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Abstract

Online idea generation platforms are increasingly used to generate ideas of innovative products. Crafting the problem statement carefully is a key factor of success, however, the current literature remains limited concerning what kind of task instructions should be used to increase the quality of ideas in online idea generation. This research examines three different types of task instructions. The unbounded task instructions allowed participants generating the ideas they wish without any restriction. The suggestive task instructions indicate domains of ideas that are innovative. The prohibitive task instructions indicate domains of ideas that are *not* innovative. The impact of these three types of task instructions on creative outcomes is compared through an empirical study on eYeka, a global online idea generation platform. Based on logit models, we found that the task instructions have a significant impact on the creativity of participants. Our result shows that prohibitive task instructions enable the production of the most original ideas whereas suggestive task instructions favor the production of the most feasible and valuable ideas. Unbounded task instructions are mostly found to be inefficient. The implications for the management of online idea generation communities are discussed.

Keywords: task instructions; problem formulation; idea generation; crowdsourcing; creativity; fixation effect;

"The formulation of a problem is often more essential than its solution,
which may be merely a matter of mathematical or experimental ."
A. Einstein, L. Infeld *in* The Evolution of Physics (p.92).

Introduction

Generating ideas that are original, feasible and valuable is crucial for firms to commercialize innovative products and services. Following the paradigm of open, innovation, a growing number of firms have started to use idea generation contests via web-based open platforms (Chesbrough, 2003; West, Salter, Vanhaverbeke, & Chesbrough, 2014). This creative technique, also labeled crowdsourcing (Howe, 2006), enables firms to access ideas that may not reside within their organizational boundaries (Fleming, 2001; Rosenkopf & Nerkar, 2001). Crowdsourcing has progressively become a major research topic in management science and marketing (Afuah & Tucci, 2012; Bayus, 2013; Boudreau, Lacetera, & Lakhani, 2011; Jeppesen & Lakhani, 2011; Piezunka & Dahlander, 2014; Terwiesch & Xu, 2008). Although several success factors have been investigated (eg. incentives (Boudreau et al., 2011; Terwiesch & Xu, 2008), types of participants (Kristensson & Magnusson, 2010; Poetz & Schreier, 2012)), a large amount of ideas submitted during crowdsourcing is still of mediocre quality.

This research explores the impact of the task instructions on the quality of ideas produced during online idea generation contests. In online idea generation, the task instruction is often stated with open-ended question, which presents the problem to be solved. The broadcast of the task instructions takes a central place because it represents the main communication mean with the online communities. Recently, research has mainly studied the behaviors of firms involved in the selection and the posting of the 'right' problem on crowdsourcing platforms (Erat & Krishnan, 2012; Sieg, Wallin, & Von Krogh, 2010; Spradlin, 2012; Zheng, Li, & Hou, 2011). However, until now, very little is known regarding the types of task instructions that improve the quality of ideas generated during online idea generation contests.

For the scientific community, and the management scholars in particular, the formulation of the problem is an important topic because it directly influences the quality of the solutions (Baer, Dirks, & Nickerson, 2013; Einstein & Infeld, 1961; Simon, 1969; Simon, 1973). As a consequence, an important amount of research in creative psychology has compared the effect of different types of task instructions on creative outcomes (Coskun, Paulus, Brown, & Sherwood, 2000; Harrington, 1975; Paulus, Kohn, & Arditti, 2011; Runco, Illies, & Reiter-Ralmon, 2005; Ward, Patterson, & Sifonis, 2004). Among other, current findings seem to show that the originality of the ideas can be increased with task instructions that delimit the boundaries of the solution space without prescribing specific paths to reach solutions (Sieg et al., 2010). However, to date, there has been no reliable evidence that the bounded task instructions are also more relevant for producing feasible and valuable ideas for the users. Given that innovation products requires original, feasible and valuable ideas (Magnusson, 2009), this research compares the impact of bounded and unbounded task instruction on ideation with these three criteria.

Although bounded task instructions can play an important role for improving crowdsourcing, how to this is not yet clear. In this research, we explore a new kind of bounded task instructions: the suggestive and prohibitive task instructions. As mentioned by Schulze et al. (2011), the organizers of crowdsourcing often have idealized solution targets before starting an online idea generation contest. It is not rare that they suggest example of innovative solutions in the hope to clarify the task instruction and to help the participants. Theoretically, prior studies in creative cognition have shown that the use of example in task instruction can have an influence on idea generation. In particular, research has found that the inclusion of example of ideas in task instructions induces a fixation effect. Indeed, the participants who are exposed to prior examples tend to generate ideas that are similar to the examples (Jansson &

Smith, 1991; Smith, Ward, & Schumacher, 1993). As a consequence, depending if the example are innovative or not, the fixation effect can have a positive or negative role for idea generation (Agogué et al., 2014). When the prior example of idea is not innovative, the participants will tend to produce not innovative ideas. Inversely, the exposure of an innovative example of idea lead to increase the quality of ideas generated. Interestingly, the current research did not examine whether such fixation effect occurs when the participants are explicitly asked *not* to follow examples. Furthermore, it is not known if it is preferable to provide task instructions with example of innovative ideas to follow (i.e suggestive task instructions) or, to provide task instructions with example of non-innovative ideas *not* to follow (i.e. prohibitive task instructions). Thus, this research compares the broadcast of three different types of task instructions: 1) the 'unbounded' task instructions, for which the participants are allowed to generate the ideas they wish without any restriction 2) the 'suggestive' task instructions that bound the solution space by indicating domains of ideas that are worth pursuing with the use of example of innovative solutions. 3) the 'prohibitive' task instructions that bound the solution space by indicating domains of ideas that are *not* worth pursuing with the use of example of *non*-innovative solutions.

Our research question is the following: what type of task instructions between unbounded, prohibitive and suggestive increase the most the originality, feasibility and value of ideas in online idea generation? This article is structured as follows. The next section describes the main challenges of formulating task instructions in online idea generation. Our three types of task instructions are theoretically discussed. Thereafter, a number of hypotheses is formulated and empirically tested in eYeka, a worldwide online idea generation platform involving a large number of participants and ideas. In the analysis section, we answer our research question. Finally, we discuss possible implications and possible avenues of research to manage online idea generation contests with task instructions.

Literature review and hypotheses development

Formulating ill-defined problems with task instructions

The formulation of task instructions has been a major topic in strategic decision-making and management research (Baer et al., 2013; Lyles & Mitroff, 1980; Newell & Simon, 1972; Simon, 1973). Historically, based on the operation research paradigm, initial research has widely investigated the formulation of well-defined problems (Simon, 1969; Simon, 1973). A main recommendation is to structure the task instructions by eliciting the convenient evaluation criteria in order to find the most satisficing solution with algorithmic search such as NK landscape search (Kauffman & Weinberger, 1989; Levinthal, 1997). Classically, the formulation of such well-defined problem often refers to engineering-related problems. For instance, the following well-defined task instruction is posted on the InnoCentive platform: "The Seeker is interested in a method for oxidizing *n*-butane to *n-* or *sec-* butanol. The ideas or concepts to selectively oxidize *n*-butane should be catalytic (using air or O_2), prevent or minimize over-oxidation, and amenable to scale up. The proposed solution should not pose significant safety/health/environmental risks when implemented on manufacturing scale". (Challenge ID: 9933629).

However, a large amount of task instructions broadcasted in online idea generation platforms are ill-defined problems (or "wicked problems) (Rittel & Webber, 1973). Such ill-defined problems are often in the form of open-ended or divergent questions (Campbell, 1988; Coskun et al., 2000; Dennis, Valacich, Connolly, & Wynne, 1996; Franzoni & Sauermann, 2014; Nakatsu, Grossman, & Iacovou, 2014). For instance, the automotive company Ford recently posted a challenge on the InnoCentive platform for looking "novel designs of accessories and the underlying process of coming up with solutions when driving in remote areas" (Challenge ID: 9933613). Unfortunately, the formulation of ill-defined problems is

much more difficult because the initial state, the goal state and the procedures to reach the goal stat are much more poorly defined (Eierman & Philip, 2003; Taylor, 1974). A great temptation would be to formulate task instructions of ill-defined problems by converting them into well-defined problems (Sieg et al., 2010), however, major theoretical works in management science have found that ill-defined problems are fundamentally not well-defined problems (Hatchuel, 2000; Jonassen, 1997; Rittel & Webber, 1973). Converting ill-defined problems into well-defined problems can lead to several biases. For instance, E. von Hippel & Tyre (1995) showed that important information is 'lost' during their convertion into well-defined problems. Moreover, some "wicked" problems cannot be formulated at all because there are non-overlapping criteria for acceptable solutions (Hippel et al. 2013; Rittel and Webber 1973). Finally, recent research in design theories tend to prove that the investigation of ill-defined problems cannot be searched through optimization but require a specific design logic (Dorst, 2006; Hatchuel, 2000). In the next section, we will focus on the current recommendations for formulating task instructions of ill-defined problems in idea generation.

Specifying the boundaries of the solution space with task instructions

Since two decades, research in creative psychology has emphasized the fact that individuals that are faced to creativity tasks predominantly tend to first generate conventional ideas rather than original ideas (Ward, 1994). Interestingly, it has been proved that the type of task instructions given to the participants who are asked to generate creative ideas may have strong influence on the outcome (Dennis et al., 1996; Volkema, 1983) (see. Table 1). It has been found that certain task instructions enable participants to expanding their exploration process by reducing the viability of readily available solution (Medeiros, Partlow, & Mumford, 2014; Reitman, 1965).

Insert Table 1 about here

A first important stream of research on task instruction has demonstrated that 'creativity goal', it means explicitly inciting participants to be creative, do increase the originality of the ideas (Chen et al., 2005; Harrington, 1975; Katz & Poag, 1979; Locke & Latham, 2013; O'Hara & Sternberg, 2001; Shalley, 1995; Stetler & Magnusson, 2015). Another result found by Paulus et al. (2011) show that urging participants to generate a large quantity of ideas lead to more ideas and more good ideas. Such results are mainly explained by the fact that such kind of task instructions increase the intrinsic motivation and engagement of participants, which are key factors for creative thinking (Amabile, 1998; Garcia, 2015).

Moreover, an important amount of research has shown that specifying the boundaries of the solution space with task instructions increase the originality of ideas. Different types of bounded task instructions have been empirically tested. Research in organizational creativity has shown that employees' creativity is increased when the boundaries of their tasks are clearly defined (Zhou and Shalley 2003; Amabile 1998; Ekvall 1996). It has also been shown that dividing large problems into sub-problems reduce cognitive load and facilitate the generation of original ideas (Coskun et al., 2000; Dennis et al., 1996). Other research has shown that the level of abstraction of the task has an influence on the creative outcomes. Ideas are more original when the boundaries of the problems are formulated in an abstract manner rather than in a domain specific manner (Ejdelind & Karlsson, 2014). Another major field of research attempts to use the constraints in order to confine task instructions. Typically, they are said to better channel the creative thinking process because the participants' attention is focused on the central element of the problem (Caniëls & Rietzschel, 2013; Goldenberg, Mazursky, & Solomon, 1999; Lombardo & Kvalshaugen, 2014; Moreau & Dahl, 2005; Rosso, 2014; Stokes, 2005, 2005). For instance, some research has shown that constraints such as a restricted budget (Hoegl, Gibbert, & Mazursky, 2008; Scopelliti, Cillo, Busacca, &

Mazursky, 2014), a limited inputs materials (Moreau & Dahl, 2005; Sellier & Dahl, 2011) or environmental requirements (Weisberg, 2011) increase originality.

Based on the evidences that original ideas are more likely to be produced from bounded task instructions than unbounded task instructions, the hypothesis H_{1a} is proposed.

> H_{1a}: *Ideas generated through bounded task instructions are more original than ideas generated through unbounded task instructions*

Surprisingly, the vast majority of research in creative psychology has predominantly investigated the creative impact of task instructions by measuring the originality of the ideas. Although this criterion is primordial, innovation management literature show that this unique criterion is not sufficient for commercializing new products (Magnusson, 2009; Magnusson, Netz, & Wästlund, 2014). Two other criteria, feasibility and user-value should be also present (Franke, von Hippel, & Schreier, 2006; Magnusson, 2009). The ideas should be feasible (or producible). An idea that is impossible or difficult to implement would be of low interest to the companies. Furthermore, the ideas should also be valuable for the users. In a similar way, an idea that does not bring any value to the customers is not interesting for the companies. In this research, we assume that the unbounded task instructions would also decrease the score of feasibility and user-value of the ideas. The two following hypotheses are:

> H_{1b}: *Ideas generated through bounded task instruction are more feasible than ideas generated through unbounded task instructions*
>
> H_{1c}: *Ideas generated through bounded task instruction are more valuable than ideas generated through unbounded task instructions*

Bounded task instruction with fixation effect: the suggestive and prohibitive task instructions

Although the current research seems to agree on the fact that bounded task instructions is helpful to guide the creativity of individuals, still, the adequate formulation of bounded task instructions requires research efforts (Marguc, Van Kleef, & Förster, 2015; Rietzschel, Slijkhuis, & Van Yperen, 2014).

In this research, we propose to empirically test a new way to bound task instruction in online idea generation. We explore the possibility of using example of ideas into task instructions. Referring back to the task instruction posted by Ford on the InnoCentive platform, Ford also suggest an example of idea: "For example, by enabling vehicle diagnostic information and back up home accessories to facilitate vehicle repair as well as making the vehicle more reliable overall" (Challenge ID: 9933613). Although the practitioners frequently employ example of ideas when posting problems on online idea generation platforms, the interest of doing this has not been empirically validated.

Theoretically, this practice echoes an important stream of research on creative psychology, which has studied the effect of exposing example of solutions prior generating ideas. These particular research has demonstrated an important cognitive mechanism, known as the 'fixation effect' (Duncker, 1945; Jansson & Smith, 1991; Smith et al., 1993). In fact, it has been found that the exposure of example of solution prior to ideation activate irrelevant knowledge that limit the number and the quality of the solutions generated (Jansson & Smith, 1991; Purcell & Gero, 1996; Smith et al., 1993). Jansson & Smith (1991) reported an experiment in which they gave open-ended design tasks to engineering design students. The authors found that the ideas of the students who were exposed to prior examples were significantly less original than the control group. A comparable research has been conducted by Ward et al. (2004) where they reported a significant decrease of originality in the ideas generated after the exposure to specific examples into the task instructions. Indeed, when

participants are exposed to prior ideas, they tend to unconscientiously plagiarize some features of the examples. Interestingly, recent research has shown that exposing example of solutions prior idea generation can be also positive for innovation. Indeed, if participants are exposed to examples of innovative ideas, the fixation effect can increase originality in idea generation. For instance, Agogué et al. (2014) conducted experiments with students that consist in asking students to generate solutions in order that an egg dropped from a height of 10m would not break. The authors show that ideas are more original when the students are exposed to examples of innovative solutions (eg. "train an eagle to catch the egg during the fall") rather than less-innovative solutions (eg. "slow the fall of the egg with a parachute"). In line with this, researchers has shown that using stimuli that are not related to the problem to solve increase the generation of original ideas (Hender, Dean, Rodgers, & Nunamaker, 2002; McFadzean, 1998). Quite interestingly, the current research did not examine whether such fixation effect occurs when the participants are explicitly asked *not* to follow examples of non-innovative ideas. Furthermore, it is not known if it is preferable to provide task instructions with example of innovative ideas to follow or, to provide task instructions with example of non-innovative ideas *not* to follow. Consequently, our research attempts to compare two ways of using examples in task instructions, depending if it is an example of innovative ideas to follow or an example of non-innovative ideas to avoid. By indicating examples of innovative idea, the suggestive task instructions indicate desirable domains of idea to explore into the idea generation process. Inversely, by introducing examples of non-innovative idea to avoid, the prohibitive task instructions indicate some undesirable domains of idea to exclude.

Based on above discussion on fixation effect, our second set of research hypotheses. Because suggestive task instructions expose examples of innovative domain of ideas, we could expect that the fixation effect would be 'positive' for participants (ie. participants would generate

ideas that are conformed to the innovative domains of ideas that are exposed). Inversely, because the prohibitive task instructions encompass examples of non-innovative ideas, we would assume that the fixation effect would have a 'negative' impact on idea generation (i.e. it stimulates the production of non-innovative ideas). As discussed above, based on the fact the idea's innovativeness is represented by the originality, feasibility and user-value, our last hypothesis can therefore be stated:

> H_{2a}: *Ideas generated through suggestive task instruction are more original than ideas generated through prohibitive task instruction*

> H_{2b}: *Ideas generated through suggestive task instruction are more feasible than ideas generated through prohibitive task instruction*

> H_{2c}: *Ideas generated through suggestive task instruction are more valuable than ideas generated through prohibitive task instruction*

Research method

eYeka crowdsourcing platform and research protocol ==sampling strategy: comparison distribution (cf. Mustapha)==

To empirically test these hypotheses, a study was conducted among a large community of online participants by eYeka (www.eyeka.com), one of the global market leaders in online crowdsourcing (King & Lakhani, 2013). Its mission is to leverage a community of creative individuals to help companies generate creative insights, unlock innovation opportunities and drive consumer engagement at a global level in a matter of weeks and within an IP protected environment. The eYeka platform relies on an increasing online community of about 300,000 members from more than 160 countries. Since its creation in 2006, eYeka has worked with more than 40 out of the top 100 leading global brands, mostly coming from the Fast-Moving Consumer Goods industry (FMCG) such as Coca-Cola, Danone, Unilever, Diageo or Nestlé.

In total, this study involves 613 individuals that produced a total of 1,682 ideas. The study comprises 35 task instructions. It includes 15 unbounded task instructions. It also explores two different types of bounded task instructions: 9 suggestive task instructions and 11 prohibitive task instructions. The task instructions collected in this research were written and posted by a marketing manager at eYeka, who have been responsible for broadcasting task instructions since several years. These 35 task instructions have been chosen because they all encompass a similar level of details and number of words. All of these task instructions were simple to understand and they all referred to the topic of drink and foods (see some of them in Appendix 1). This topic was chosen because FMCG witnesses severe competition with a high need of innovative products. Furthermore, it is a sector where consumers easily participate in the co-creation process (Wijnberg & Williams, 2012). The ideas were generated from October 2013 to March 2014. For this, the members of eYeka's crowdsourcing platform were asked to write their ideas without any access to the ideas produced by other members (i.e. blind conditions). This crowdsourcing format, pioneered by the eYeka platform, is called "Quick Questions" and runs on the online platform without any participation restriction – all broadcasted task instructions are visible to eYeka members. All the instruction tasks stayed visible during two weeks on the eYeka platform.

Dependent variables: top originality, top feasibility and top value of the ideas

In the literature, innovative ideas are often defined by three criteria: 1) the originality of the idea compared to existing products on the market 2) the value of the idea representing its ability to solve the underlying problem and consequently to create customer benefit, and 3) the feasibility (or producibility) of an idea representing its ability to be produced with current technologies existing on the market (e.g., Amabile et al. 2005, Franke et al 2006, Kristensson et al 2004, Moreau and Dahl 2005; Magnusson et al, 2003; Magnusson 2009). Each idea was assessed on these three criteria using a 10-Likert-scale.

The three criteria were extensively discussed with three judges. Two experts were senior executives with more than 25 years of experience in product innovation and business development at fast-moving consumer goods companies. The third judge is an expert in ideation and social media platform with strong experience in marketing analysis. All of them were unaware of the objective of the research. Because of the high number of ideas, the following evaluation process has been employed. First, the three judges jointly evaluated a first set of 200 ideas presented in a random order. This permits to have a shared calibration and understanding of evaluation criteria; it also ensures consistency per task instruction. Then, the first expert evaluates the rest of the ideas. Finally, the second judges evaluate 20% of the total ideas. Pearson's correlation were measured and the inter-rater agreements reached an acceptable level (>.7)

As the main goal behind the online idea generation process is to target the best ideas (Girotra, Terwiesch, & Ulrich, 2010), our dependent variables are dichotomous variables indicating whether a given idea have a score greater than six regarding the originality (ie. top originality), feasibility (ie. top feasibility) and user-value (ie. top user-value) (for a similar approach, see Magnusson, 2009; Magnusson et al., 2003).

Independent Variables: Unbounded, prohibitive and suggestive task instructions

In total, the ideas were collected from 35 task instructions. All the task instructions were unbranded, meaning that questions were asked for products generically without indicating company or brand names, and non-incentivized, meaning that there was no prize or reward to be won for participants. They were all structured as open-ended questions in the domain of food and drinks, and all participants were explicitly instructed to generate new and original ideas.

Each task instruction has been allocated to one of the three categories (i.e. unbounded, suggestive and prohibitive) by two of the authors and one external professor specialized in innovation. To help them, the following indication was given: "The unbounded task instructions (i.e., "please, think about all ideas you want") do not guide the participants in their creativity. The participants are asked to generate all ideas they want." – "The suggestive task instructions (i.e., "please, think about ideas of this kind") guide the participants in their creativity. The participants are asked to generate that follow some example of innovative ideas."- "The prohibitive task instructions (i.e., "please, DO NOT think about ideas of this kind") guide the participants in their creativity. The participants are asked NOT to generate ideas that follow some example of non-innovative ideas.". After their individual rating, inter-rater reliability tests have been performed to assess the degree of agreement among the 3 raters. Pearson's coefficients have been used to measure pairwise correlations. Pearson's correlation tests were significant and acceptable according to conventional guidelines ($r = .72$). The few disagreements were easily solved after meeting between the raters. As a result, this study comprises 15 unbounded task instructions and 20 bounded task instructions split into 9 suggestive task instructions and 11 prohibitive task instructions. In the rest of the article, the unbounded task instructions are considered as the baseline category.

Control Variables

First of all, we controlled for unobserved differences between the 35 task instructions using dummies. We also control the possibility that the success is not simply due to the fact that the participants are more used to employ online idea generation. Consequently, the *prior experience* of each participant is included in the analysis. The *prior experience* is calculated by the number of contests for which the individuals had been participated since its subscription to the eYeka platform. According to the current literature in crowdsourcing, the *prior experience* is seen as an important aspect for providing innovation ideas in

crowdsourcing (Bayus, 2013; Jeppesen & Lakhani, 2011). In particular, it has been shown that experienced individuals are better to understand and frame the problems to solve than novices (Schön, 1983). In addition to the solvers' prior experience, their *winning experience* is also claimed to play a primordial role for enhancing the likelihood of winning contests (Adamczyk, Bullinger, & Möslein, 2012; Bockstedt, Mishra, & Druehl, 2011; Khasraghi & Aghaie, 2014). The *winning experience* variable represents the number of winning contests for each participant since his or her first submission on the eYeka platform. For instance, (Bayus, 2013) demonstrated that the participants with past success on a crowdsourcing platform come up with ideas that are similar to their prior winning ideas.

In addition to these control variables, we add four other control variables: *participants' level*, *creative skills, gender*, and *geographic origin*. This information has been found on the eYeka community database. To participate, the individuals freely joined the eYeka community by providing an anonymous username and they provide information regarding these four control variables. The *participants' level,* it means to what extend the individuals are used to generate ideas of new products. The *participants' level* is defined as a categorical variable: amateur, semiprofessional or professional. Indeed, a conventional belief is that professionals, unlike amateurs, have the experience and required knowledge to produce more innovative ideas (Ulrich & Eppinger, 2012). Recently, (Poetz & Schreier, 2012) have reported a different results, showing that users generate more novel and valuable ideas but less feasible ideas than professionals. To go deeper into details, we also specifically control the kind of *creative skills* of participants. Current findings have shown that design skills play an important role in the generation of novel concepts in new product development (Perks, Cooper, & Jones, 2005). For instance, the abilities of participants to draw and quickly prototype is found to positively affect the idea generation process (van der Lugt, 2005). During their subscription, the participants notify whether they have some of the following creative skills: graphic design (ie.

"any skills in combining text and pictures for advertisements, magazines or books"), illustration (ie. "any skills in creating visuals to illustrate an idea"), animation (ie. "any skills in animation (cartoons for example)"), creative writing (ie. "any skills that goes outside the bounds of common forms of writing"), video (ie., "any skills in video making or editing") and packaging (ie. "any skills in creating the product's package). Finally, two demographic variables are included in the analysis. The *Gender* is a binary variable equals to 1 if the participant is a woman and 0 for a men. Current literature in creativity found significant but mixed results regarding possible gender differences (Matud, Rodríguez, & Grande, 2007; Simpkins & Eisenman, 1968; Stetler & Magnusson, 2015). The *Geographic origin* stands for the regions where the participants come from. We have, in our sample, six regions (Europe, Africa, Asia, Latin America and the Caribbean, North America, and Oceania) and we considered Europe as the reference region because the research setting was a European company (eYeka) with a predominantly European user base.

Descriptive statistics

Among the 1,682 ideas generated, 741 ideas are related to unbounded task instructions, 446 from suggestive task instructions and 495 from prohibitive task instructions. On average, the three kinds of task instructions permit to generate quite similar number of ideas: 49 ideas per unbounded task instruction, 49 ideas per suggestive task instruction and 45 ideas per prohibitive task instruction. In our sample, participants without any of the six creative skills produced 29% of the total number of ideas. Among the creative skills identified the ideas are generated as follow: 26% of ideas from participants with video skills, 59% of ideas from participants with graphic creative skills, 33% of ideas from participants with illustration skills, 19% of ideas from participants with animation skills, 30% of ideas from participants with creative writing skills and 32% of ideas from participants with packaging skills. Only 34% of the ideas are generated by women.

As our dependent variables are binary variables, we used logit models. The estimated models are reported in Table 3 with some measures of fit and robust estimators of variances were used to account for the heteroscedasticity and the clustering effects of the 35 tasks.

Hypotheses testing

The table 3 describes our results.

First, for prohibitive task instructions' ideas, the odds of being top original are 1.59 times larger than the odds for ideas related to unbounded task instructions (β =0.47, p<.01) and there is no significant difference between the latter's and ideas associated with suggestive task instructions. So, hypothesis H$_{1a}$ is partially supported and H$_{2a}$ is not supported. Regarding feasibility, on one hand there is a higher likelihood for suggestive task instructions to generate top feasible ideas than unbounded task instructions (β =1.64, p<.01) meaning that the chances of getting a top feasible idea from those generated by suggestive task instructions are 5.16 times larger than the chances of getting a top feasible idea from those related to unbounded task instructions. On the other hand, the prohibitive task instructions are less likely to generate a top feasible idea compared to the unbounded task instructions (β =-4.68, p<.01). Once again, hypothesis H$_{1b}$ is partially supported while the hypothesis H$_{2b}$ is supported. Finally, the ideas from unbounded task instructions are less likely to be top valuable than suggestive task instructions (β =0.82, p<.01) as well as prohibitive task instructions (β =0.37, p<.01). In other words, the likelihood to obtain a top valuable idea from suggestive task instructions is 2.27 times greater compared to unbounded task instructions and 1.58 times greater compared to prohibitive task instructions. So, hypotheses H$_{1c}$ and H$_{2c}$ are supported.

Regarding control variables, *participants' level, winning experience, geographic origin* and most of the *creative skills* do not seem to have an important effect. Not surprisingly, the

participants with creative writing skills are more likely to provide top original and top user value ideas (β =0.78, p<.01 and β =0.57, p<.10). In line with prior literature, *prior experiences* increase the chances to create top original ideas and top user value ideas (β =0.04 and β =0.04 p<.05) and females are less likely to generate top originality and top user value ideas (β =-0.42 and β =-0.38 p<.01).

Insert Table 3 about here

Discussion, implications and further research

Summary of results

Prior research has pointed out that the task instructions that clearly delineate the boundaries of the solution space without prescribing the routes to solutions increase the originality of the ideas. However, it is still unclear what could be the format of such bounded task instructions. Moreover, little is known if such task instructions also increase two crucial aspects in innovation, the fact that the ideas should be also feasible and valuable.

Based on the empirical study of the major crowdsourcing platform eYeka, this research compares the creative impact of unbounded task instructions with the creative impact engendered by task instructions that constraint creativity by including example of ideas. Theoretically, prior research has found that examples of innovative ideas boost the production of originality of ideas whereas the examples of non-innovative ideas hamper the production of originality of ideas (Agogué et al., 2011; Smith et al., 1993). This article compares the creative impact of three kinds of task instructions: the unbounded task instructions, for which individuals are totally unconstrained and free in their idea generation process; the suggestive task instructions, for which individuals are incited to follow example of innovative ideas; the

prohibitive task instructions, for which individuals are incited not to follow example of non-innovative ideas. The results are summarized in the Table 4.

Insert Table 4 about here

Our results confirm the fact that the nature of the task instructions has an impact on the creative outcomes in online idea generation. Overall, our results are in line with current findings claiming that unbounded is not relevant for producing original ideas (Moreau & Dahl, 2005; Stokes, 2005). Furthermore, we also found that the task instructions that are totally unconstrained are also not the most appropriate to generate feasible or valuable ideas. Concerning the study of prohibitive and suggestive task instructions, our findings offer some counter-intuitive results. Our result shows that neither the prohibitive nor the suggestive task instructions permit to generate ideas that are original, feasible and valuable ideas. Regarding the originality criteria, we found that the prohibitive task instruction is the most appropriate. This result contradicts current findings on fixation effect. In contrast to earlier findings (Jansson & Smith, 1991; Smith et al., 1993; Thomas B. Ward, Smith, & Finke, 1999), we found that introducing example of non-innovative idea in task instructions can be highly positive for generating original ideas. A possible explanation for this might be that the fixation effect does not seem to occur when participants are explicitly asked *not to* conform to the example. The superiority of prohibitive task instruction for achieving original ideas can be also explained by the fact that such task instructions bound the solution space, it designate the irrelevant paths, without prescribing specific paths to the solutions. Regarding the criteria of feasibility and value, we found that the suggestive task instructions are the most relevant ones. This finding seems to corroborate the current research that argues that individuals naturally

tends either to produce original ideas or feasible and valuable ideas (Magnusson, 2009; Poetz & Schreier, 2012).

Theoretical and managerial implications

Our findings offer interesting theoretical implications and avenues of research for the management of ideation in online communities and the formulation of creative task instructions.

This result directly responds to the call about *how* firms must concretely operate in innovation contests (Anderson, Potočnik, & Zhou, 2014; Elmquist, Fredberg, & Ollila, 2009). Current research in innovation contests has mainly studied how firms behave when they have to post the "right" problems on online idea generation platform (Sieg et al., 2010; Spradlin, 2012). Our research complement these works and it shows that a same "right" problem can be formulated differently, which produce ideas more or less innovative. The use of prohibitive task instructions and suggestive task instructions appears as a powerful and quite inexpensive mean to significantly improve the ideas' innovativeness submitted in online idea generation. This discrepancy between originality and feasibility/user-value offers interesting avenue of research. Indeed, our result suggests that it may be interesting to organize online idea generation contests in two phases: (1) triggering original ideas with prohibitive task instructions-based contests, (2) integrating the most original one in suggestive task instructions to improve the feasibility and the value of the ideas. Further research is required to measure the interest of managing series of interdependent task instructions (Franzoni & Sauermann, 2014). Furthermore, our research offers new perspectives of study concerning the reasons and factors explaining the motivation of people to participate in crowdsourcing. Providing the appropriate incentives such as monetary prizes is an important stream of research in crowdsourcing (Boudreau et al., 2011; Terwiesch & Xu, 2008), however, little research has been done to describe the inherent cognitive mechanisms that could attract the

participants to join a community (Garcia, 2015). Because crowdsourcing relies on a self-selection process, the task instructions may provide an interesting means for firms to better control the enrollment of the participants. For instance, it is possible that some type of task instructions leads to attract participants with specific skills and expertise. Furthermore, it could be interesting to observe if some task instructions better support the enjoyment and engagement of participants in online platforms (Garcia, 2015).

Our research findings also contribute to a better theoretical understanding of how the formulation of task instructions impacts the innovativeness of the ideas. Prior research has mainly insisted on the fact that participants can be incited to be creative by explicit instructions (Harrington, 1975; Runco et al., 2005). In this research, we demonstrate that the task instructions can both circumscribe the scope of solutions and offer directions to the participants by using fixation effect (Jansson & Smith, 1991; Smith et al., 1993; Ward et al., 1999). Contrary to current findings on fixation effect, our data shows that the exposure of non-innovative example prior idea generation leads to more original ideas than when innovative example or no examples are given. More research is necessary to valid the hypothesis that the fixation effect does not occur when participants are explicitly asked *not to* conform to the example. Further research is required to investigate in which circumstances individuals can benefit of positive fixation effects or overpass negative ones. Besides, further research might compare the effect of fixation effect for participants with different skills or professions (graphic designers, engineering designers or architects…). Our result provides initial evidences that some skills of participants such as design graphic and creative writing may moderate fixation effect. Moreover, further work should investigate if such professions require dedicated task instructions. For instance, it could conceivably be hypothesized that participants with strong marketing or technical knowledge require less guidance than novices.

Our research admits some limitations. This research is based on a quantitative study of ideas from very simple task instructions related to the product category of food and beverages. Thus, future research is required to confirm these results in other crowdsourcing context, especially in sectors that require a higher level of technological expertise (computer and electronic products, transportation, biotechnology…). Another limitation is that some of our results are based on declarative data, like the skills that we took into consideration in our analysis. Further research could better control this variable by defining the creative skills according to education degree obtained by the participants. Furthermore, other forms of task instructions and levels of analysis can be taken into account. For instance, further research could be done regarding the formulation of online calls for proposal to trigger innovative R&D projects or the online description of job tasks to recruit creative candidates.

problem formulation for organizations to innovate

References

Adamczyk, S., Bullinger, A. C., & Möslein, K. M. (2012). Innovation Contests: A Review, Classification and Outlook. *Creativity and Innovation Management*, *21*(4), 335–360.

Afuah, A., & Tucci, C. L. (2012). Crowdsourcing As a Solution to Distant Search. *Academy of Management Review*, *37*(3), 355–375.

Agogué, M., Kazakçi, A., Hatchuel, A., Le Masson, P., Weil, B., Poirel, N., & Cassotti, M. (2011). The impacts of examples on creative design: explaining fixation and stimulation effects. *Journal of Creative Behavior*. Retrieved August 7, 2014, from http://hal.archives-ouvertes.fr/hal-00707354/

Agogué, M., Kazakçi, A., Hatchuel, A., Le Masson, P., Weil, B., Poirel, N., & Cassotti, M. (2014). The Impact of Type of Examples on Originality: Explaining Fixation and Stimulation Effects. *The Journal of Creative Behavior*, *48*(1), 1–12.

Altshuller, G. S., Shulyak, L., & Rodman, S. (1999). *The innovation algorithm: TRIZ, systematic innovation and technical creativity*. Worcester, Mass.: Technical Innovation Center.

Amabile, T. M. (1998). How to kill creativity? *Harvard Business Review*, *76*(5), 76–87.

Anderson, N., Potočnik, K., & Zhou, J. (2014). Innovation and Creativity in Organizations A State-of-the-Science Review, Prospective Commentary, and Guiding Framework. *Journal of Management*, 0149206314527128.

Baer, M., Dirks, K. T., & Nickerson, J. A. (2013). Microfoundations of strategic problem formulation. *Strategic Management Journal*, *34*(2), 197–214.

Bayus, B. L. (2013). Crowdsourcing New Product Ideas over Time: An Analysis of the Dell IdeaStorm Community. *Management Science*, *59*(1), 226–244.

Bockstedt, J., Mishra, A., & Druehl, C. (2011). Do Participation Strategy and Experience Impact the Likelihood of Winning in Unblind Innovation Contests? *SSRN Electronic Journal*, 1–31.

Boudreau, K. J., Lacetera, N., & Lakhani, K. R. (2011). Incentives and Problem Uncertainty in Innovation Contests: An Empirical Analysis. *Management Science*, *57*(5), 843–863.

Campbell, D. J. (1988). Task complexity: A review and analysis. *Academy of management review*, *13*(1), 40–52.

Caniëls, M. C. J., & Rietzschel, E. F. (2013). A Special Issue of Creativity and Innovation Management: Organizing Creativity: Creativity and Innovation under Constraints: Call for Papers. *Creativity and Innovation Management*, *22*(1), 100–102.

Chang, J. W., Huang, D. W., & Choi, J. N. (2012). Is Task Autonomy Beneficial for Creativity? Prior Task Experience and Self-Control as Boundary Conditions. *Social Behavior and Personality: an international journal*, *40*(5), 705–724.

Chen, C., Kasof, J., Himsel, A., Dmitrieva, J., Dong, Q., & Xue, G. (2005). Effects of Explicit Instruction to "Be Creative" Across Domains and Cultures. *The Journal of Creative Behavior*, *39*(2), 89–110.

Chesbrough, H. W. (2003). *Open Innovation: The New Imperative for Creating and Profiting from Technology* (Harvard Business School Press.). Boston, Mass.

Coskun, H., Paulus, P. B., Brown, V., & Sherwood, J. J. (2000). Cognitive stimulation and problem presentation in idea-generating groups. *Group Dynamics: Theory, Research, and Practice*, *4*(4), 307–329.

Dennis, A. R., Valacich, J. S., Connolly, T., & Wynne, B. E. (1996). Process Structuring in Electronic Brainstorming. *Information Systems Research*, *7*(2), 268–277.

Dorst, K. (2006). Design problems and design paradoxes. *Design issues*, *22*(3), 4–17.

Duncker, K. (1945). On problem-solving. (L. S. Lees, Tran.)*Psychological Monographs*, *58*(5), i–113.

Eierman, M. A., & Philip, G. C. (2003). The Task of Problem Formulation. *International Journal of Information Technology & Decision Making*, *2*(3), 353.

Einstein, A., & Infeld, L. (1961). *The evolution of physics: the growth of ideas from early concepts to relativity and quanta*. CUP Archive.

Ejdelind, A. E., & Karlsson, J. R. (2014, August 5). *A quantitative analysis of how the level of abstraction in a problem formulation affects idea quality*. Copenhaguen Business School. Retrieved from http://hdl.handle.net/10417/5189

Ekvall, G. (1996). Organizational climate for creativity and innovation. *European Journal of Work and Organizational Psychology*, *5*(1), 105–123.

Elmquist, M., Fredberg, T., & Ollila, S. (2009). Exploring the field of open innovation. *European Journal of Innovation Management*, *12*(3), 326–345.

Erat, S., & Krishnan, V. (2012). Managing Delegated Search Over Design Spaces. *Management Science*, *58*(3), 606–623.

Fleming, L. (2001). Recombinant uncertainty in technological search. *Management science*, *47*(1), 117–132.

Franke, N., von Hippel, E., & Schreier, M. (2006). Finding Commercially Attractive User Innovations: A Test of Lead-User Theory*. *Journal of Product Innovation Management*, *23*(4), 301–315.

Franzoni, C., & Sauermann, H. (2014). Crowd science: The organization of scientific research in open collaborative projects. *Research Policy*, *43*(1), 1–20.

Garcia, M. (2015). Solver engagement in knowledge sharing in crowdsourcing communities: Exploring the link to creativity. *Research Policy*, *44*(8), 1419–1430.

Girotra, K., Terwiesch, C., & Ulrich, K. T. (2010). Idea Generation and the Quality of the Best Idea. *Management Science*, *56*, 591–605.

Goldenberg, J., Mazursky, D., & Solomon, S. (1999). Toward Identifying the Inventive Templates of New Products: A Channeled Ideation Approach. *Journal of Marketing Research*, *36*(2), 200–200.

Harrington, D. M. (1975). Effects of explicit instructions to "be creative" on the psychological meaning of divergent thinking test scores. *Journal of Personality*, *43*(3), 434–

454.

Hatchuel, A. (2000). Towards Design Theory and Expandable Rationality : The Unfinished Program of Herbert. *Journal of Management & Governance*, 260–274.

Hender, J. M., Dean, D. L., Rodgers, T. L., & Nunamaker, J. (2002). An Examination of the Impact of Stimuli Type and GSS Structure on Creativity: Brainstorming Versus Non-Brainstorming Techniques in a GSS Environment. *Journal of Management Information Systems*, *18*(4), 59–85.

Von Hippel, E., & Tyre, M. J. (1995). How learning by doing is done: problem identification in novel process equipment. *Research Policy*, *24*(1), 1–12.

Hippel, V., A, E., Krogh, V., & Georg. (2013). *Identifying Viable "Need-Solution Pairs": Problem Solving Without Problem Formulation* (SSRN Scholarly Paper No. ID 2355735). Rochester, NY: Social Science Research Network. Retrieved July 23, 2015, from http://papers.ssrn.com/abstract=2355735

Hoegl, M., Gibbert, M., & Mazursky, D. (2008). Financial constraints in innovation projects: When is less more? *Research Policy*, *37*(8), 1382–1391.

Howe. (2006). The Rise of Crowdsourcing. *Wired Magazine*. Retrieved from http://www.wired.com/wired/archive/14.06/crowds_pr.html

Jansson, D., & Smith, S. (1991). Design fixation. *Design Studies*, *12*(1), 3–11.

Jeppesen, L. B., & Lakhani, K. R. (2011). Marginality and Problem Solving Effectiveness in Broadcast Search. *Organization Science, 20*.

Jonassen, D. H. (1997). Instructional design models for well-structured and III-structured problem-solving learning outcomes. *Educational Technology Research and Development*, *45*(1), 65–94.

Katz, A. N., & Poag, J. R. (1979). Sex differences in instructions to "be creative" on divergent and nondivergent test scores. *Journal of Personality*, *47*(3), 518–530.

Kauffman, S. A., & Weinberger, E. D. (1989). The NK model of rugged fitness landscapes and its application to maturation of the immune response. *Journal of Theoretical Biology*, *141*(2), 211–245.

Khasraghi, H. J., & Aghaie, A. (2014). Crowdsourcing contests: understanding the effect of competitors' participation history on their performance. *Behaviour & Information Technology*, *33*(12), 1383–1395.

King, A., & Lakhani, K. R. (2013). Using Open Innovation to Identify the Best Ideas. *MIT Sloan Management Review*, *55*(Fall 2013), 41–48.

Kristensson, P., & Magnusson, P. R. (2010). Tuning Users' Innovativeness During Ideation. *Creativity and Innovation Management*, *19*(2), 147–159.

Levinthal, D. A. (1997). Adaptation on rugged landscapes. *Management science*, *43*(7), 934–950.

Locke, E. A., & Latham, G. P. (2013). *New Developments in Goal Setting and Task Performance*. Routledge.

Lombardo, S., & Kvalshaugen, R. (2014). Constraint-Shattering Practices and Creative Action in Organizations. *Organization Studies*, *35*(4), 587–611.

Van der Lugt, R. (2005). How sketching can affect the idea generation process in design group meetings. *Design Studies*, *26*(2), 101–122.

Lyles, M. A., & Mitroff, I. I. (1980). Organizational Problem Formulation: An Empirical Study. *Administrative Science Quarterly*, *25*(1), 102.

Magnusson, P. R. (2009). Exploring the Contributions of Involving Ordinary Users in Ideation of Technology-Based Services. *Journal of Product Innovation Management*, *26*(5), 578–593.

Magnusson, P. R., Netz, J., & Wästlund, E. (2014). Exploring holistic intuitive idea screening in the light of formal criteria. *Technovation*, *34*(5-6), 315–326.

Marguc, J., Van Kleef, G. A., & Förster, J. (2015). Welcome Interferences: Dealing with Obstacles Promotes Creative Thought in Goal Pursuit: Obstacles and Creativity. *Creativity and Innovation Management*, *24*(2), 207–216.

Matud, M. P., Rodríguez, C., & Grande, J. (2007). Gender differences in creative thinking. *Personality and Individual Differences*, *43*(5), 1137–1147.

McFadzean, E. (1998). The Creativity Continuum: Towards a Classification of Creative Problem SolvingTechniques. *Creativity and Innovation Management*, *7*(3), 131–139.

Medeiros, K. E., Partlow, P. J., & Mumford, M. D. (2014). Not too much, not too little: The influence of constraints on creative problem solving. *Psychology of Aesthetics, Creativity, and the Arts*, *8*(2), 198–210.

Moreau, C. P., & Dahl, D. W. (2005). Designing the Solution : The impact of Constraints on Consumers' Creativity. *Journal of Consumer Research*, *32*(June), 13–23.

Nakatsu, R. T., Grossman, E. B., & Iacovou, C. L. (2014). A taxonomy of crowdsourcing based on task complexity. *Journal of Information Science*, *40*(6), 823–834.

Newell, A., & Simon, H. A. (1972). *Human Problem Solving* (Englewood Cliffs.). Prentice-Hall.

O'Hara, L. A., & Sternberg, R. J. (2001). It Doesn't Hurt to Ask: Effects of Instructions to Be Creative, Practical, or Analytical on Essay-Writing Performance and Their Interaction With Students' Thinking Styles. *Creativity Research Journal*, *13*(2), 197–210.

Paulus, P. B., Kohn, N. W., & Arditti, L. E. (2011). Effects of Quantity and Quality Instructions on Brainstorming. *The Journal of Creative Behavior*, *45*(1), 38–46.

Perks, H., Cooper, R., & Jones, C. (2005). Characterizing the Role of Design in New Product Development: An Empirically Derived Taxonomy*. *Journal of Product Innovation Management*, *22*(2), 111–127.

Perttula, M., & Sipilä, P. (2007). The idea exposure paradigm in design idea generation. *Journal of Engineering Design*, *18*(1), 93–102.

Piezunka, H., & Dahlander, L. (2014). Distant Search, Narrow Attention: How Crowding Alters Organizations' Filtering of Suggestions in Crowdsourcing. *Academy of Management Journal*, amj.2012.0458.

Poetz, M. K., & Schreier, M. (2012). The value of crowdsourcing: can users really compete with professionals in generating new product ideas? *Journal of Product Innovation Management*, *29*(2), 245–256.

Purcell, A. T., & Gero, J. S. (1996). Design and other types of fixation. *Design Studies*, *17*(4), 363–383.

Reitman, W. R. (1965). *Cognition and thought: an information-processing approach*. Wiley.

Rietzschel, E. F., Slijkhuis, J. M., & Van Yperen, N. W. (2014). Task structure, need for structure, and creativity. *European Journal of Social Psychology*, *44*(4), 386–399.

Rittel, H. W. ., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy sciences*, *4*(2), 155–169.

Rosenkopf, L., & Nerkar, A. (2001). Beyond local search: boundary-spanning, exploration, and impact in the optical disk industry. *Strategic Management Journal*, *22*(4), 287–306.

Rosso, B. D. (2014). Creativity and Constraints: Exploring the Role of Constraints in the Creative Processes of Research and Development Teams. *Organization Studies*, *35*(4), 551–585.

Runco, M. A., Illies, J. J., & Reiter-Ralmon, R. (2005). Explicit Instructions to Be Creative and Original. *The International Journal of Creativity & Problem Solving*, *15*(1), 5–15.

Runco, M. A., & Okuda, S. M. (1991). The instructional enhancement of the flexibility and originality scores of divergent thinking tests. *Applied Cognitive Psychology*, *5*(5), 435–441.

Schön, D. A. (1983). *The reflective practitioner: how professionals think in action*. New York: Basic Books.

Schulze, T., Seedorf, S., Geiger, D., Kaufmann, N., & Schader, M. (2011). Exploring task properties in crowdsourcing-an empirical study on mechanical turk. *ECIS* (Vol. 11, pp. 1–1).

Scopelliti, I., Cillo, P., Busacca, B., & Mazursky, D. (2014). How Do Financial Constraints Affect Creativity? *Journal of Product Innovation Management*, *31*(5), 880–893.

Sellier, A.-L., & Dahl, D. W. (2011). Focus! Creative Success Is Enjoyed Through Restricted Choice. *Journal of Marketing Research*, *48*(6), 996–1007.

Shalley, C. E. (1995). Effects of Coaction, Expected Evaluation, and Goal Setting on Creativity and Productivity. *The Academy of Management Journal*, *38*(2), 483–503.

Sieg, J. H., Wallin, M. W., & Von Krogh, G. (2010). Managerial challenges in open innovation: a study of innovation intermediation in the chemical industry. *R&D Management*, *40*(3), 281–291.

Simon, H. (1969). *The Sciences of the Artificial*. Cambridge, Massachusetts: The MIT Press.

Simon, H. A. (1973). The structure of ill structured problems. *Artificial Intelligence*, *4*, 181–201.

Simpkins, R., & Eisenman, R. (1968). Sex differences in creativity. *Psychological reports*, *22*(3), 996–996.

Smith, S., Ward, T., & Schumacher, J. (1993). Constraining effects of examples in creative

generation task. *Memory and Cognition*, *21*, 837–845.

Spradlin, D. (2012). Are you solving the right problem? *Harvard Business Review*, *90*(9), 84–93.

Stetler, K. L., & Magnusson, M. (2015). Exploring the Tension between Clarity and Ambiguity in Goal Setting for Innovation. *Creativity and Innovation Management*, n/a–n/a.

Stokes, P. D. (2005). *Creativity from Constraints: The Psychology of Breakthrough*. Springer Publishing Company.

Taylor, R. N. (1974). Nature of Problem Ill-Structuredness: Implications for Problem Formulation and Solution. *Decision Sciences*, *5*(4), 632–643.

Terwiesch, C., & Xu, Y. (2008). Innovation Contests, Open Innovation, and Multiagent Problem Solving. *Management Science*, *54*(9), pp. 1529–1543.

Ulrich, K. T., & Eppinger, S. D. (2012). *Product design and development* (5th ed.). New York: McGraw-Hill/Irwin.

Volkema, R. J. (1983). Problem Formulation in Planning and Design. *Management Science*, *29*(6), 639–652.

Ward, T. B. (1994). Structured Imagination: the Role of Category Structure in Exemplar Generation. *Cognitive Psychology*, *27*(1), 1–40.

Ward, T. B., Patterson, M. J., & Sifonis, C. M. (2004). The Role of Specificity and Abstraction in Creative Idea Generation. *Creativity Research Journal*, *16*(1), 1–9.

Ward, T. B., Smith, S. M., & Finke, R. A. (1999). Creative cognition. *Handbook of creativity* (pp. 189–212). New York, NY, US: Cambridge University Press.

Weisberg, R. W. (2011). Frank Lloyd Wright's Fallingwater: A Case Study in Inside-the-Box Creativity. *Creativity Research Journal*, *23*(4), 296–312.

West, J., Salter, A., Vanhaverbeke, W., & Chesbrough, H. (2014). Open innovation: The next decade. *Research Policy*, *43*(5), 805–811.

Wijnberg, L., & Williams, J. J. (2012). Consumer Participation in FMCG Crowdsourcing Contests.

Zheng, H., Li, D., & Hou, W. (2011). Task Design, Motivation, and Participation in Crowdsourcing Contests. *International Journal of Electronic Commerce*, *15*(4), 57–88.

Zhou, jing, & Shalley, C. E. (2003). Research on employee creativity : a critical review and directions for future research. *research in Personnel and Human Resources Management*, *22*.

Table 1. Current types of task instructions studied in the literature

Types of task instruction	Description	Main refs.	Main results
Creative task (or novelty task): 'be original !')	Explicit instruction to be creative during idea generation	Chen et al., 2005; Harrington, 1975; Katz & Poag, 1979; O'Hara & Sternberg, 2001; Runco et al., 2005; Runco & Okuda, 1991; Shalley, 1995; Stetler & Magnusson, 2015	Creative tasks increase idea originality because they increase participants' intrinsic motivation and effort
Quantity task	Explicit instruction to generate as many (resp. original) ideas as possible	Paulus et al., 2011	Quantity task lead to more ideas and more 'good' ideas than no specific focus, a quality task, or a joint quantity and quality task
Quality task	Explicit instruction to generate as many original ideas as possible		
Decomposed task	Decomposing instruction of general problems into sub-problems	Coskun et al. 2000; Dennis et al. 1996	Decomposing general problem into a series of sub-problems increase number of ideas generated
Abstract task (*vs* domain-specific)	Writing task instruction in deep–structure approach (eg. use of general concepts and physical laws) (vs domain-specific)	Altshuller, Shulyak, & Rodman, 1999; Ejdelind & Karlsson, 2014; T.B. Ward et al., 2004	Abstract formulation increase the production of creative ideas through analogical thinking
Clear (*vs* ambiguous) task	Ambiguous goal: offering different possible interpretations	Amabile, 1998; Chang, Huang, & Choi, 2012; Ekvall, 1996; Stetler & Magnusson, 2015; Zhou & Shalley, 2003	On average, clear-cut tasks increase the creativity because it directs attention and increase motivation
Resources - constrained task (*vs* unconstrained)	Instructions under restrictions of certain resources	Hoegl et al., 2008; Scopelliti et al., 2014	Financial constraints increase the novelty and user-value of ideas
		Moreau and Dahl 2005; Sellier and Dahl 2011	Requirement and material constraints included in task increase creativity
		Mumford 2002; Weisberg 2011	Environment/social constraints enable creativity
Constrainting examples task (or stimuli)	Inclusion of an example of solution in the task instructions	Jansson & Smith, 1991; Smith et al., 1993	Examples of unoriginal ideas (ie. problem-related stimuli) decrease originality
		Agogué et al., 2014; Hender et al., 2002; McFadzean, 1998; Perttula & Sipilä, 2007	Examples of original ideas (ie. problem-unrelated stimuli) increase originality