) submitted ideas were identical to the prior ideas. We find more identical ideas in the 50 (vs. 5) prior ideas group (mean number of ideas that are copies: $M_{50} = .17$, $SD = .49$; $M_5 = .01$, $SD = .07$; $F(1, 396) = 15.19$, $p < .001$), but this number does not differ significantly by competitive presentation ($M_{competitive} = .07$, $SD = .32$; $M_{uncompetitive} = .10$, $SD = .39$; $F(1, 396) = .80$, $p > .10$).

Results. First, utilizing analysis of variance (ANOVA), we find a main effect of presentation such that participants are more creative in the uncompetitive (vs. competitive) condition ($F(1, 396) = 16.44$, $p < .001$; Figure 2). The main effect supports our notion of the detrimental influence of seeing competitive ideas per se. The interaction between number of prior ideas and their presentation is significant ($F(1, 396) = 15.96$, $p < .001$). In line with H_{1a} , we find that when prior ideas are presented competitively, increasing the number of prior ideas significantly reduces the creative performance of participants ($M_5 = 3.05$, $SD = .25$; $M_{50} = 2.82$, $SD = .45$; $F(1, 396) = 22.88$, $p < .001$; Cohen's $d = -.63$). Concerning H_{2a} , in the uncompetitive condition, creative performance is not significantly different between seeing 50 vs. 5 prior ideas ($M_5 = 3.06$, $SD = .33$; $M_{50} = 3.10$, $SD = .31$; $F(1, 396) = .82$, $p > .10$; $d = .14$).

Table 2 shows all means across all measures. We see a consistent negative effect from exposure to more prior ideas across all five measures in the competitive condition. Although we failed to find a significant effect in the uncompetitive condition for top-box innovativeness, we find a positive effect for top-box originality, number of ideas, and total innovativeness, partially supporting H_{2a} . For means and ANOVA for the mediating variables, see Web Appendix E.

To test whether constraint of expression and cognitive stimulation mediate the role of prior ideas on participants' creative performance as outlined in H_{1b} and H_{2b} , we ran a

moderated parallel mediation model with 10,000 bootstrapped estimates (Hayes 2015; Preacher and Hayes 2008; Preacher, Rucker, and Hayes 2007; for regressions, see Web Appendix E, Table 6). We first report the indirect effect over constraint of idea expression followed by the total effect over cognitive stimulation (Figure 3). Mediation analyses in the following studies are performed in the same fashion. In support of H_{1b} , we find that increasing the number of prior ideas significantly increases constraint of idea expression in the competitive condition ($\beta = .78$, $SE = .21$, $p < .001$). Constraint of idea expression is negatively related to top-box innovativeness ($\beta = -.09$, $SE = .02$, $p < .001$). The conditional indirect effect is negatively significant in the competitive condition ($\omega_{M1} = -.07$ [$-.13, -.03$]^b) and not significant in the uncompetitive condition ($\omega_{M1} = .02$ [$-.01, .05$]); moreover, the index of moderated mediation is significant and negative ($\omega_{M1} = -.09$ ^b [$-.16, -.03$]). Cognitive stimulation shows a different pattern. In support of H_{2b} , we find that increasing the number of prior ideas positively influences cognitive stimulation in the uncompetitive condition ($\beta = .48$, $SE = .21$, $p < .05$). However, cognitive stimulation is not significantly related to top-box innovativeness ($\beta = .01$, $SE = .02$, $p > .05$), resulting in a nonsignificant indirect effect in both conditions ($\omega_{M2(Competitive)} = <.01$ [$-.01, .02$]; $\omega_{M2(Uncompetitive)} = <.01$ [$-.01, .02$]).

Web Appendix E, Table 7, reports the indirect effects over constraint of idea expression and cognitive stimulation for all five creative outcomes (plus Guilford's originality measure). Importantly, the indirect negative effect via constraint of idea expression in the competitive condition is significant across all measures. Cognitive stimulation appears to primarily affect the number of ideas, total innovativeness, and Guilford's originality measure, but not the maximum quality that an individual can achieve, thus offering only partial support for H_{2b} .

Discussion

Our results show that prior ideas can harm or stimulate people's creative performance depending on whether the prior ideas shown in a creative task are presented competitively. In support of H_{1a} and H_{1b} , an increase in the shared number of prior ideas increases perceived constraint of idea expression and decreases the resulting creative performance when they are competitively presented. Results for H_{2a} and H_{2b} are mixed. Although we do not find a positive influence of seeing more prior ideas on top-box innovativeness (and usefulness), we find that higher numbers of prior ideas can stimulate the generation of more ideas, higher top-box originality, and an increase both total innovativeness and Guilford's originality measure when they are presented uncompetitively. We return to these mixed findings in the "General Discussion" section.

We performed a series of follow-up robustness check studies to this study, which we report in Web Appendix F (i.e., three follow-up studies). Most importantly, these checks suggest that the prior ideas' harmful influence remains after changing the incentive scheme from top 5% to winner takes all (see Web Appendix F, "Contest Incentive Study"), that creative

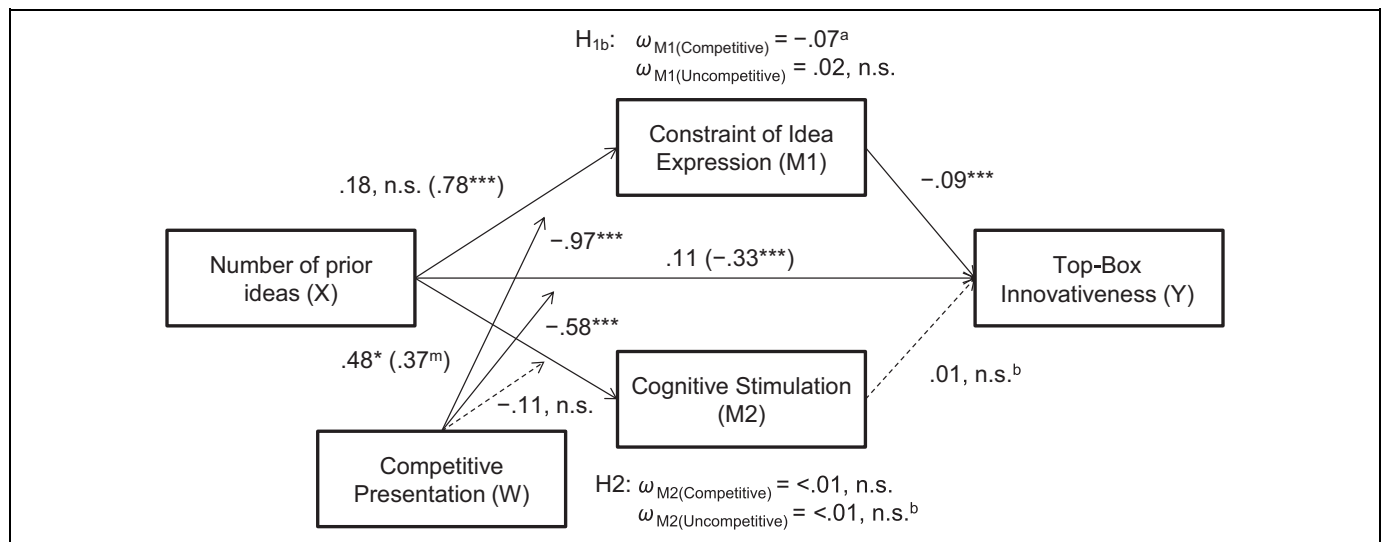


Figure 3. Results of mediation analysis (Study 2).

* $p < .05$.

** $p < .01$.

*** $p < .001$.

[†] $p < .10$

^aSignificant at 5% level based on bootstrapped confidence intervals.

^bEffects are significant for alternative measures of creative performance (number of ideas generated, total innovativeness, and Guilford's originality).

Notes: Numbers in parentheses are effects under competitive presentation. Results after including demographic controls are comparable; standard errors are bootstrapped with 10,000 replications.

performance reduces monotonically with increasing numbers of prior ideas (see Web Appendix F, "Number of Levels of Prior Ideas Study"), and that competition saliency moderates the effect (Web Appendix F, "Competition Saliency Study").

Finally, we find some evidence for possible external fixation, as more ideas were identical to the prior ones in the larger (vs. smaller) number of prior ideas group in the competitive condition. Such fixation may explain the reduction in creative performance. However, in the uncompetitive condition where individuals copied prior ideas to the same extent, the effect on creative performance is not significantly negative (for top-box innovativeness and usefulness) and even reverses (for top-box originality, number of ideas, total innovativeness, and Guilford's originality measure). We interpret this as evidence against external fixation in explaining the prior ideas harmful influence. In Study 3 (and follow-up), we make an effort to explicitly control for functional fixedness and alternative process explanations.

Study 3: Lowering the Perceived Constraint of Idea Expression Mitigates the Negative Effect

In Study 3, we experimentally manipulate the level of felt constraint of idea expression and use moderation analysis to test its fundamental role in our process explanation (Spencer, Zanna, and Fong 2005). Specifically, we test whether reducing felt constraints through less constraining instructions (within a

competitive frame) can alleviate the negative influence of competitive prior ideas. This outcome would provide process evidence supporting H_{1b} and also demonstrate an approach to reducing the negative effects of exposing individuals to competitive prior ideas. In this study we also control for two alternative explanations for the effect: that is, (1) the pool of available ideas naturally depletes with more ideas (idea pool depletion) and (2) the 50 (vs. 5) ideas group may contain better top ideas just by chance (idea comparability).

Method

The study design paralleled that of Study 2 (within the competition condition). We again use Guilford's unusual uses task for a brick to measure creative performance. We manipulated the number of competitively presented prior ideas (5 vs. 50) and used either high- or low-constraining instructions (high vs. low constraints) in a 2 × 2 between-subjects design. Most participants (89%) correctly recalled the number of prior ideas they were shown in a recognition check question (n.s. between competitive conditions). In the high-constraint idea expression condition, respondents received the following instructions when seeing the prior ideas: "Importantly, you cannot express your own ideas the way you want and as freely as you like because you are not allowed to copy ideas of others that have already been submitted." Individuals in the low-constraint idea expression condition received these instructions: "Importantly, you are not allowed to copy ideas of others that have already been

submitted. However, note that you can express your own ideas the way you want and as freely as you like.” After seeing the ideas, participants responded to the perceived constraint of idea expression scale ($\alpha = .93$), followed by the unusual uses task. As a manipulation check, perceived constraint of idea expression is significantly higher with the high- (vs. low-) constraints instructions ($M_{\text{high}} = 3.05$, $M_{\text{low}} = 2.20$; $t(982) = 7.82$, $p < .001$).

Additional Controls

Importantly, we adjusted the sampling of prior ideas to avoid potential confounds (in Study 3, Study 3 follow-up, and Study 4).⁷ First, when larger numbers of prior ideas are displayed, the prior ideas can constrain expression simply because of potential overlap with the individuals’ own ideas. Therefore, the pool of available ideas naturally depletes with more ideas (idea pool depletion). Although the redundancies found in parallel ideation are limited, some ideas are more frequently suggested, and redundancies do exist (Kornish and Ulrich 2011). Aiming to separate a possible idea pool depletion effect from the prior ideas’ harmful influence, we removed 19 common ideas from the set of 100 prior ideas, resulting in 81 prior ideas (Web Appendix A, Table 2). We define common ideas as ideas that were mentioned by at least 5% of other individuals (following Guilford [1967]; percentages were determined by an analysis of 7,405 ideas [4,404 original] submitted by 1,840 individuals in a large-scale pretest). For example, we removed prior ideas such as “paperweight,” “pencil holder,” or “weapon” for unusual uses of a brick.⁸

We also adjusted *how* the prior ideas were sampled. On average, because of the randomization, the sampled ideas will not differ in their means between the smaller and larger number of prior ideas groups. However, they will differ in their extremes because the more the ideas that are sampled, the higher the chance that the sample contains extreme ideas. Therefore, the groups will differ in their maximum creative performance scores, reducing the comparability of the idea groups (idea comparability). This may confound our analysis, as innovators may be particularly sensitive to the best prior (most innovative) ideas in a competition, resulting in a potentially inflated negative effect of seeing more ideas. To control for this possibility, we used a search algorithm (see Web Appendix G) that ensures comparability between the number of prior idea groups on a set of creative performance measures, including top-box scores in this study (and the Study 3 follow-up and Study 4).

⁷ We thank an anonymous reviewer for bringing up these possibilities.

⁸ A back-of-the-envelope calculation shows that any remaining idea pool depletion effect is very small. From our pretest, in the 50 ideas group at least 4,354 ideas would still be available for discovery, while in the 5 ideas group at least 4,399 would be available. The idea pool depletion effect would thus be maximally 1.03% (45/4,354). As this is much less than the 36.72% reduction in number of ideas or 7.60% in maximum innovativeness in Study 2, idea pool depletion does not appear to be a first-order concern.

A total of 984 U.S. respondents from MTurk participated in the study ($M_{\text{age}} = 37.36$ years, $SD = 11.43$; 53.46% female). Altogether, respondents submitted 4,523 ideas. The mean respondent submitted 3.99 ideas ($SD = 2.41$, $\min = 1$, $\max = 17$) and the mean top-box innovativeness score equaled 2.66 ($SD = .64$, $\min = 1$, $\max = 4.67$; rater $\alpha_{\text{S}_{\text{innovativeness}}} > .71$, $\alpha_{\text{S}_{\text{originality}}} > .75$, $\alpha_{\text{S}_{\text{usefulness}}} > .79$).

Results and Discussion

A positive interaction term implies that the prior ideas influence top-box innovativeness differently in the high- versus low-constraints conditions ($F(1, 983) = 11.68$, $p < .001$; Table 2). In the high-constraints condition, we replicate the finding that increasing the number of prior ideas significantly reduces top-box innovativeness ($M_5 = 2.76$, $SD = .62$; $M_{50} = 2.51$, $SD = .67$; $F(1, 980) = 7.77$, $p < .01$; $d = -.25$). In the low-constraints condition, however, the effect reverses and becomes significantly positive ($M_5 = 2.68$, $SD = .65$; $M_{50} = 2.79$, $SD = .62$; $F(1, 447) = 4.17$, $p < .05$; $d = .18$). Perceived constraint of idea expression increases more strongly with the number of prior ideas in the high- (vs. low-) constraints condition (interaction: $F(1, 980) = 8.23$, $p < .01$). In the high-constraints condition, increasing the number of prior ideas significantly increases perceived constraints ($M_5 = 2.56$, $SD = 1.62$; $M_{50} = 3.59$, $SD = 2.00$; $F(1, 980) = 46.87$, $p < .001$; $d = -.58$). In the low-constraints condition, however, the effect is attenuated but remains significant ($M_5 = 1.99$, $SD = 1.44$; $M_{50} = 2.41$, $SD = 1.62$; $F(1, 980) = 8.13$, $p < .01$; $d = -.28$). Cognitive stimulation does significantly increase with the number of prior ideas ($M_5 = 4.12$, $SD = 1.51$; $M_{50} = 4.40$, $SD = 1.61$; $F(1, 980) = 7.78$, $p < .01$; $d = .18$), but the interaction with high/low constraints is not significant ($F(1, 980) < .01$, $p = .94$).

Discussion

This study again shows a reversal, corroborating the notion that prior ideas have a harmful negative influence and discounting the idea that external fixation is a potential process explanation for the identified effects. In a Study 3 follow-up (see Web Appendix H), we explicitly measure similarity to the prior ideas (as an indication of functional fixedness) and remove ideas that overlap with prior ideas in the analysis. In this follow-up, we also performed an exploratory mediation analysis testing for the role of self-efficacy, perceived competence, perceived chances of winning, and perceived competitiveness as additional factors potentially influencing the identified pattern of effects. The results of this follow-up study corroborate our mechanism. Taken together, our results provide clear evidence that perceived constrained expression is the key mechanism underlying the harmful influence of prior ideas on creative performance. Importantly, note that Study 2 manipulates competition (implying constraints) and Study 3 manipulates constraints directly (holding competition constant). Combined,

these studies suggest that prior ideas have a negative effect only when both competition and constraints are present.

Study 4: Creative Performance Monotonically Falls When Seeing More Ideas for Both Novices and Experts

The fourth study uses three levels of prior ideas (3 vs. 10 vs. 100) and tests whether domain expertise moderates the harmful influence of seeing more competitive prior ideas (H_3). As we have discussed, the harmful influence of seeing more ideas is likely to be more pronounced among those high in domain expertise, which we directly measure through an adapted scale. In addition to domain expertise, we also measured other exploratory moderators for individual differences, and we summarize these measures and results in Web Appendix I. The results show that the negative effect is visible for both novices and experts, and creative performance monotonically falls with more competitive prior ideas.

Method

The study design again paralleled that of Study 3, with the main difference being the inclusion of the trait measures in random order at the beginning of the survey. We measure domain expertise drawing on Mishra, Umesh, and Stem (1993; $\alpha = .95$; see Web Appendix I, Table 14). We again used the unusual uses task for a brick to measure creative performance, and manipulated the number of competitively presented prior ideas (here, we used 3 vs. 10 vs. 100 out of 140) in a three-cell between-subjects design. As in Study 3 and its follow-up, we control for idea pool depletion and comparability. For idea comparability, we used our search algorithm to find comparable combinations of 3, 10, and 100 ideas. For this purpose, we first increased the size of our prior ideas pool from 100 to 140 by adding 40 original ideas from a pretest (original ideas, stated by $<5\%$). We again removed the 19 common ideas (Web Appendix A, Table 2). Most participants (55%) correctly recalled the number of prior ideas they were confronted with in a check question, but the percentages differed significantly for the 100 ideas group (59%; $\chi^2 = 6.03$, $p < .05$; results are robust to adding recall as a control).

After seeing the ideas, participants responded to the perceived constraint of idea expression ($\alpha = .93$) and cognitive stimulation ($\alpha = .92$) scales followed by the unusual uses task. A total of 1,000 U.S. respondents from MTurk participated in the study ($M_{\text{age}} = 37.04$ years, $SD = 11.51$; 51.30% female). Altogether, respondents submitted 3,667 ideas. The mean respondent submitted 3.67 ideas ($SD = 2.55$, $\text{min} = 1$, $\text{max} = 16$) and the mean top-box innovativeness score equaled 3.51 ($SD = .67$, $\text{min} = 1$, $\text{max} = 5$). Ten raters each again evaluated ideas' innovativeness, originality, and usefulness ($\alpha_s > .73$).

Results

Results from an ANOVA show that the number of ideas significantly influences creative performance ($F(2, 997) = 9.27$, $p < .001$). Seeing more ideas significantly reduces top-box innovativeness when participants saw 10 (vs. 3) prior ideas ($M_3 = 3.63$, $SD = .58$; $M_{10} = 3.47$, $SD = .68$; $F(1, 997) = 10.57$, $p < .01$; $d = -.26$) as well as when participants saw 100 (vs. 3) prior ideas ($M_{100} = 3.42$, $SD = .74$; $F(1, 997) = 16.36$, $p < .001$; $d = -.32$; results comparable for other measures, see Table 2).

We turn to regression analysis for interactions with the domain expertise measure, and estimate two separate interaction terms with the 10 vs. 3 ideas and 100 vs. 3 ideas comparisons (in the same model). We find significant interactions across creative performance measures when comparing 10 vs. 3 ideas for domain expertise (e.g., $\beta_{\text{expertise} \times 10 \text{ (vs. 3)}} = -.11$, $p < .05$). The negative interactions show that the prior ideas' harmful influence is more pronounced among individuals high in this measure, in line with H_3 . This result does not change after adding our idea similarity control (functional fixedness) to the regression. Interestingly, we do not find any significant interaction when comparing 100 vs. 3 ideas. This shows that both experts and novices are negatively influenced in a similar way (if the number of ideas is large enough), but experts are harmed more quickly with increasing numbers of prior ideas (for all coefficient estimates, see Web Appendix I, Table 15). Mediation analysis again confirms the importance of perceived constraint of idea expression as mediator (see Web Appendix I).

Discussion

Replicating our previous findings, we again show that seeing more competitive prior ideas harms creative performance in a monotonic fashion. The negative effect, however, is shown to be moderated by the level of domain expertise of the participant, providing support for H_3 . Those higher in domain expertise are more severely affected by seeing more competitive prior ideas. Mediation analysis suggests that experts feel similar constraints compared with nonexperts, but they are more strongly affected by the perceived constraint of idea expression. Remarkably, at the same time we find that experts fixate less on the externally provided prior ideas, and external fixation does not explain these results. This points to internal rather than external sources of fixation, in line with the reasoning for H_3 .

We note that the negative effect magnifies for related types of individual difference (ideation expertise, creative self-efficacy, involvement, lead user-ness) but not for others (innovativeness, emergent consumer, achievement orientation; for full analysis of these exploratory measures, see Web Appendix I). The former measurement approaches are related to domain expertise in that they are also high in how knowledge and expertise relate to ideation, providing convergent validity on H_3 . The latter approaches are more related to individual's motivation instead of knowledge, suggesting discriminant validity. The specific reasons for these differences across individual

measures may be worth exploring in future research. Note that in this study, measuring the moderators early in the process may be a limitation, as the measurement may influence later creative performance. Expertise could also be measured in other ways (e.g., by doing an unrelated creative task). Our current measure may also tap anticipated success in the task rather than expertise in a substantive domain. Although our theorizing and conclusions are specific to domain expertise, similar results may be expected for the related constructs of anticipated success, self-efficacy, and ideation expertise. Future research could attempt to explore this distinction. In Study 5, we test a direct intervention for reducing the negative impact of competitive prior ideas by changing the way they are presented in innovation contests.

Study 5: Optimizing the UI on an Ideation Platform

It is difficult to fully change the competitive nature of open innovation contests (i.e., to mitigate the negative outcomes that the competitive presentation of prior ideas entails). Therefore, Study 5 tests if the presentation of prior ideas can alleviate their harmful influence within a competitive setting. We adjusted the UI of a mock-up open innovation platform, offering a realistic ideation-contest setting in which individuals propose ideas to actual ideation problems. We tested three interfaces—all ideas listed (listing), restricted number of ideas listed (restricted), and grouped ideas (categorized)—across three different contests initiated by the same institution.

The open interface mimics a typical way prior ideas are presented. Similar UIs are used by many open innovation contest platforms including Atizo, 99designs, or Crowdspring. Restricting the number of prior ideas follows from the finding that competitive prior ideas can constrain creative performances. A simple improvement for ideation platforms may be to simply restrict the visibility of ideas to a smaller number than the actual submitted ideas.

We also tested whether grouping ideas in an actionable way to adjust the UI would improve creative performances of participants. We draw this approach from the human–computer interaction literature, which highlights that the structural presentation of information can have a powerful influence on performance (Shneiderman 2000). We explore whether the presentation format utilized in an open innovation contest can mitigate the harmful influence of competitive prior ideas, and instead reduce felt constraints that hinder creative performance. Specifically, we investigate the impact of presenting prior ideas in groups instead of separately, as an alternate way to organize information. Ideas in open innovation contests frequently share commonalities and elements of overlap. As such, they can often be grouped into taxonomic categories (Kornish and Ulrich 2011). Individuals process new stimuli based on their prior knowledge of the stimuli's category (Sujan 1985) and will often naturally organize products into taxonomic or goal-based categories (Barsalou 1985; Rosch et al. 1976). These stimuli can be processed more (less) easily when there is a (no) match between

an individual's categorization and the format of presentation (Fiske and Taylor 1991; Morales et al. 2005). This results in fewer cognitive interferences as semantically similar concepts are processed and a train of thought can be maintained (Nijstad, Stroebe, and Lodewijkx 2002). We propose that visually grouping prior ideas with conceptually similar content into a categorized format (instead of separately) will have a direct impact on the creative performance of participants. Visual grouping of competitive prior ideas can help creative performance because it reduces the signal of competition and facilitates the processing of prior ideas, mitigating constraint of idea expression.

Unlike the field setting used in Study 1, we do not fix the number of prior ideas, and we provide a predefined number of rewards instead of a percentage (i.e., the top five ideas win instead of top 5%), mirroring typical prizes of such contests (Hofstetter, Zhang, and Herrmann 2018). We created an actual open innovation platform on a publicly available internet domain that mimicked the standard platform functionalities (i.e., viewing the contest brief, viewing prior ideas, and submitting one's own ideas). Individuals who accessed the platform could participate in a real open innovation contest with actual monetary incentives. The platform's UI was personalized based on user HTTP cookies.

Method

Each user was randomly assigned one of the three UIs. In the basic version of the UI (listing), the prior ideas were presented separately in an ordered list tile layout with four columns and nine rows. A maximum total number of 36 ideas could thus be displayed on one page. If there were more ideas, they were displayed on other pages that were accessible over a paging functionality. The ideas were sorted by submission date in descending order (i.e., the most recent idea was shown first). Whenever a new idea was submitted, it was automatically displayed as the first idea and all previous ideas moved down by one position.

In the restricted version of the UI (restricted), only a random selection of four ideas out of all submitted ideas was displayed. These four ideas were randomly sampled for each individual and then fixed such that they stayed the same for the user, independent of any newly submitted ideas. Individuals could not access more than these four ideas. In the grouped version of the UI (grouped), an independent moderator combined ideas into taxonomic groups. The moderator supervised the contest live and grouped ideas in real time, leaving some ideas grouped and others not. The ideas that were not grouped were displayed on the left side of the screen in a 2×9 tile layout, and grouped ideas in multiple colors indicating their group membership were displayed on the right side in a second 2×9 tile layout. On each side, ideas and groups were sorted by submission date in descending order (Web Appendix J, Figure 7).

We randomly assigned participants to one of three similar ideation contests about university activities and services (e.g., ideas for activities during breaks, ideas for how to promote university programs, ideas for food offerings) and they could only see and participate in their assigned contest (controlling

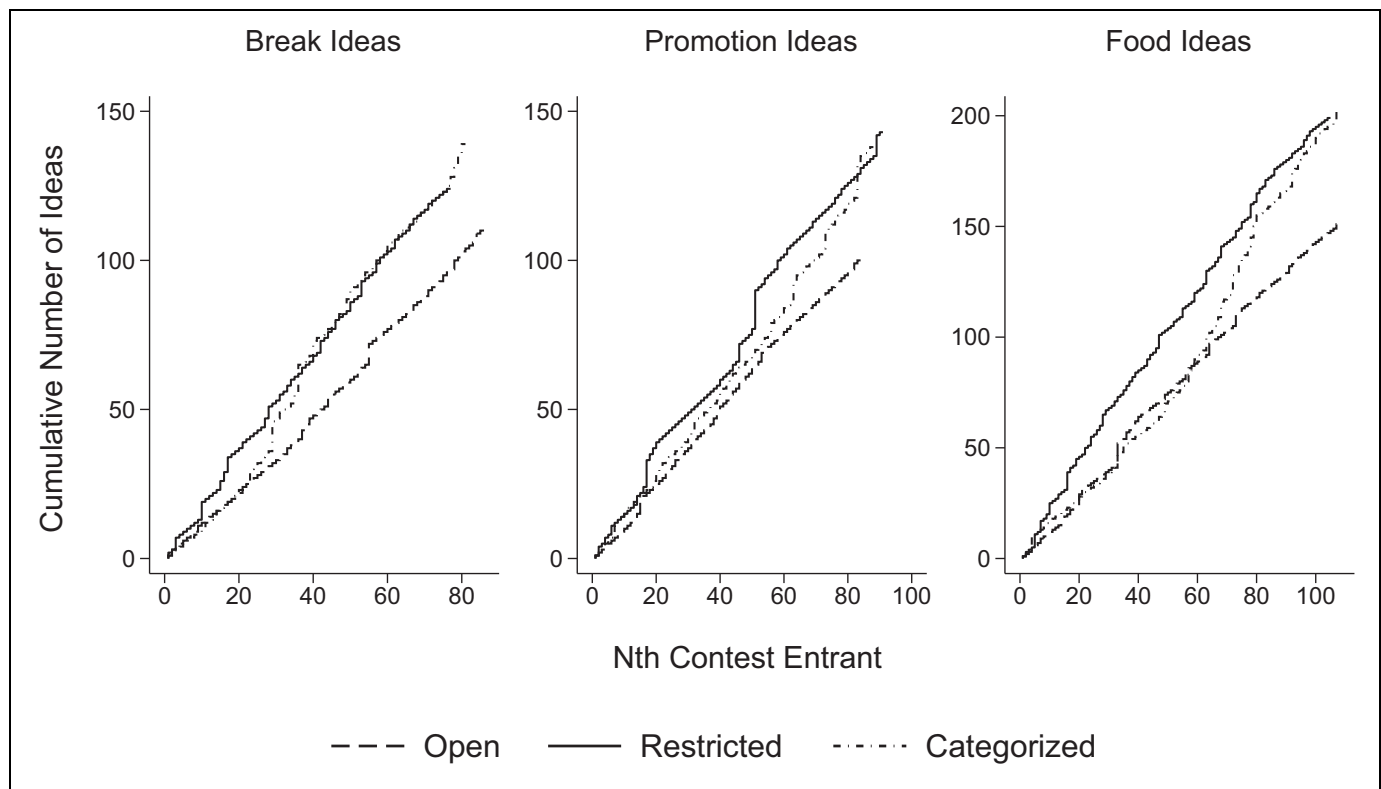


Figure 4. Restricted and categorized (vs. open) presentation of prior ideas produces more ideas in three different innovation contests (Study 5).
 Notes: The figure shows the mean creative performances of individuals in the different experimental conditions across the three contests. It shows the cumulative number of ideas over the course of the contest from the first to the last person entering the contest. At position $x = 20$, for instance, the 20th person entered the contest.

for self-selection). We also told participants that the five most original ideas would win €20, and that their ideas competed against all other submitted ideas for these rewards. In all three UIs, participants were informed about the total number of prior ideas submitted (up to 557 ideas in the largest contest, and 386 and 376 in the smaller contests, respectively), fixing objective winning chances. They could submit as many ideas as they wanted to. Idea titles could be up to 60 characters long and content up to 180 characters long.

We invited a total of 2,744 individuals from an online panel (Clickworker.de) and 828 (30.17%) chose to participate, independent of the experimental treatment ($\chi^2 = 2.20$, $p = .33$). These participants submitted 1,319 ideas in total. The average entrant submitted 1.59 ideas ($SD = 1.35$, $\min = 1$, $\max = 13$). Each contest lasted three days. After the contest ended, all ideas' originality and usefulness were evaluated by two marketing experts; as raters, they were blind to the UI version and the author of the idea on a seven-point Likert scale (1 = "Not original/useful at all," and 7 = "Extremely original/useful"). The two raters showed significant agreement in all contests.⁹

As in Study 1, we calculated innovativeness as $(\text{originality} + \text{usefulness})/2$. We also focus on top-box innovativeness in this study as our key variable of interest. Importantly, we included project controls in all analyses to control for contest and evaluation differences across competitions.

Results and Discussion

We pool the data across the three contests for the analysis ($N_1 = 244$, $N_2 = 321$, $N_3 = 263$). First, we find that the three experimental groups differ significantly ($F(2, 825) = 10.21$, $p < .001$). Top-box innovativeness is significantly higher in the restricted (vs. open) condition ($M_{\text{restricted}} = 4.49$, $SD = .51$; $M_{\text{open}} = 4.36$, $SD = .78$; $F(1, 825) = 4.75$, $p < .05$; $d = -.19$) and in the categorized (vs. open) condition ($M_{\text{categorized}} = 4.62$, $SD = .66$; $F(1, 825) = 20.42$, $p < .001$; $d = -.35$). Table 2 shows ANOVA results for all of our five key measures of creative outcomes. Figure 4 shows the cumulative number of ideas generated in the three groups over the course of each contest. We can observe that the cumulative number of ideas increases more steeply, resulting in higher total numbers for the restricted and grouped (vs. listing) UIs and providing visual support for the aforementioned results. These results indicate the potential for optimizing UIs in open innovation contests, as both the restricted and grouped interfaces significantly increased creative performance of participants. We report

⁹ Originality: $\kappa_{\text{break ideas}} = .12$, $z = 5.87$, $p < .01$; $\kappa_{\text{promotion ideas}} = .13$, $z = 5.46$, $p < .01$; $\kappa_{\text{food ideas}} = .12$, $z = 6.46$, $p < .01$; usefulness: $\kappa_{\text{break ideas}} = .14$, $z = 5.87$, $p < .01$; $\kappa_{\text{promotion ideas}} = .05$, $z = 2.32$, $p < .05$; $\kappa_{\text{food ideas}} = .07$, $z = 2.83$, $p < .01$.

further evidence in favor of grouping in Web Appendices K, L, and M (i.e., three follow-up studies), highlighting the relevance of this possibility for future research. Another fruitful direction could be to look at combinations of grouped and restricted UIs.

General Discussion

In this article, we show that in open innovation contests (i.e., competitions), exposing participants to too many ideas reduces the creativity of the ideas generated. Importantly, competitive framing of the prior ideas is shown to trigger this negative effect. Competing against prior ideas introduces the importance of distinguishing one's ideas from prior ones, thereby increasing felt constraints of idea expression in an ideation task featuring numerous prior ideas. This finding extends the observation that individuals decrease their efforts when winning chances are lower (Boudreau, Lacetera, and Lakhani 2011), as we find that even after fixing objective winning chances (Studies 2–4) and controlling for perceived winning chances (in Study 3 follow-up), seeing more prior ideas discourages creative performance in innovation contests. Interestingly, this effect is reduced when similar ideas are grouped together (effectively reducing the number of ideas).

Our findings also show that without a competitive frame, external ideas are less constraining and can actually increase creative performance. This result is in line with prior research showing positive effects when seeing more uncompetitive ideas (Gallupe et al. 1992; Paulus et al. 2013). Here, we did not find a positive effect on top-box innovation or usefulness (similar to Paulus et al. 2013), but benefits did identify for originality and the number of solutions identified. We conjecture that the uncompetitive framing of prior ideas—and the stimulation it provides—better facilitates novel thinking but not necessarily an effective identification of solutions.

Across studies, the identified effects are consistent yet small in magnitude on top-box measures (but larger in the number of generated ideas). Given that managers of innovation contests typically care most about the quality of top ideas, even small changes in quality can have a lasting harmful or helpful impact on the organization (Fleming 2007; Girotra, Terwiesch, and Ulrich 2010). We believe this finding is actionable for future research to both build on and refine—for example, how to effectively leverage prior ideas using an uncompetitive framing approach is a question with great potential for creative ideation. Importantly, all our studies manipulate the number of prior ideas exposed to participants, which raises the following question: Would it be best to not show any prior ideas and, instead, host only blind contests? The small number of prior ideas we display in Study 4 (three ideas) and the Study 2 follow-up (one idea; Web Appendix F) suggest that showing any larger number of competitive prior ideas will harm creativity. However, future research could further explore the value of not showing any competing prior ideas at all.

Implications

Our results have implications for research related to open innovation, creativity, ideation, contest theory, and design. Foremost, the importance of competitive framing in open innovation is established in our conceptualization. Indeed, competitive framing is found to be a powerful force in directing how prior ideas are processed cognitively. Second, we define the constraint of idea expression on the part of the participant as an important mechanism in driving our effects, contributing to the discussion of how constraints influence creativity (Moreau and Dahl 2005). Other mechanisms may also be in play, as we found a significant indirect effect via perceived winning chances. Future research is warranted in order to investigate their role in how competitive prior ideas influence creative performances. The finding that the prior ideas' harmful influence is robust across different types of innovators and aggravated by domain expertise adds to the discussion of how expertise can impede creativity (Dane 2010).

Theoretically, our results also broaden the discussion related to the optimal design of innovation contests (e.g., Terwiesch and Xu 2008; Wooten and Ulrich 2015). The extant literature has emphasized extrinsically motivating features of contest design, such as the reward size and structure, or the number of entrants as key drivers of contest outcomes (e.g., Cason, Masters, and Sheremeta 2010; Terwiesch and Xu 2008). However, our results highlight that contest participants also react to other subtler signals that inform the processing of ideas. Visual grouping represents one such signal, and our investigation of its influence on contest participant's ideation outcomes provides an impetus for more research in this vein.

Our findings provide a substantive contribution to those organizations that are considering how best to organize ideation. Given the negative effects of seeing competitively positioned prior ideas, it seems reasonable to conclude that standard brainstorming sessions and innovation contests may undermine an individual's creativity if people feel that the sessions are competitive and see many other ideas before they themselves generate ideas. The implication for such intraorganization idea generation is to engage in brainwriting exercises which let people think on their own before engaging in teams, exhausting to the extent possible the individual's own ideas well before considering the ideas of others. When considering others' competitive ideas electronically, we showed that negative effects can be addressed simply through interface design. Prior ideas should be displayed with strategic intent (instead of simply presenting all information last-in first-out) to improve results. Managing the interaction with participants in this way incurs little cost and thus is an actionable strategy in improving the integrity and effectiveness of innovation efforts. Future research should explore other possibilities here—that is, are there other ways that the communication and visual presentation of innovation contests can shape the motivation and behavior of participants?

Limitations and Future Research

This research opens a number of paths for future exploration. First, future research could work to provide a deeper understanding of how external constraints in open innovation are impacting creative performance in the conceptual model we have defined. For instance, is there a distinction in felt constraints that represents the belief that one can perform the behavior versus felt constraints in the belief that one's abilities will produce a certain outcome (i.e., outcome expectation)? These two representations have been found to be empirically related (Eccles and Wigfield 1995), but they may produce different creative outcomes. Second, the role of competition in creativity tasks can be further explored following the call of Amabile (2018). Competition may introduce good or bad stress, affecting the creative performance of competitors in different ways. Seeing more competing ideas can induce stress, which may exacerbate the already harmful influence of said ideas, as stress negatively affects memory, attention, and cognition (Ellis 2006; LeBlanc 2009). Third, a limitation to our analyses is the limited number of prior ideas we showed in this study. It could be that cognitive stimulation turns into cognitive overload beyond a certain point, resulting in a negative influence of prior ideas even when presented uncompetitively (see, e.g., optimal levels of stimulation, Steenkamp and Baumgartner 1992; Yerkes and Dodson 1908). Such an effect would further reinforce the negative influence of prior ideas, possibly even when the ideas are uncompetitive. We did not test this possibility, which could be a viable direction for future research. Fourth, an opportunity exists to better define what types of ideas and idea groupings might best facilitate individuals' cognitive efforts and positively stimulate participants in contests. For example, would bizarre ideas that are impossible to actually be realized be useful in provoking individuals to produce something creative? Or, would it be better to show individuals more conservative ideas and let them build from a more traditional knowledge base? Note that artificial intelligence could be leveraged here to automate the grouping of ideas or the ideal stimulation and feedback to ideators. Fifth, other individual factors driving prior ideas' harmful influence should be further explored. We did not find significant mediation for perceived competence, self-efficacy, competitiveness, and winning chance, although these measures were significantly influenced by the number of prior ideas. Other individual factors such as demographics could also be further explored (e.g., Baer and Kaufman 2008). A better understanding of these factors and their relation to individuals' performance in contest-based ideation offers a potentially fruitful area of future research. Although we found similar results for self-reported experts and novices, these negative competition effects may not extend to highly professional creatives who regularly produce creativity for pay and are thus less prone to negative emotional stimulation effects. There are many examples of brilliant creative content within highly competitive domains such as advertising, product design, architectural design, news story illustrations, books, and even the writing of scientific papers.

We also do not explore the various specific motives of participants entering contests or how goal proximity may influence results. Indeed, future research could take a goal theory perspective on contest-based ideation. We also did not explicitly investigate self-selection of individuals into contests depending on the number of prior ideas and their nature (there was no significant self-selection in our studies). Self-selection may be an important mechanism to consider given that individuals can typically choose from a wide range of different contests on open innovation platforms. People may also be discouraged from participating at all in an innovation contest when seeing large numbers of prior ideas, potentially harming creative outcomes of contests even more. How prior ideas inform entry decisions is certainly an essential topic for future research.

Finally, the nature of the innovation problem (and how it may moderate the identified effects) poses another productive direction for future research. In our analyses, we focused on low complexity ideation problems with many possible solutions. Negative effects of prior ideas may magnify for innovation problems for which fewer possible solutions exist (i.e., for problems with a reduced solution space). For more complex problems, positive stimulation effects of prior ideas may become more relevant. These questions point to the nascent state of understanding that both academia and management has with respect to the democratization of innovation that is being seen today. Our research efforts seek to add to the growing body of knowledge here and validate the importance and value of this trend in innovation.

Acknowledgments

The authors thank Reto Aebbersold, Markus Christen, Melanie Clegg, Emanuel de Bellis, Andreas Gerber, Marek Gorny, Christian Hirsig, Joey Hoegg, Thomas Ott, and seminar participants at the Wharton School of University of Pennsylvania, University of Miami, University of Louisville, University of St. Gallen, University of Lucerne, Hebrew University, and Università della Svizzera italiana for helpful discussions. They thank the reviewers and participants from EMAC and ACR for their valuable comments.

Associate Editor

Donald Lehmann

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This research was partly funded by Innosuisse – Swiss Innovation Agency (grant 12747.1 PFES-ES).

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