

MASTER

How do interactions influence a creative day? a diary study investigating the effect of work-related interactions on workplace idea generation

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How Do Interactions Influence A Creative Day? A Diary Study Investigating The Effect Of Work-Related Interactions On Workplace Idea Generation

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identity number 0819617

in partial fulfilment of the requirements for the degree of

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I wanted to go out of my comfort zone and try something new. Within a company, with other participants than students. Within a rich and complex environment of an airline company; a dream I always had when I was just a little boy.

At first it was difficult to find a suitable project for a master thesis within the company. I tried formulating different projects but it proofed to be difficult to find a match between science and business. At last I succeeded, and in front of you is the proof.

To me it was not just a graduation project or an internship. Of course I learned a lot about conducting a proper research, learned about social networks, about creativity, constructing questionnaires and multilevel modelling. This project was so much more.

My goal was to gain experience within a company, to know what it is like to conduct a research within a different setting than at the University. Despite the struggles at the beginning of the project, I am glad I choose this road. I learned to promote and prove the value of a research project and to engage people to participate voluntarily in a research. I learned about Scrum, about implementation of innovations, about creativity and service design. I got a glimpse of what it's like within the mystery and complex world of an airline company.

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To me, this project marks the end of my time of being a student. To you and anyone who is reading this thesis, I hope you will learn something from this study or it will inspire you for your own research.

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How Do Interactions Influence A Creative Day? A Diary Study Investigating The Effect Of Work-Related Interactions On Workplace Idea Generation

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Abstract

Although initial creativity research focused primarily on creativity as an individual trait (Barron & Harrington, 1981) more recent research has focused on the association between the context of social relationships and creativity. The main idea of this approach is that creativity is the result of combining novel and heterogeneous information and that social interactions can provide it. This study investigated the effect of work-related interactions on workplace idea generation, with a focus on the daily interactions. This research was studied at a day and interaction-level; thus investigating the effect of the interactions themselves on creativity. On a day-level it was hypothesized that (1) the number of interactions positively affects daily idea generation and (2) that the heterogeneity of these interactions has a positive effect on daily idea generation. On a interaction-level, it was hypothesized that (3) interactions with colleagues that were considered a weak tie have a higher positive effect on idea generation than interactions with a strong tie and (4) interactions with colleagues higher in centrality results in a higher degree of idea generation. Data was gathered within an innovation department of a large airline company by conducting a one-time cross-sectional questionnaire and dairy study consisting of five daily questionnaires. Results showed support for hypothesis 1, that the number of daily interactions positively affects daily idea generation. The other hypotheses did not find support within this study. Additional analysis reserved a central role for levels of energy and job crafting that positively affected idea generation as well. Results imply that idea generation within employees can be shaped by influencing the number of daily interactions, keeping energy levels high during the day and offering opportunities for job crafting within interactions.

Keywords: idea generation, daily interactions, diary study, heterogeneity of interactions, weak ties, centrality, energizing, job crafting.

1. Introduction

More and more companies (e.g. Google, Pixar, and 3M) acknowledge the importance of creative employees and aim to encourage creativity by constructing meeting places that allow ideas to develop out of serendipity in informal and non-planned encounters. As Steve Jobs ones said: "Creativity comes from spontaneous meetings, from random discussions. You run into someone, you ask what they're doing, you say 'Wow' and soon you're cooking up all sorts of ideas" (Isaacson, 2011). Barsch et al. (2008) found empirical evidence that indeed most managers considered innovation to be one of the key determinants of success. However, the same amount of managers report being less confident in their ability to promote innovative outcomes in their colleagues. Therefore, there is a need for a greater understanding of the contextual factors that may enhance or discourage employees' creativity.

If organizations are to achieve competitive advantage, it is important to attain to the creative performance of their employees (Amabile, 1988; Devanna & Tichy, 1990; Kanter, 1983; Shalley, 1995). Employees that work creatively, suggest useful products, ideas or procedures that can be used for subsequent development and possible implementation, therefore fostering innovation (Amabile, 1988; Staw, 1990; Woodman, Sawyer, & Griffin, 1993). The implementation of innovative products enhances an organization's ability to respond to opportunities, and, thereby, compete (Kanter, 1983, 1988; March & Simon, 1958; Van de Ven, 1986; Van de Ven & Angle, 1989). Although innovation and creativity are distinct concepts, most researchers reserve a central role for creativity in innovation.

Although initial creativity research focused primarily on creativity as an individual trait (e.g. Barron & Harrington, 1981), more recent research focussed on how contextual factors can affect an individual's creativity and elaborated on the idea that creativity is primarily a social process. In contrast to the lone genius view, this line of research suggests that interactions with others influence various aspects of the creativity process (e.g., Amabile, 1983; Simonton, 1984; Woodman, Sawyer, & Griffin, 1993). The main idea of this approach is that creativity is the result of combining novel information and insights. Social interactions can provide access to new information and insights where certain interactions provide more novel information than others. Each interaction varies in their content, intensity, and depth and the question remains which interactions foster creativity in particular. Are certain types of interactions more helpful for individuals to be creative at work? How does one's position in the network influence an individual's level of creativity and in what way? As Simonton (1984) described it: "A successful 'social psychology of creativity' demands that the creative individual be placed within a network of interpersonal relationships". Creativity is thus acknowledged by both companies and scientific research to be encouraged by social interactions.

Burt (1992) was one of the first to extend the general view that creativity is a social process to a more social-centric view where the social context is captured. He studied the influence of an employee's network on individual performance, including creative performance. He found that employees with certain network characteristics were more creative than others (Burt, 2004). This spurred other researchers to begin identifying the social network parameters that shape creativity at work (e.g. Cross and Cummings, 2004; Fleming, Mingo, & Chen, 2007; Obstfeld, 2005; Rodan & Galunic, 2004; Uzzi & Spiro, 2005). A social networks approach is powerful to study the social context because it emphasizes the relationships themselves and the pattern of connections or the structure of ties (Perry-Smith & Mannucci, 2015). Research that utilized a social network approach has, for example, studied the strength of relationships (Baer, 2010; Sosa, 2011) and the number and nature of contacts (Perry-Smith, 2006; Zhou et al., 2009). With respect to the structure of ties, the level of redundancy (e.g. Burt, 2004; Fleming et al., 2007) or an individual's position in the overall network has been studied (Perry-Smith & Shalley, 2003; Perry-Smith, 2006).

Recent research suggests that creativity is not a static concept but one that fluctuates across days. For example, according to Binnewies and Wörnlein (2011) employees are more creative on some days than on other days. Although ideally, employees would come up with creative ideas every day, it is difficult to maintain the same creative output. Some evidence regarding the influence of social interactions on creativity across day has been recently found by Groenewoudt, Rooks, & Van Gool (2017). Their study showed that the relationship between the number of problems is positive correlated with creativity across days and that this effect is moderated by interactions with non-redundant others. While the influence of the social context on creativity has gained prominence within the literature, the approach of studying the social interactions on daily creativity has only recently begun. The objective of this paper was to investigate the influence of work-related interactions on workplace creativity.

1.1. Creativity and idea generation

In this research, the outcome measure was creativity within employees who are working on innovation projects. It is important to specify the definition of creativity as it was used within this research. Although creativity is a complex and diffuse construct, the focus of this paper is on novel and appropriate or useful ideas concerning products, services, processes, and procedures, which is consistent with definitions of creativity in the literature (Amabile, 1983; Shalley, 1991; Perry-Smith & Mannucci, 2015). The scope of this study was limited to the generation phase of creativity and excludes the implementation of creative ideas that is commonly studied in research specifically on networks and innovation (e.g. Rodan & Gulcanic, 2004; Tsai, 2001). This stage has been referred to as "generative creativity" or idea creation (Fleming, Mingo, & Chen, 2007). For this definition, it is important to note that it is not sufficient to come up with lots of ideas that are crazy or nonsensical, which is typically encountered during brainstorming sessions, but that the ideas have to be appropriate or useful.

Likewise, an idea that is useful but not novel, cannot be considered creative. Therefore, creativity can be considered a multiplicative process rather than additive; when an idea lacks either novelty or usefulness, then the idea also lacks creativity. Regarding the link with innovation, creativity can be conceptualized as a first and necessary step required for innovation.

Sometimes the impact of an idea is also considered, to distinguish between extraordinary creativity from ordinary creativity; also referred to as big-c and little-c creativity. The first refers to creativity that is believed to be limited to well-known creators or renowned individuals. The latter refers to everyday creativity, that is found in everyone, from college students to children (Kaufman & Beghetto, 2009). Although novelty and usefulness are necessary preconditions of creativity, ideas that lack impact can still be considered to be creative.

Concluding, in this study, creativity was defined by ideas that are novel and useful, which has been referred to as "idea generation" and the focus is on those creative activities that occur every day.

1.2. The social side of creativity

The study of creativity as the result of a social process is premised on the idea that exposure and interaction with others stimulates the generation of new ideas. By communicating with others they might bring in their own expertise and knowledge (Zhou & George, 2001). This can result in new perspectives by combining them with already known information (Mumford, Whetzel, & Reiter-Palmon, 1997). In a cognitive thought process, ideas are recombined by broad categorizations in the mind and remote associations, resulting in new and useful permutations (Simonton, 2003). While personality facilitates these processes, there are cognitive limits and biases that might constrain creativity (Cialdini, 1989). The social context can help expand the available inputs to creativity by providing a greater variety of ideas or information (Amabile et al., 1996). Within this perspective, the social context can be seen as a possible source of diverse knowledge with each interaction providing new information. Indeed, scholars have argued that interactions with others can provide with novel and heterogeneous information that is useful for generating new ideas (Burt, 2004). Therefore, I stated the hypothesis that a higher number of interactions, with each interaction potentially providing new information, has a positive effect on daily idea generation.

Hypothesis 1: The number of daily interactions has a positive effect on daily idea generation.

1.3. Heterogeneity of interactions

Assuming that interactions with others can provide someone with new perspectives and ideas, it becomes interesting to investigate which interactions in particular provide with these resources. Burt (2004) found that interactions with different people about an idea, was positively associated with the ability to come up with a good idea. Especially people who provide novel and heterogeneous information led to a higher ability to come up with a good idea. Burt (2000) suggested that this kind of information comes from people from otherwise unconnected groups in particular. Unconnected groups may provide access to others with differing ideas and perspectives, whereas closely connected others may limit perspectives. Burt describes this theory as 'structural holes' because there is a gap in the network structure between the groups that are not connected. His research has found supporting evidence that people who span structural holes are more creative (Burt, 2004).

In this line of reasoning, I assume that those unconnected groups are heterogeneous and hypothesize that the heterogeneity of daily interactions has a positive effect on daily idea generation. In this study, heterogeneity of interactions was defined as the diversity of interactions with respect to the interaction partner's background and thus it takes a different approach to that of Burt. For example, during the day an individual can have interactions with diverse others, with respect to educational background, job function, team, working experience etc.

In this research, of particular interest was heterogeneity of job function. Within the innovation department, there were many different people working in multidisciplinary teams making it interesting

to investigate whether diversity of job functions in particular has a positive effect on daily idea generation. The idea of this is that with each interaction with a person that is different from the previous one can foster a different perspective that could lead to a new idea. On the other hand, interactions that are with the same type of colleagues are less likely to have a different perspective and therefore less likely to lead to a new idea.

Hypothesis 2: The heterogeneity of daily interactions with respect to job functions has a positive effect on daily idea generation

1.4. Weak ties and creativity

Within research on the social context of creativity, a concept that has gained interest is that of Granovetter (1973) on the strength of weak ties. According to his theory, tie strength can be seen as a movement along a continuum with weak ties on one end and strong ties on the other; movement along this continuum can be seen as a function of the frequency of interaction, duration of interaction, emotional closeness and reciprocity of the interaction (Granovetter, 1973). Therefore, strong ties are interactions that score high on all components such as that the interaction occurs frequently, for longer periods of time, the two parties like each other and share similar perspectives on the importance of the relationship. Weak ties, on the other hand, are characterized by low levels of each of the components and are likely to have perspectives and approaches that are new to ego. Thus, as a tie grows stronger, individuals come to know each other better. As a consequence, the perspectives and approaches of strong ties may become more shared and redundant (Coleman, 1988).

This theory could have important implications on the study of the social context on creativity. In this line of reasoning, weak ties are particularly valuable to the production of creative ideas because they allow for enhanced access to socially distant sources of information. This information is likely to be novel and, therefore, likely to fuel the combinatory process of generating novel ideas the creative process (Brass, 1995; Perry-Smith & Shalley, 2003). On the other hand, strong ties are more likely to share perspectives and have the same information, making them less likely to fuel the generation of new ideas.

Indeed, this proposition has gained empirical evidence. For instance, Perry-Smith (2006) found support that weak ties in particular foster idea generation because they may facilitate the generation of alternatives and encourage autonomous thinking. The relationship between weak ties and creativity was mediated by a more heterogeneous set of direct contacts. Similarly, Zhou, Shin, Brass, Choi, and Zhang (2009) found that a higher number of weak ties correlated with higher levels of creativity. Furthermore, their results suggest an inverted U-shape relation between weak ties and creativity as increasing levels of weak ties result in diminishing returns for a higher number of weak ties, suggesting a curvilinear relationship (Baer, 2010). McFayden & Cannella (2004) have also demonstrated that it might be an optimal number of weak ties, rather than a maximum number, that facilitates creativity.

The notion of weak ties as described by Granovetter (1973) is somewhat similar to the notion of structural holes by Burt (1992). Granovetter's (1973) perspective is primarily on the strength of the relationship and includes the frequency, duration, emotional closeness and reciprocity of the interaction. Burt's (1992) perspective, on the other hand, describes weak ties in a structural way such that those ties that have a brokerage position can be considered weak ties, also known as a structural bridge. However, both theories are built on the premise that weak ties, either defined as a structural bridge or relational, are more likely to be non-redundant connections containing diverse perspectives and approaches. Perry-Smith & Mannucci (2015) emphasize a distinction between relational and structural characteristics of weak ties and that they should be measured simultaneously so that the effects of each can be disentangled.

In contrast to previous studies, in this research I take a different approach and investigate whether an interaction with a weak tie influences the creativity within that interaction itself. Consistent with previous findings, I argue that weak ties are likely to allow for enhanced access so socially distant sources of information and therefore could provide with novel information that could fuel the creative

process. It is expected that interactions with weak ties occur sporadically each day, perhaps sometimes not at all on specific days. On days that there is an interaction with a weak tie, this will have a profound impact on the degree of idea generation of that interaction. Thus, I hypothesize the following:

Hypothesis 3: An interaction with a weak tie has a higher positive effect on idea generation than an interaction with a strong tie.

1.5. Position in the network

Another network parameter that is suggested to influence creativity is centrality within the network. The concept of centrality refers to the actor's position within the whole network or global structure (Freeman, 1979). Not only an actor's direct ties, but also their indirect ties are captured within the measure of centrality and can, therefore, be studied. An actor with high centrality is argued to be in a privileged position because they have a prominent position within the network with reference to the other actors. This person is in touch with a high number of other individuals within the network and they can be a fundamental link between otherwise disconnected network members.

With respect to creativity, Perry-Smith & Shalley (2003) have argued that a prominent position within a network affects creativity, because it provides exposure to different perspectives. They argue that a central individual can reach a large part of the network and can, therefore, reach distant social circles. These distant social circles provide access to different perspectives and can foster creativity. Perry-Smith (2006) studied the effect of centrality on creativity and found that the relationship depended on the number of ties outside an organizational network. However, contrary to expectations, they did not find a significant direct effect of centrality on creativity. As a possible explanation, they argue that the relationship might not be linear but curvilinear. Indeed, other scholars suggest that an excessive level of centrality might be constraining to creativity (Cattani & Ferriani, 2008; Dahlander & Frederiksen, 2011; Perry-Smith & Shalley, 2003). Individuals with high centrality may experience difficulties with recharging for fresh ideas (Cattani & Ferriani, 2008; Dahlander & Frederiksen, 2011; Perry-Smith & Shalley, 2003). Furthermore, with increasing centrality comes an increasing number of contacts that need to be sustained. Maybe those individuals devote too much time to their contacts that it diminishes their devotion to creative activities (Perry-Smith & Shalley, 2003).

As with the hypothesis on the strength of weak ties, I take the approach to study the effect of centrality on the interactions themselves. Thus, I study whether an interaction with someone high in centrality leads to higher creativity within that interaction. This is consistent with the argumentation of Perry-Smith & Shalley (2003) that a position high in centrality can provide exposure to different perspectives and can therefore foster creativity.

Hypothesis 4: An interaction with an individual who has a higher degree of centrality results in a higher degree of idea generation.

1.6. Control variables

Job crafting. Although job crafting is a concept that was first coined by Wrzesniewski and Dutton (2001), I refer to the term as defined by Tims, Bakker, and Derks (2012) that is incorporated within the job demands-resources (JD-R) theory. Job crafting is defined by them as the proactive changes employees make in their job demands and resources. To better understand the role of job crafting on creativity, I briefly turn to the JD-R theory.

Originally JD-R was a model that was introduced to explain job burnout through job demands that can be alleviated through job resources (Bakker, Demerouti & Euwema, 2005). The two most important processes within the model are the health-impairment process which is predicted by job demands and the motivational process which is predicted by job resources. Job demands are those aspects of the job that require sustained psychological and/or psychological effort (Demerouti et al., 2001). Job resources are those aspects of the job that are functional in achieving work goals, reduce

job demands or stimulate personal growth (Bakker, 2011). The health-impairment process has a negative impact on job performance and the motivational process has a positive impact on job performance. This is a simplification of the JD-R theory as it is today as the relationships within and between those processes is somewhat more complicated, but it should be enough to understand the role of job crafting. For a more complete view on the JD-R theory one can refer to Bakker and Demerouti (2017).

The role of job crafting was added later when the perspective of JD-R shifted from a top-down perspective of job designs within organizations to a more bottom-up approach. That is to say, at first, it was assumed that organizations design the job demands and job resources of their employees and that employees were assumed to be reactive and experience strain after being exposed to these work environments. However, because employees are often proactive and take personal initiative to change the status quo (Griffin, Neal, & Parker, 2007), scholars later argued that employees might also proactively change their work tasks. Indeed, several scholars found supporting evidence that led to the proposition that employees who are motivated by their work are likely to use job crafting behaviours, which lead to higher levels of job and personal resources and motivation (Bakker & Demerouti, 2017).

Job crafting initially starts when an employee is motivated to change a certain aspect of his or her job which can happen because of a variety of reasons. These motivations then compel employees to actively change their job designs. They can change their set of tasks, their social relationships with others or thoughts about their work. This can have beneficial or costly effects for the employee such as meaningful work or stress. Job crafting is often an continuous process that evolves when the context of the job evolves.

In line with Tims et al. (2012), three distinct job crafting behaviours were examined: seeking resources, seeking challenges and reducing demands. Seeking resources refers to proactive behaviour enacted to gain resources (Lee, 1997). Seeking challenges may include behaviours such as looking for new tasks or taking on more responsibilities. Seeking challenges may not always be a desirable option as a job can be too demanding and new tasks might not be perceived as challenging anymore. Reducing demands might be a better option. Reducing demands may include behaviours targeted toward minimizing emotionally, mentally or physically demanding job aspects (Petrou et al., 2012).

In this study, the three job crafting behaviours were included and were measured per interaction as I expect them to have an influence on the idea generation levels of the interactions. I expect that those interactions that are high in seeking resources to have a positive effect on the generation of ideas of that interaction. Seeking challenges should also result in a higher degree of idea generation. Higher degree of reducing demands should result in lower idea generation.

Job characteristics on creativity. Although some jobs can be considered to be more creative than others, almost any job requires some level of creativity (Shally, Gilson, & Blum, 2000; Unsworth, 2001). However, different objective job characteristics have been found to have an influential role with respect to an employee's motivation and attitude towards work has been studied for a long time (Hackman & Oldham, 1975). Amabile (1988) proposed, in her model of creativity, that job characteristics are an important component to enhance an individual's creativity as well. Furthermore, the way jobs are structured has been found to influence an employee's intrinsic motivation and creativity at work (Amabile, 1988; Hackman & Oldham, 1980; Oldham & Cummings, 1996; Kanter, 1988; West & Farr, 1980).

Jobs differ with respect to the extent that it requires an employee to be creative, especially jobs that are complex and demanding versus jobs that are more simple and routinized. Specifically when jobs that score high on challenge, autonomy, and complexity, employees should be better focused on their jobs. Therefore, they are more likely to be persistent in their tasks and thus more likely to consider alternatives, which results in creative outcomes (Shalley & Gilson, 2003). On the other hand, simple and routinized jobs may not trigger employees to focus all their attention and effort on their jobs and, therefore, making them less likely to think flexibly and potentially to perform creatively. In that regard, Shalley et al. (2000) found that employees had higher job satisfaction and lower intentions to turnover when the work environment complemented the creative requirements of the job.

Although many different job characteristics have been studied in relation to creativity, in this study the focus is on problem solving demands. Jackson et al. (2003) define problem solving demands as the degree to which a job requires unique ideas and reflect the more active cognitive processing requirements of a job. This is consistent with notions of Binnewies et al. (2007) and Amabile (1988) that creativity is a process in which an individual may start thinking about new ideas when exposed to a new problem. As such, the construct is conceptually related to creativity demands of the job (Shalley, Gilson, & Blum, 2000).

Concluding, given that every job requires some level of creativity but different jobs demand different levels of creativity it is important to take into consideration the objective job characteristics that could influence the creativity of employees. As I expect that jobs differ in their creativity demands with in the studied department, they are likely to have an effect on the other relationships as previously hypothesized and I include problem solving demands as a control variable.

1.7. Research aims

Given the recent findings on both the social network approach and fluctuations on daily creativity, this study focused on the daily influence of social interactions. In particular, I investigated the influence of different aspects of those social interactions to be able to identify which aspects of the interaction fosters idea generation. The approach to study the influence of social interactions on idea generation was twofold. First, the interactions during the day were studied in relation to daily idea generation. Second, to focus even more on the influence of a social interaction itself, the degree of idea generation as an outcome per interaction was studied. Furthermore, instead of solely focusing on various social network parameters – that are more static in nature and primarily used in previous studies – this study combines information from a social network approach, with the specific interactions that took place during the day – that are more dynamic in nature. By measuring the interactions and idea generation daily with a diary study, this study contributes to a more thorough understanding of why and how social interactions influence idea generation at a daily and interaction-level.

This study was conducted within an innovation department of a large airline company. Generally research on the influence of social networks on employee performance and creativity were studied within homogeneous groups. For example, Groenewoudt et al. (2017) studied the influence of non-redundant interactions on creativity with a sample of employees of a Dutch applied university. However, it is typical for an innovation department to work with multidisciplinary teams such as within a Scrum-way-of-working. Scrum teams are multidisciplinary and work closely together. Therefore, it is interesting to study how the social context affects creativity amongst different employees in an environment that is typical for innovation departments and creative employees. Figure 1 shows a graphical representation of the theoretical models at a day and interaction-level.



Figure 1. Theoretical models at day and interaction-level.

2. Method

2.1. Design

This research was conducted at an innovation department of an airline company in the Netherlands. Data collection was divided into two parts: a general questionnaire and a daily questionnaire for five consecutive working days. This was done to reduce the daily burden on the participants. Within the general questionnaire, most of the questions referred to demographic and trait characteristics of the participants. The daily questionnaires referred to the daily experience of idea generation and interactions. Therefore, the design of this study was mixed using a cross-sectional design for the general questionnaire and a diary study for the daily questionnaires. The dairy study was conducted multiple days to increase the number of observations.

2.2. Participants

Initially 116 participants of this department were invited by e-mail to participate. Later the sample size grew to a total of 129 due to some employees that were missing in the original sample (n = 11) and new employees (n = 3) that were added later. In total, 90 responses were gathered for the general questionnaire of which some were partially completed (n = 5). Partially completed questionnaires were deleted, resulting in 85 recorded responses (response rate was 65.9%). Not all participants that completed the general questionnaire also participated in the daily questionnaires (n = 15). Therefore, the sample for the general questionnaire was slightly different from the daily questionnaires. Within the general questionnaire, the mean age of participants was 35, their job tenure was on average 5.8 years and a mean of 11.5 years of work experience. Most of them worked full-time (n = 60) at the time of data collection, others worked part-time for 36 hours (n = 8), 32 hours (n = 8), and 24 hours (n = 4). Most of the participants were men (49 men and 35 women). Their highest completed degree was either secondary education (n = 9), Bachelor's degree (n = 33) or Master's degree (n = 42).

The innovation department used a Scum-way-of-working which is a framework on how teams should work on a complex projects. Therefore, each team used Scrum to organize their way of working and the participant's job functions were described accordingly: Product Owner (n = 12), Scrum Master (n = 5), Developer (n = 20), Systems Architect (n = 2), Business analyst (n = 10), Tester (n = 4), Service Designer (n = 4), Product Designer (n = 5), Lead (n = 3), Communication (n = 2) or supporting roles (n = 18). There were a total of 9 teams that worked on various innovative projects such as virtual reality products, robotic process automation, artificial intelligence etc. 48% of the employees worked in such teams. Other participants had supporting roles within the department.

The daily questionnaires were completed by 78 unique participants. Eight participants completed at least one of the daily questionnaires but did not complete the general questionnaire. The daily questionnaires were filled in by respectively, 60 (47%), 49 (38%), 51 (40%), 40 (31%), and 55 (43%) participants. The response rate dropped on the second day because of some complaints on the length of the questionnaire. The fourth day had the lowest response rate because it was on a Friday, the last day before the weekend on which many people work from home. This resulted in data of 255 days. The last day, the response rate increased again because participants were notified that it was the last questionnaire. The questionnaire was filled in for one day only (n = 15), two (n = 10), three (n = 14), four (n = 17), and five days (n = 22). A total of 967 interactions were captured in the questionnaires. There were 43 recorded daily questionnaires that did not record any interactions and four questionnaires contained more than ten interactions. Most of the recorded interactions were with colleagues from inside the department (77%) and 60% was with someone who filled in the general guestionnaire. From talking to participants, possible reasons of why they did not fill in the guestionnaires were gathered: they worked part time and did not go to work that particular day, they worked somewhere else that day, they worked at another company (externally), they worked part-time, they forgot to fill it in or they did not want to participate.

2.3. Measures

The general questionnaire contained demographic, control and personal-level variables; the daily questionnaires contained the dependent variable for idea generation and variables relating to the interactions. Qualtrics software was used to construct the questionnaires and to collect the responses. A complete overview of all the questionnaire questions can be found in the Appendix A and B. This section is structured per level: personal-level, day-level and interaction-level.

2.3.1. Personal-level measures

The general questionnaire included personal-level measurements: age, gender, job function, educational background, educational level, job tenure, job experience, extraversion, self-monitoring, job autonomy, job crafting (seeking resources, seeking challenges and reducing demands) and problemsolving demands. A complete overview of the personal-level measurements can be found in Appendix A. Within this study, gender, age and problem-solving demands were used as control variables. Only a few personal-level variables were used within the analyses because the number of participants was 85 for the general questionnaire and 79 for the daily questionnaire. The other personal-level variables that were measured can be used in subsequent studies that use this data set.

Problem-solving demands. Problem-solving demands was measured with 4 items from Morgeson & Humphrey (2006). For example: "My Job involves solving problems that have no obvious correct answer". All items had responses on a 5-point Likert scale from "strongly disagree" to "strongly agree". The scale had a Cronbach's alpha of .71.

Social Network. Previous research suggests that advice networks provide with information, which is key for creativity (Ibarra & Andrews, 1993). Cross (2000) argued that advice networks can refer to one of five informational benefits people can get from each other: (1) solutions, (2) meta-knowledge, (3) problem reformulation, (4) validation and (5) legitimation. In a subsequent study Cross (2001) found that these different kinds of advice networks connect different people, resulting in different social network structures. In this study, I measured the extent to which people turn to colleagues for solutions. According to Cross (2001), this type of advice network should result in the broadest network. This type of network was chosen because multiple scholars have argued and found evidence that idea generation starts with the identification of a problem (Binnewies et al., 2007; Groenewoudt et al., 2017) and that the search for new ideas comes from searching for knowledge and skills to solve the problem (Amabile, 1988).

Every participant was asked to indicate for each colleague within the department (n = 129) the extent to which they had turned to him/her within the last month for answers to fairly specific or detailed questions at work. The response scale ranged from "I have not turned to this person during the last month" to "I have turned to this person 7 or more times during the last month". It was a challenge to create a design for this question that was easy to comprehend and would not burden the participant too much if he/she had to answer this question for all 129 colleagues. Therefore, to ease the burden on the participants and increase chances of retrieval, I created a list of all employees of the department and grouped them by team and in alphabetical order (see Appendix C). The same question was repeated 11 times for each team and once for those who did not belong to a specific team. Furthermore, the default response was set to 0 ("I have not turned to this person during the last month"), because a small test amongst the participants showed that most interactions had this result. Thus, participants only had to select a response if they did have an interaction with that colleague within the last month.

2.3.2. Day-level measures

Idea generation. Idea generation was measured each day within the daily questionnaire using self-reported measures. The three items were adapted from Tierney et al. (1999) and scaled on a 5-

point Likert scale ranging from "strongly disagree" to "strongly agree" (e.g. "Today, I generated novel, but operable work-related ideas"). The items had a Cronbach's alpha score of .70. Although work engagement and work pressure were also measured on a day-level, they were not used within this study.

Idea generation validation. To validate the measure of idea generation, the aim was to gather idea generation scores of participants from colleagues as well. In a Scrum team, the Scrum master is responsible for team management and is most likely to track the performance of their team members. Therefore, the Scrum master of each team was appointed to validate the idea generation measure. He/she was asked to estimate the idea generation of each of their team members with one item "Today, he/she generated novel, but operable work-related ideas", which corresponded with one of the self-reported measures of idea generation used as a self-report measurement. However, due to the length of the daily questionnaire, some complaints on 'rating' colleagues on performance, and confusion whether the Scrum masters also had to fill in the daily questionnaire, this questionnaire was only employed on day 1 and 5, which resulted in just 6 responses. Therefore, this measurement was not used to validate the idea generation measure.

Interactions. It was a challenge to design the questionnaire in such a way that as many work-related interactions as possible were captured without burdening the participants too much. Furthermore, the participants should be able to reliably remember the interaction in order to answer questions related to it. Therefore, the participants were asked to answer the question: "Today, who were the people you had work-related one-on-one contact with?". I limited the interactions to those that were work-related and that occurred one-on-one to facilitate retrieval of the interactions and to reduce the burden on the participants. To capture as many interactions as possible while minimizing the burden on the participants, a drop-down list was made with all employees of the department in alphabetical order (see Appendix C). Participants could list a maximum of ten interactions per day in chronological order ($M_{per day} = 3.79$, SD_{per day} = 3.11). They had the option to select a name from the drop-down list if the interaction was with a colleague from within the department ($M_{per day} = 2.91$, SD_{per day} = 2.60). Or they could type in the name of a person outside the department in an open field ($M_{per day} = .88$, SD_{per day} = 1.73). The follow-up questions concerning the interactions were only displayed if participants selected or filled in at least one name. These five follow-up questions were categorized per question and contained a list with all the names of the colleagues they interacted with.

Heterogeneity. To measure the heterogeneity of interactions during the day, the interactions per day were aggregated and linked with background information of the participant. Originally, I wanted to construct two measures of heterogeneity: 1) on the heterogeneity of interactions with respect to job functions, and 2) with respect to teams. However, because many employees within the department were not part of a team (53%) many interactions were with people from outside a team (29% of interactions) and the measurement was not as accurate as expected. A measurement of heterogeneity on job function was more accurate. Of the total 967 interactions, 22.44% were with people from outside the department and they were grouped in a separate category as it was unknown what their job function was from the data. To compute a measure of diversity the Blau index was used, which is the same measure as Gini-Simpson.

Blau index (Gini-Simpson) =
$$1 - \sum_{i=1}^{R} p_i^2$$

Because not all employees of the department filled in the general questionnaire, job functions of participants that were missing were supplemented manually. Furthermore, for each participant, the team in which they worked was added manually to the data as well.

2.3.3. Interaction-level measures

Of each interaction multiple measures were captured to gain information about the interaction itself. Those interaction-level measures were captured within the daily questionnaire.

Idea generation & Energizing. Of each interaction, I measured the degree of idea generation with one item ("During this interaction, I came up with novel, but operable work-related ideas") (Tierney et al., 1999). Furthermore, the extent to which an interaction was energizing was captured with one item ("People can affect the energy and enthusiasm we have at work in various ways. Interactions with some people can leave you feeling drained; whereas others can leave you feeling enthused about possibilities. When you interacted with each person below, how did it affect your energy level?") (Gerbasi et al., 2015).

Job crafting. Within each interaction, job crafting was measured with three distinct concepts: seeking resources, seeking challenges, and reducing demands. Often these concepts are measured with multiple items. However, to limit the burden on participants I constructed 1-item questions that try to capture all dimensions of each concept (adapted from Tims et al., 2012). Each question contains a brief explanation of each concept and a subsequent question (see Table I). These questions were tested for comprehensibility before actual data collection (n = 4). To increase clarity of the questions, important words were put in bold and were underlined.

Tie strength. According to Granovetter (1973), the strength of a tie is determined by four aspects: frequency, duration, closeness and reciprocity of the interaction. From the advice network of the general questionnaire, I generated a measure of tie strength by approximating a measure of frequency. Those responses that were collected as "I have not turned to this person within the last month", were coded as weak ties. The other responses indicated that the participants did have contact within the last month, and those were coded as strong ties. This approach was limited to one aspect that determines the strength of a tie. Reason was that participants had to answer this question for every colleague within the department (n = 129), which was already a burden on the participants.

Centrality. Centrality as a network parameter is defined in various ways, but three are most used in literature, namely, degree, closeness, and betweenness centrality. Freeman (1979) defined degree centrality as the as the number of links incident on the actor. Two separate measures of degree centrality are also used for networks with directed ties: indegree and outdegree. Indegree is the number of ties directed towards the actor and outdegree the number of ties directed towards others within the network. Closeness centrality is measured by the average length of the shortest path between the actor and all other actors within the network. Thus an individual high in closeness centrality is the closer it is to all others. Betweenness centrality refers to the number of times an actor acts as a bridge along the shortest path between two other actors.

A measure of centrality was made by computing in-degree (the number of ties received by ego) and out-degree (the number of ties initiated by ego) of the network generated by the social network of

Table I. Job crafting items.		
Variable	Variable description	Variable question
Seeking resources	Interactions or meetings can provide you with resources for your work. Resources can be anything that helps you in your work or that stimulates your personal growth or development (e.g. feedback, advice, new work-related information or social support).	To what extent did you <u>actively seek such</u> resources during the following interactions?
Seeking challenges	Interactions or meetings can bring you in to contact with challenges in your work (e.g. by exposing you to new work-related problems or more complex work tasks).	To what extent did you <u>actively seek such</u> challenges during the following interactions?
Reducing demands	Your work can be mentally, emotionally or physically straining.	To what extent did you <u>actively try to make</u> your work less straining during the following interactions?

the general questionnaire. Indegree (M = 21.65, SD = 14.47) and outdegree (M = 16.48, SD = 9.14) were highly correlated (r = 0.75, p < 0.001). This suggested that participants reciprocated that they go to each other for answers to fairly specific or detailed questions at work; when an individual turns to a certain colleague for specific solutions, this colleague is likely to go to the individual as well. Furthermore, outdegree was considered a less reliable measure of centrality because not everyone within the department filled in the general questionnaire. That means that those who did not fill it in, would receive an outdegree score of 0. On the other hand, most of the participants within the network would still get a score for indegree as they were in the list.

Group meetings and background information. Originally, the daily questionnaire contained questions relating to group meetings and to background of the interaction partner when this person was from outside the department. However, modifications to the daily questionnaire were made on the second day because participants complained on the length of the questionnaire after the first day. Initially, the questionnaire contained questions about group meetings and follow-up questions were asked regarding interactions with people from outside the department. The follow-up questions were meant to capture background information of the interaction partners such as at which department the interaction-partner worked. Potentially, ten different meetings could be listed per day and there were two follow-up questions. Those questions were removed from the questionnaire on day 2 onwards and participants remarked that the questionnaire was indeed shorter and it took them less time to complete.

2.4. Procedure

Prior to the data collection, I conducted four short unstructured interviews and two test studies for the general (n = 4) and daily questionnaire (n = 4) to ensure the most important interactions were captured and that the daily questionnaires were feasible for participants to fill in. Key criteria were that the interactions were captured as conveniently and accurately as possible and that the daily questionnaire did not burden the participants too much. I limited the number of test participants to prevent biasing the sample. Reis & Gable (2000) recommended that a daily assessment should not exceed 5-7 minutes in total. From the test results, I estimated that participants should have been able to fill in the daily questionnaire within 5-10 minutes, depending on the number of interactions they had.

First, the general questionnaire was distributed to all employees of the department. Participants were asked to agree with the informed consent form prior to data collection. The employees of the department were also notified about the research through a short presentation prior to data collection. Participants were reminded to fill in the general questionnaire twice by e-mail (one week after the start and one day after the end of data collection) and several times by the researcher face-to-face at work. Furthermore, the department was reminded each day to fill in the questionnaire via posters that were designed as a tear-off calendar and spread around the department (e.g. near the entrance or the coffee machine). The poster contained a QR-code that redirected the participants to the questionnaire. The QR code was not used by participants. The researcher himself was also around to notify people about the research and to answer questions. As a motivator, a competition was made amongst the teams that the one with the highest response rate could win.

One week after the start of the general questionnaire, the daily questionnaire was distributed via e-mail at 3 pm and filled in by the participants either at the end of the same working day or the next morning the latest. The daily questionnaire started on Tuesday to ensure data collection followed the schedule of a two-weekly Scrum Sprint that started on Tuesdays. Each team worked on their own project and sprint. Therefore, either the beginning or the end of one sprint was captured and not a switch between sprints. In the questionnaire, they were notified that all responses should refer to that particular day's experiences at work.

2.5. Data analysis

The measurements in this study were repeated at multiple levels. First of all, from the diary study the observations of each participant was repeated across days. That is to say, from each participant up to five daily observations could be gathered. A consequence of this nested structure is that observations are not statistically independent from each other. For example, the observations of the same participant are likely to be more correlated than the observations of another participant.

There was another level as each day a participant could list multiple interactions. Within each day the interactions could also be more similar to each other than on another day for another participant. As a result, the data could be nested on three levels: person-level (level 3), day-level (level 2), and interaction-level (level 1). A graphical representation of the hierarchical structure can be found in Figure 2.

Conducting an ordinary least squares (OLS) regression analysis in a diary study would be inappropriate as it does not take into account the nested structure of the data; dependency amongst observations within participants would be ignored. In OLS regression analysis it is an important assumption that there is independence of observations (Preacher et al., 2011). Ignoring nested data and analysing by means of OLS regression leads to Type I and Type II errors (Bliese & Hanges, 2004).

Multilevel modelling (MLM) is a technique to account for the dependencies within the nested structure (Snijders, 2011). Not all nested data automatically require multilevel modelling. If there is no variation between daily observations of participants, the data can be analysed using OLS regression analysis. Therefore, it is a common first step to assess the degree of nonindependence amongst observations before deciding on the analysis. Intraclass correlation (ICC) is a measure that gives an indication of the degree of nonindependence and what proportion of the total variance within idea generation could be attributed to differences between participants. Simulation studies suggest that when ICC ≤ 0.05 the data can be analysed with OLS regression analysis and higher values should be analysed with MLM techniques (Finch & French 2011).

To calculate the ICC, a null model was constructed without any predictor variables and only the intercept. After deciding whether to use MLM or the conventional OLS regression with the ICC, the subsequent step was to center the variables for correct interpretation in a multilevel analysis. Centering involves rescaling a predictor variable so that a value of zero can be interpreted meaningfully and the between and within effects can be disentangled. For example, most predictor variables that are measured on an interval scale have a score of zero that usually has no substantive meaning; these variables need to be centered. On the other hand, dummy variables typically do have a meaningful zero and do not need to be centered. There are two types of centering: grand mean centering (GMC) and centering within cluster (CWC). To illustrate how centering was done, I simplify the example to two levels: person-level (level 2) and day-level (level 1). In this case, the variables at the higher level (level 2) need to be centered using GMC and the variables at the lower level (level 1) need to be centering using CWC (González-Romá & Hernández, 2016). In addition, this MLM technique assumes that the dependent variable resides at the lowest level and cannot affect higher-level variables (Mathieu & Taylor, 2007). Table II shows how the variables were centered for the analyses and gives an overview of the study variables.

Two separate MLM analyses were conducted: 1) on day-level idea generation, and 2) on interaction-level idea generation. For each analysis I used a stepwise method of adding variables to the model and estimating the model fitness. For the analysis on day-level, subsequently to the null model were added: the control variables (model 1), number of daily interactions (model 2), and heterogeneity of interactions (model 3a). As the number of daily interactions and heterogeneity of interactions had a high correlation (r = .72, p < 0.001), a separate analysis was also conducted with heterogeneity of interactions in model 3b, without the number of interactions.

On interaction-level, to the null model were subsequently added: the control variables (model 4), centrality (model 5), weak ties (model 6), energizing (model 7), and job crafting variables (model 8). To test the hypotheses and the contribution of variables, each variable was tested for a statistically significant contribution to the model in explaining the variance in idea generation. Furthermore, for each

consecutive model a goodness of fit test was done to test if the model had improved statistically significant with respect to the previous model.



Figure 2. Graphical representation of hierarchical structure of measurements. In blue: the interactions with colleagues from within the department. In red: the interactions with people from outside the department.

Centering of variables at different levels. GMC = Grand Mean Centering. CWC = Centering Within Cluster.

Level 3: Person	Gender Age Problem solving demands	GMC GMC	Control variable (categorical) Control variable Control variable
Level 2: Day	Vigour Creativity	CWC	Control variable daily analyses Dependent variable
	Number of interactions Heterogeneity	CWC CWC	Independent variable daily analysis (aggregated measure) Independent variable daily analysis (aggregated measure)
	Weak ties Centrality	CWC	Independent variable interaction analysis (categorical) Independent variable interaction analysis
Level 1: Interaction	Seeking resources Reducing demands Seeking challenges Energizing	CWC CWC CWC CWC	Control variable interaction analysis Control variable interaction analysis Control variable interaction analysis Control variable interaction analysis

3. Results

The results section was divided into two separate parts. First, the results at a day-level were reported to test hypotheses 1 and 2 (section 3.1). Second, the results at an interaction-level were reported to test hypotheses 3 and 4 (section 3.2).

3.1. Day-level

3.1.1. Social networks & In-degree.

Before conducting the analyses for testing hypotheses 1 and 2 at a day-level, the results of the advice network were inspected. In Figure 3, the advice network from the general questionnaire was visualized. The results of this network were used to calculate the in-degree for each participant. The size of the node indicates the level of in-degree; bigger nodes have a higher in-degree. Remember that this advice network was based on the question: "To what extent have you turned to the following people within the last month for answer to fairly specific or detailed questions at work". Thus, nodes with a high in-degree are employees who colleagues turn to for specific or detailed questions. The colour of the node represents the job function. Interestingly, nodes bigger in size seemed to be the job functions related to Lead, Product owner and some to supporting roles. Indeed, in Figure 4 the in-degree was

Table II.

averaged per job function and the results showed that Leads and Product owners had higher in-degree scores. For the supporting roles this was not the case because although there were some participants that had supporting roles that were high in in-degree there were also those that were low in in-degree and the results were averaged across participants with the same job function.

In the Appendix D additional visualizations were added that were not of specific interest within this study but could give a more complete picture of the networks that were generated from the data. Within Appendix D, first, a visualization of the advice network can be found that shows the information flow between teams instead of job functions. Results from this visualization showed that many participants did not belong to a Scrum team but were involved in many interactions. Second, the same advice network was visualized but categorized by which participant filled in the general questionnaire with separate colours. The results of this visualization showed that employees who did not fill in the general questionnaire and thus the question for the advice network, typically had a lower in-degree score, which was as expected. Furthermore, a network of who interacted with whom could also be visualized per day. The results can be found in the Appendix D. Although the results of the daily networks were not used directly in this specific study, the visualizations can give insights into the interactions between employees and their job function.



Figure 3. Visualization of the advice network generated with the social network question within the general questionnaire. Each colour represents a distinct job function (a legend can be found in the Appendix D). The circles represent the nodes of the network, with each node referring to a unique participant. The lines between nodes represent the ties that connect the different nodes; a tie means that two nodes had contact with each other for answers to fairly specific or detailed questions at work. Size of the nodes indicate the degree of indegree.



Figure 4. The average in-degree per job function.

3.1.2. Heterogeneity of interactions

A bar chart was made depicting the percentage of interactions that were with a certain type of job function. The results can be found in Figure 5. Because not all types of job functions were distributed evenly within the original sample, the percentage of type of job functions within the original sample was added. Therefore, a comparison could be made between the percentage of each job function within the original sample and the percentage of each job function that occurred within the interactions. For example, within the original sample 33.3% of the participants had a supporting role and 15.8% of the interactions that were captured within the diary study were with participants that had a supporting role. On the other hand, only 2.3% of the original sample had a Lead job function but 5.6% of the interactions were with them. This gives some idea of which job functions had the most interactions. However, it was unknown whether these results were due to not filling in the daily questionnaires or that indeed the number of interactions was lower and higher respectively than one would expect based on the original sample. Results also showed that 22.4% of the interactions occurred with colleagues that were not from within the same department and, therefore, it was unknown what their job function was; these interactions were grouped in a separate category.

In Figure 6 a scatterplot of idea generation and heterogeneity of interactions can be found. A quick glance at this scatterplot does not unveil any pattern between the heterogeneity of interactions and idea generation. However, the plot shows that many of the daily interactions had a score of 0 because either there were no interactions or there was no diversity within the interactions. This might explain why the number of interactions and the heterogeneity of interactions correlated highly (r = .72, p < 0.001); when there were no interactions the heterogeneity of interactions was also 0 (see Table III).



Figure 5. Comparison between the percentage of each job function within the original sample and within the interactions.



Figure 6. Scatter plot of idea generation at a day-level and heterogeneity of interactions.

Means, standard deviations and correlations for study variables at day-level.									
Variable	Mean	SD	1	2	3	4	5	6	
1. Idea generation	3.35	.70							
2. Number of Interactions	3.79	3.11	.16**						
3. Heterogeneity	.39	.33	.23***	.72***					
4. Vigour	3.64	.92	.32***	02	.06				
5. Gender ^a	1.48	.50	01	.01	08	.07			
6. Age ^a	34.30	8.98	13*	13*	.05	.05	01		
7. Problem solving demands ^a	4.35	.49	.07	.15*	08	07	04	10	
							(70) 0		

Notes: correlations are on day-level, averaged across all five days (n = 255), except for the correlations marked with ^a (n = 73). Gender was coded 1 for male and 2 for female.

3.1.3. Temporal patterns.

Table III

Temporal patterns were investigated because the data was gathered across days. Figure 7 shows a visualization of the temporal patterns of the study variables for the analysis on day-level. A quick glance on the visualization suggested there was little reason to believe there was variance within the study variables across days. The only study variable that did seem to show some variation across days is the number of interactions per day. This pattern followed a similar pattern as the number of completed questionnaires per day, which was the lowest on Friday. Besides, the number of employees working at the office was typically lowest on Fridays as many people work from home or take a day off. Combined with the effect that questionnaire responses typically drop after the first day, it seemed logical to assume that the number of interactions per day showed a similar pattern as the number of employees working at the office; if there were more people working at the office there was a higher chance of social interactions. To investigate whether the variance within the study variables was not attributional to the variance across days, one-way ANOVA analyses were conducted for each study variable. The variables were averaged per day (Idea generation F(4, 255) = .72, p = .58; interactions F(4, 255) = 1.80, p = .13; heterogeneity F(4, 255) = 1.11, p = .35; vigour F(4, 255) = .80, p = .53). The results of these analyses showed that the variance within the study variables was not attributable to the day the data was collected.



Figure 7. Temporal patterns for study variables at day level. *Note:* for each working day the means of the study variables were calculated across participants.

3.1.2. Hypotheses testing 1 & 2, day-level

The results of the multilevel models were depicted in various tables. First, in Table III the means, standard deviations, and correlations amongst the study variables that were averaged across days can be found. In Table IV an overview can be found of the different models that were tested. Within this table the intraclass correlations at a personal and day-level can be found and the model fitness of the different models. In Table V, the first two models (model 1: intercept and control variables; model 2: contains model 1 and number of interactions) and their results were summarized. In Table VI the effect of heterogeneity was tested in two separate models 3a (with number of interactions and heterogeneity combined) and 3b (only heterogeneity of interactions). Within these tables a distinction was made between fixed and random variables and within and between effects, because the variables were centered and the effects could be distinguished between effects that were due to differences between participants and within participants. Of importance within this study were the within effects; the effects that varied within participants. Therefore, in Tables V and VI it is important to look at the fixed effects that differ within participants that are described as "fixed effects (within)" in the multilevel model tables. Furthermore, each model had residual variances at two levels: level 1 (σ_e^2) and level 2 (σ_u^2). The residual variance gives an indication of how much variance at each level is still unexplained. At level 2 this means that the variance that is still unexplained resides between participants. At level 1, this means that the variance that is still unexplained resides within participants. As of main interest where the within effects, the most important residual variance was that of level 1.

To decide which statistical modelling technique to use for the analyses, a null model was made containing only the intercept and a nesting at either personal-level or day-level (see Table IV). The results showed that 32% of the variance within idea generation per day was attributable to variations among participants (ICC = .32) and less than 1% was attributable between days (ICC = .01). Therefore, a decision was made to conduct multilevel modelling with clustering at the personal level.

Model 1 contained the control variables age, gender, vigour and problem solving demands. The model results are depicted in Table 6 and did not show that problem solving demands predicted idea generation at a day level (B = .15, z = 1.27, p = .21). However, feeling vigorous (within effect) did seem to predict idea generation (B = .13, z = 2.25, p = .02).

To test hypothesis 1 that stated that a higher number of daily interactions has a positive influence on daily idea generation, the variable for number of interactions was added in model 2 which can be found in Table V. Indeed, the number of daily interactions did seem to contribute statistically significant to predicting idea generation (B = .07, z = 3.44, p < .01). Model 2 also improved the model fit (Δ -2LL = 12.33, p < .001, $\sigma_e^2 = .31$).

In model 3a, the heterogeneity of the daily interactions was entered to test hypothesis 2 that stated that the higher the degree of heterogeneity the higher the degree of idea generation per day (Table VI). This model did not show evidence that the heterogeneity of interactions did predict idea generation (B = .14, z = .54, p = .59). The model fit also did not improve statistically significant ($\Delta -2LL = 3.82$, p > .05, $\sigma_e^2 = 31$). However, the model did show that the number of interactions contributed statistically significant (B = .06, z = 2.08, p < .05). In Table III it was found that the number of interactions and the heterogeneity of interactions correlated strongly (r = .72, p < .001); making it is difficult to disentangle the effects of these independent variables. Therefore, in model 3b, the heterogeneity of interactions did significantly contribute to predicting idea generation (B = .48, z = 2.77, p < .01).

Table IV.

Idea generation			
Models	-2Log Likelihood	Df	Δ -2LL (=Δ χ2)
Null model (intercept only)			
Level 3 (person-level) ICC = 0.32	513.68		
Level 2 (day-level) ICC < 0.01	540.09		
Model 1 (intercept + controls)	459.61	5	54.07**
Model 2 (Model 1 + number of interactions)	447.28	2	12.33***
Model 3a (Model 2 + heterogeneity)	443.46	2	3.82
Model 3b (Model 1 + heterogeneity)	448.42	2	11.19***

Notes: * p < 0.05, ** p < 0.01, *** p < 0.001 (two-tailed)

Table V.

Multilevel estimates for predicting creativity at a day-level.

Model		1 (null model)			2 (number of interaction			
Variables	В	SE	Z	В	SE	Z		
Intercept	2.05	0.32	6.46***	1.95	0.33	5.88***		
Fixed effects (between)								
Age	-0.01	0.01	-1.97	-0.01	0.01	-1.82		
Gender	-0.08	0.11	-0.75	-0.08	0.11	-0.76		
PSD	0.15	0.12	1.27	0.14	0.12	1.11		
Vigor	0.39	0.06	4.98***	0.40	0.08	5.10***		
Number of interactions				0.02	0.02	0.91		
Fixed effects (within)								
Vigour	0.13	0.06	2.25*	0.09	0.06	1.61		
Number of interactions				0.07	0.02	3.44**		
Random effects								
Residual variance level 2 ($\sigma_u^2)$		0.09			0.09			
Residual variance level 1 (σ_e^2)		0.33			0.31			
n of observations		239			239			

Notes: PSD = problem-solving demands, * p < 0.05, ** p < 0.01, *** p < 0.001 (two-tailed)

Table VI.

|--|

Model	3	3a (heterogeneity)			3b (heterogeneity)			
Variables	В	SE	Z	В	SE	Z		
Intercept	1.92	0.33	5.90***	1.87	0.32	5.83***		
Fixed effects (between)								
Age	-0.01	0.01	-1.41	-0.01	0.01	-1.46		
Gender	-0.04	0.11	-0.34	-0.05	0.10	-0.48		
PSD	0.19	0.12	1.52	0.15	0.12	1.33		
Vigour	0.37	0.08	4.71***	0.38	0.08	5.01***		
Number of interactions	-0.03	0.03	-0.83					
Heterogeneity	0.63	0.24	1.90	0.42	0.21	1.96*		
Fixed effects (within)								
Vigour	0.10	0.06	1.64	0.12	0.06	2.00*		
Number of interactions	0.06	0.03	2.08*					
Heterogeneity	0.13	0.24	0.54	0.48	0.18	2.77**		
Residual variance level 2 (σ_u^2)		0.08			0.08			
Residual variance level 1 (σ_e^2)		0.31			0.32			
n of observations		239			239			

Notes: PSD = problem-solving demands, * p < 0.05, ** p < 0.01, *** p < 0.001 (two-tailed)

3.2. Interaction-level

3.2.1. Temporal patterns

Again, temporal patterns of the study variables were investigated before conducting the analyses (see Figure 8). A quick glance at the visualization showed that the variables were measured relatively stable across days and the differences were rather small. To investigate whether the variance within the study variables was not attributional to the variance across days, one-way ANOVA analyses were conducted for each study variable that was averaged per day (Idea generation F(4, 963) = 1.25, p = 0.29; indegree F(4, 722) = .88, p = .47; weak ties F(4, 693) = 1.11, p = .07; energizing F(4, 962) = 2.11, p = .08; seeking resources F(4, 959) = 3.44, p < 0.01; seeking challenges F(4, 959) = .99, p = .41; reducing demands F(4, 954) = 3.38, p < .01). The results showed that only the variance within seeking resources and reducing demands were attributable to the day the data was collected.



Figure 8. Temporal patterns of study variables at interaction-level.

Note: for each working day the means of the study variables were calculated across participants.

Table VII.

Means, standard deviations and correlations for study variables at interaction-level.												
Variable	М	SD	1	2	3	4	5	6	7	8	9	
1. Idea generation	3.56	0.76										
2. Indegree	18.23	9.36	05									
3. Weak tie	0.13	0.34	05	06								
4. Energizing	3.85	0.65	.32***	01	.002							
5. Seeking resources	3.43	0.94	.32***	.01	.05	.32***						
6. Seeking challenges	3.38	0.81	.42***	01	03	.14***	.43***					
7. Reducing demands	3.21	0.87	.25***	03	.03	.08**	.31***	.25***				
8. Gender	1.48	0.50	03	.03	.14	.06	001	.04	.02			
9. Age	34.30	8.96	05	.13**	.08*	.06	06	09**	04	01		
10. Problem solving demands	4.35	0.48	12***	.12**	.001	03	12***	06	16***	04**	10***	

Notes: * p < 0.05, ** p < 0.01, *** p < 0.001 (two-tailed)

3.2.2. Hypotheses testing 3 & 4, interaction-level

The results of the multilevel models were depicted within various tables. Table VII shows the means, standard deviations and correlations amongst the study variables. Table VIII shows an overview of the models at interaction-level, it shows the intraclass correlations and the model fits. Tables IX and X show the results from the models at interaction-level. Models 7, 8, and 9 were summarized in Tables X and XI and are discussed in the additional analyses. These tables can be interpreted in the same manner as the tables of the analyses at day-level; a focus on the "*fixed effects (within)*" and the residual variance at level 1.

First, null models were compared with nesting at different levels to investigate whether multilevel modelling was appropriate and at which levels (see Table VIII). The results showed that 15% of the variance within idea generation per interaction was attributable to variations between participants (ICC = .15), less than 1% was attributable to variations between days (ICC < .001), and 24% to variations between interactions (ICC = .24). Because the variance was mainly at the personal-level and interaction-level but not on day-level, I made the decision to use a two-level model with a nesting on the personal-level. This approach is typical for event sampling studies (Ohly et al., 2010). Furthermore, I did not include any predictors at a day-level. Therefore, the fixed between effects in each table represent the differences between participants and the fixed within effects the difference within participants. Of main interest were the fixed within effects.

Model 4 contained the control variables age, gender and problem solving demands (see Table IX). The model did not show that problem solving demands predicted idea generation at an interaction level (B = -.19, z = -1.87, p = .06). This meant that the differences between participants on problem solving demands did not predict idea generation with a statistically significant effect.

In model 5, the variable for indegree was added to see whether an interaction with someone who is more central within the network leads to a higher idea generation and test hypothesis 3. The results are summarized in Table IX and one should focus on the fixed within effect of indegree; the differences within participants. The results did not support hypothesis 3 because the predictor variable for indegree did not show a statistically significant result (B = <-.01, z = -1.23, p = .22). However, there was a rather contradictory result showing a significant improvement in model fit with respect to model 1 ($\Delta -2LL = 571.69$, p < .001, $\sigma_e^2 = .46$). Furthermore, the residual variance at level 1 (within participants) decreased from 0.50 to 0.46. This suggests that indegree explains some of the variance within idea generation.

In model 6, the variable for weak ties was added to test hypothesis 4: whether interactions with weak ties lead to higher idea generation (see Table X). Because the variable for weak ties was coded as a dummy variable, this variable was not centered. The results did not find support to assume that a contact that is considered a weak tie leads to higher idea generation (B = -.12, z = -1.40, p = .16). This result was also reflected in a non-significant result of improvement in model fit ($\Delta -2LL = 1.94$, p > 0.05, $\sigma_e^2 = .45$).

Table VIII.

Differences in model fit for predicting creativity at an interaction-level.

Idea generation			
Models	-2Log Likelihood	Df	Δ -2LL (=Δ χ2)
Null model (intercept only)			
Level 3 (person-level) ICC = 0.15	2142.35		
Level 2 (day-level) ICC < 0.001	2202.31		
Level 1 (interaction-level) = 0.24	2111.03		
Model 4 (intercept + controls)	2029.74	3	112.61***
Model 5 (Model 4 + indegree)	1458.05	2	571.69***
Model 6 (Model 5 + weak ties)	1456.11	1	1.94
Additional analyses:			
Model 7 (Model 6 + energizing)	1378.80	2	77.31***
Model 8 (Model 7 + resources + demands + challenges)	1222.80	6	156.00***
Model 9 (Model 6 + resources + demands + challenges)	1283.31	6	172.80***

Notes: * p < 0.05, ** p < 0.01, *** p < 0.001 (two-tailed)

Table IX.

Multilevel	estimates f	or predicting	idea	deneration at	an inter	oction-level
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Model		4 (null model)			5 (indegree)	
Variables	В	SE	z	В	SĔ	z
Intercept	3.51	0.14	24.65***	3.54	0.25	14.10
Fixed effects (between)						
Age	<0.01	0.01	-0.58	<-0.01	0.01	-0.70
Gender	0.03	0.09	0.36	0.03	0.11	0.23
PSD	-0.19	0.10	-1.87	-0.20	0.12	-1.62
Indegree				<-0.01	0.01	-0.13
Fixed effects (within)						
Indegree				<0.01	<0.01	-1.23
Random effects						
Residual variance level 2 ($\sigma_u^2)$		0.09			0.12	
Residual variance level 1 (σ_e^2)		0.50			0.46	
n of observations		912			673	

Notes: PSD = problem-solving demands, * p < 0.05, ** p < 0.01, *** p < 0.001 (two-tailed)

Table X

Multilevel estimates for predicting idea generation at an interaction-level (continue)

Model		6 (weak ties)	,		7 (energizing)	
Variables	В	SE	Z	В	SE	Z
Intercept	3.57	0.25	14.11	1.32	0.58	2.29
Fixed effects (between)						
Age	<-0.01	0.01	-0.61	-0.01	0.01	-1.57
Gender	0.04	0.11	0.32	-0.04	0.10	-0.40
PSD	-0.20	0.12	-1.58	-0.24	0.11	-2.23
Indegree	<-0.01	0.01	-0.24	0.01	0.01	0.81
Energizing				0.56	0.13	4.20***
Fixed effects (within)						
Indegree	<-0.01	<0.01	-0.24	<-0.01	<0.01	-1.60
Weak	-0.12	0.09	-1.40	-0.11	0.08	-1.28
Energizing				0.38	0.05	8.17***
Random effects						
Residual variance level 2 ($\sigma_u^2)$		0.13			0.13	
Residual variance level 1 ($\sigma_e^2)$		0.45			0.41	
n of observations		673			673	

Notes: PSD = problem-solving demands, * p < 0.05, ** p < 0.01, *** p < 0.001 (two-tailed)

Table XI.

Multilevel estimates for predicting idea generation at an interaction-level (continue)

Model		8 (job crafting)			9 (job crafting)	
Variables	В	SE	z	В	SE	z
Intercept	0.72	0.54	1.33	1.52	0.37	4.14
Fixed effects (between)						
Age	<-0.01	0.01	-0.31	<0.01	0.01	0.38
Gender	-0.05	0.08	-0.63	-0.03	0.09	-0.38
PSD	-0.07	0.10	-0.70	-0.04	0.10	-0.43
Indegree	0.01	0.01	0.85	<0.01	0.01	0.40
Energizing	0.28	0.14	1.95			
Seeking resources	0.05	0.10	0.44	0.10	0.11	0.92
Reducing demands	0.25	0.08	3.14**	0.28	0.08	3.31**
Seeking challenges	0.22	0.11	2.04*	0.24	0.11	2.11*
Fixed effects (within)						
Indegree	-0.01	<0.01	-1.86	<0.01	<0.01	-1.66
Weak	-0.06	0.08	-0.79	-0.07	0.08	-0.92
Energizing	0.34	0.04	7.76***			
Seeking resources	0.02	0.03	0.48	0.08	0.03	2.21*
Reducing demands	0.17	0.03	4.85***	0.15	0.04	4.18***
Seeking challenges	0.31	0.04	7.91***	0.30	0.04	7.56***
Random effects						
Residual variance level 2 ($\sigma_u^2)$		0.06			0.06	
Residual variance level 1 (σ_e^2)		0.33			0.37	
n of observations		668			668	

Notes: PSD = problem-solving demands, * p < 0.05, ** p < 0.01, *** p < 0.001 (two-tailed)

3.3. Additional analysis

In model 7 (see Table X), the effect of an energizing interaction was added and this proved to be a significant result (B = .56, z = 4.20, p < 0.001) and a significant improvement in model fit (Δ -2LL = 77.31, p < 0.01, $\sigma_e^2 = .41$). In model 8 (see Table XI), the three job crafting variables were added, resulting in a significant result for reducing demands (B = .17, z = 4.85, p < 0.001) and seeking challenges (B = .31, z = 7.91, p < 0.001) and an overall improvement in model fit (Δ -2LL = 156, p < 0.001, $\sigma_e^2 = .33$). Seeking resources was not significant, but a possible explanation might be that one gets energized by job crafting. Therefore, in model 9 the effect of job crafting was tested without energizing (see Table XI). Indeed, in that case seeking resources had a statistically significant effect on idea generation (B = .08, z = 2.21, p < 0.05) and a statistically significant improvement in model fit ($\Delta - 2LL = 172.80$, p < 0.001, $\sigma_e^2 = .37$).

The results from these additional analyses should be interpreted with caution. Although the results suggest that energy levels and job crafting play a role in idea creation, these results were found within the additional analyses that were conducted after the original hypotheses test with the data that was available. A consequence of repeated testing of predictor variables is that the likelihood of finding an erroneous significant effect increases. This means that, although for each individual test the alpha level was set to 5%, with each test the chances increase that an erroneous significant result was found. A common way to deal with repeated tests and to correct for the increase in likelihood of error, is the Bonferroni correction. Within this method the desired p-value (e.g. 5%) is divided by the number of tests that were conducted.

4. Discussion

The aim of this study was to examine work-related interactions influence workplace idea generation. This research was studied at a day and interaction-level. At a day-level, it was hypothesized (1) that the number of daily interactions has a positive effect on daily idea generation and (2) the heterogeneity of these interactions has a positive effect on daily idea generation. At an interaction-level, it was hypothesized that (3) interactions with colleagues that were considered a weak tie has a higher positive effect on idea generation than an interaction with a strong tie and (4) interactions with colleagues higher in centrality results in a higher degree of idea generation. Data was gathered within an innovation department of a large airline company by conducting a one-time cross-sectional (general) questionnaire and dairy study consisting of five daily questionnaires. The results of this study are discussed in this section.

First, at a day-level it was hypothesized (1) that the number of daily interactions has a positive effect on daily idea generation. The results of this study supported this hypothesis, suggesting that when employees have more interactions during the day they have a higher degree of daily idea generation. Therefore, this result is in line what has been previously found on literature about the effects of the social context on creativity (Amabile, 1996; Burt, 2004).

Second, at the same level, it was hypothesized (2) that the heterogeneity of these interactions has a positive effect on daily idea generation. The results of this study rejected this hypothesis, suggesting that the diversity within the interactions does not result in a higher degree of idea generation – not with respect to diversity of job functions. Previous research found that especially novel and heterogeneous information is useful for generating new idea because it allows individuals to combine and compare information (Burt, 2004). It was expected that days that had more heterogeneous interactions should lead to a higher degree of idea generation; this result was not found. One possible explanation for not finding this result is discussed within the limitations.

At an interaction-level, it was hypothesized (3) that interactions with colleagues that were considered a weak tie has a higher positive effect on idea generation than an interaction with a strong tie. Results of this study did not find supporting evidence, suggesting that it does not matter whether the interaction is with someone who is a weak tie or a strong tie with respect to idea generation within an interaction. Within this study, it was argued that weak ties were those interactions that could contain

diverse and non-redundant information and could, therefore, foster idea generation. One explanation for not finding this result could be that the impact of the weak ties was not strong enough. Only 13% of the interactions were with weak ties. That interactions with weak ties would not occur as much, was as expected but perhaps the effect of such an interaction is not profound enough to lead to a higher idea generation than an interaction with a strong tie. Furthermore, within this study the strength of ties was determined by the frequency of interactions; an interaction was considered a weak tie when the two interaction partners had not turned to each him/her for answers to fairly specific or detailed questions at work within the last month (referring to the question about the advice network). However, according to a study performed by Marsden & Campbell (1984), measures of closeness or intensity were the best indicators of tie strength and frequency exaggerated the strength of ties. Indeed, scholars have argued that inconsistencies in how tie strength has been measured may explain the mixed results for weak ties in the literature (Brown & Konrad, 2001).

At an interaction-level it was also hypothesized (4) that interactions with colleagues higher in centrality results in a higher degree of idea generation. Contrary to expectations, results did not show that interactions with colleagues higher in centrality lead to a higher degree of idea generation. It was argued that interactions with people that are higher in centrality have more access to socially distant circles and can, therefore, provide with more diverse perspectives. A possible explanation for not finding the effect at this level could be that an interaction with someone high in centrality does not tap into the benefits of having a central position. Someone who is high in centrality could have access to different social circles but those social circles cannot be accessed during the interaction. Literature...

An interesting but not completely surprising result was that levels of energy throughout the day and during interactions was a stable effect for predicting idea generation at both a day-level and an interaction-level. At a day-level, the results did show that vigour has an effect on idea generation suggesting that employees that feel energized and enthused during the day and during interactions have higher levels of idea generation. This result is consistent with previous research suggesting that generating ideas requires high levels of effort and persistence (Amabile, 1988) and it entails hard work (George & Zhou, 2002). Furthermore, having high levels of energy has been suggested to stimulate creative behaviour at work (Sonnentag & Niesen, 2008).

Interestingly vigour was statistically significant when number of interactions was not included in the model – at a day-level analysis. By adding the number of interactions the effect of level of vigour disappeared. This could suggest that the degree of vigour is related to the number of interactions; a higher number of interactions requires a higher degree of vigour. Thus, this could imply that vigour has an indirect effect on idea generation because the interactions require energy.

A similar result was found at an interaction-level. Results also showed that the energy level of interactions predicted the degree of idea generation, suggesting that interactions that are energizing also are the interactions that have a higher degree of idea generation. Interestingly, seeking resources was not a statistically significant effect on idea generation when levels of energizing was included in the analyses. By removing the variable for energy level of interactions, the effect of seeking resources was significant. This result suggests that interactions that are more energizing are probably also the interactions that provide one with opportunities to manage their resources. Moreover, from the additional analyses, the results reserve a central role for job crafting in relation to idea creation. It seems that higher levels of job crafting are related to higher levels of idea generation.

4.1. Practical implications

For business, the results could help to understand how idea generation during the day and during interactions can be fostered. This is important because creative employees suggest useful products and improvements that could contribute to the firm's performance and especially for an innovation department. The results from this study help us understand how social interactions influence idea creation across days and during interactions. Employers and employees could use this information to shape the conditions of a day and interactions in such a way that they foster idea creation. The results suggested that the interactions during the day indeed influence the creative output of employees.

Important within those interactions is the energy levels within those interactions and the energy levels during the day. Therefore, organizations could try to foster interactions amongst their employees. They could design the office in such a way that employees meet each other regularly, for example, with an open office or at the coffee machine and at informal sit areas. Results also showed that interactions with colleagues that are energizing interactions or provide with opportunities for job crafting lead to higher degrees of idea generation. Therefore, employees should try to keep the interactions energized for example by having the meetings while standing or through energizing exercises. Having open discussions about work demands can stimulate job crafting which can also lead to a higher degree of idea generation.

4.2. Limitations & Future research

Findings from the present study provide evidence that more interactions during the day influence higher degrees of idea generation across days. However, the results were inconclusive whether the heterogeneity of those interactions was also a factor. A remark has to be made about the measurement of heterogeneity by job functions. It was expected that most of the participants within the sample would have job functions corresponding to those of a Scrum-way-of-working. The results showed that 52% did not work in Scrum teams and had other job functions that were related to supporting roles. Those job functions were not further specified in this study resulting in a measurement that was not as accurate as expected. However, the biggest obstacle to distinguish between the effects was that heterogeneity and number of interactions correlated. This study was conducted within an environment that was highly diverse with multidisciplinary teams and highly diverse job functions. Therefore, most interactions that did occur were with people with another job function and thus diverse. This probably explains why the number of interactions and the heterogeneity of those interactions were highly correlated. One way to solve this issue is to conduct the same study within an environment that is less diverse. Another is to categorize the job functions that are more or less the same; categorizing them in such a way that each different category represents a different social circle which could contain non-redundant information. On a positive note, the results showed that most interactions were highly diverse and thus, that most participants did not work in isolation without discussing work with other colleagues. Future research could investigate into more detail how different types of diversity measures could affect the creativity process. For example, diversity can be related to different concepts (e.g. related to diversity of teams instead of job functions) or measured with different diversity indices.

The interactions that were captured in this study were focused on those that were one-to-one, work-related and lasted at least ten minutes with a maximum of twenty interactions. This was done to facilitate retrieval of the most important interactions and to limit the daily burden on the participants. However, other one-on-one meetings that were not work-related or lasted less than ten minutes could have had an effect on idea generation as well. For example, meetings that are not about work could provide one with completely different insights and interactions that lasted less than ten minutes could be more spontaneous and lead to serendipity perhaps.

At the beginning of this study, group meetings were captured as well within the daily questionnaire. However, after the first day participants complained about the duration of the daily questionnaire and therefore questions related to the meetings were removed. Those group meetings could have had an effect on idea generation because during group meetings problems and ideas could be discussed and shared as well. On the other hand, by removing those extra questionnaires the participants perceived the questionnaire less as a burden and were encouraged to fill in the questionnaires the rest of the days as well. Otherwise, participants might have dropped even further, excluding some important participants within this study. Future research could focus on other types of interactions to investigate how these interactions affect creativity. For example, it could focus more on the other meetings that are less formal, more spontaneous and include group meetings to study the effect of those interactions on idea generation.

Another limitation within the measurement was the discrepancy within the two survey methods. Within this study, personal-level variables of the participants and network parameters were captured

within the general questionnaire; the daily interactions were captured within the daily questionnaires. This was done to reduce the daily burden on the participants. Although everyone from the same department was asked to participate in this study and both types of questionnaires, not everyone who filled in the general questionnaire filled in the daily questionnaire and vice versa. As a consequence, some of the interactions did not contain information about social network parameters and were excluded from the analyses. Furthermore, separating the questionnaires increased the complexity of combining and analysing the data, making the process more prone to errors.

Creativity is a construct that consists of different concepts and can be measured in many different ways. Idea generation was measured using a self-report measurement; a participant could indicate the extent to which they were generating novel but operable ideas on a five-point Likert scale. On a day-level, this construct was measured using three items and at interaction-level with one. There are, however, different ways in which idea generation could be measured. For example, by measuring the number of ideas, assessing the quality of the ideas or by letting someone else give a score of idea generation. Within this study, initially, the Scrum masters were asked to validate the self-reported measurements of idea generation on a day-level. However, practice proved that Scrum masters were already occupied by the daily questionnaire and it was confusing for them to fill in two questionnaires per day. Therefore, priority was given to the daily questionnaire over the validation questionnaire. Consequently, the validation measurement was removed from this study.

In this study, a decision was made to limit the measurement to the first stage of a creative process, namely idea generation and excludes, for example, the idea validation phase. Social network measurements were proven to have different effects on the different stages of the creative process. For example, Ohly et al. (2010) suggested that network structures most beneficial for idea generation might be different from idea implementation. Thus, the results of this study can be different when another stage of the creative process is studied as the outcome.

The social network parameters in this research were derived from a certain type of advice network. This network was generated upon a network of colleagues that asked each other for advice on solutions to problems (Cross, 2000) and specifically within the last month. However, Cross (2000) found that people helped other people in five unique ways of which solutions to problems is only one. Each type of advice generates a different type of social network and thus results in different social network parameters, for example, the centrality parameter. Therefore, future research could look into more detail how the different types advice networks as specified by Cross (2000) could affect the different stages of the creativity process.

Network overlap could also be an issue when a multilevel modelling approach is used. By conducting a multilevel modelling approach, this study assumed that the network overlap was neglectable. A Bayesian approach takes into account that there is network overlap and thus that each alter can affect multiple egos (Browne, Goldstein & Rasbach, 2001).

The influence of personal characteristics on creativity was limited within this research. Future research could also elaborate on the effect of personal characteristics on idea generation and the interaction between personal characteristics and social network parameters, taking an interactionist perspective (Zhou & Hoever, 2014). Research has shown that both factors that are inherent to the actor and those inherent to the context influence creativity. Studying both factors in a single study can give a richer understanding of how actor and context interact. For example, it could have been interesting to investigate whether the type of job moderates the effect of social interactions on creativity. In this study, personal characteristics were limited to a couple of control variables because the number of unique participants was not high enough to conduct statistical analyses reliably at a personal level (n = 79).

5. Conclusions

The importance of having creative employees to foster a competitive and sustainable business has been established. As Steve Jobs said, this creativity comes from interactions with others and can be fostered with constructing inviting meeting places. Results from this research support this notion. The current study was aimed to investigate the influence of work-related interactions on workplace

creativity by specifically focusing on the interactions themselves and during the day. Results support the idea that the number of interactions during the day positive influences the degree of idea generation. Nonetheless, heterogeneity of those interactions with respect to diversity in job functions was not found to influence the degree of idea generation. Furthermore, contrary to expectations, the centrality of the interaction partner or the strength of the tie between partners was not found to influence the degree of idea generation at an interaction-level. Results did reserve a central role for energy levels during the day and during interactions and for job crafting opportunities within the interactions. Combining this research with future research on the influence of different aspects of the interactions themselves on creativity, both research and business can gain a better understanding of how the social interactions influence employees' creativity. As a consequence, this leads to higher innovation outputs and a more competitive and sustainable business.

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Appendix A. Scales – General questionnaire

	Question/Statement	Answer format
1.	What is your age?	Open field
2.	What is your gender?	Male/Female
3.	What is the highest form of education you have completed?	Primary education, secondary education, Bachelor degree,
4	(Oldnam & Cummings, 1996) What is the background of your bighest completed degree?	Master degree.
4.	(Cannella et al. 2008)	Aits, Sciences, Engineering, Business, Law, Other
5.	What is your iob function?	Product owner, scrum master, developer, architect, analyst,
•.		tester, service designer, product designer, communications,
		lead, business developer, intern, other
6.	How many hours per week do you work for [this company]	Open field
7	according to your contract?	
γ. ο	How many years are you employed by [this company]	Open field
0. 9	Before you went to this department, did you have another job at	Yes/No
•	another department within this company?	
40	Extraversion. (5-items) (not used)	
10.	I feel comfortable around people	1 strongly disagree – 5 strongly agree (5-point Likert scale)
12	I make friends easily	1 'strongly disagree' – 5 'strongly agree' (5-point Likert scale)
13.	I am the life of the party	1 'strongly disagree' – 5 'strongly agree' (5-point Likert scale)
14.	I know how to captivate people	1 'strongly disagree' - 5 'strongly agree' (5-point Likert scale)
	Self-monitoring (13-items) (adapted from Lennox & Wolfe, 1984)	
15	Ability to monitor self-presentation (7-items) (not used)	1 (strongly disagree) 5 (strongly agree) (5 point Likert scale)
15.	that something else is called for	stioligiy disagree - 5 stioligiy agree (5-point Likert scale)
16.	I have the ability to control the way I come across to people.	1 'strongly disagree' – 5 'strongly agree' (5-point Likert scale)
	depending on the impression I wish to give them.	5) 5 - 5) 5 (effectively)
17.	When I feel that the image I am portraying isn't working, I can	1 'strongly disagree' – 5 'strongly agree' (5-point Likert scale)
40	readily change it to something that does.	
18.	I have trouble changing my behavior to suit different people and different situations. (reverse coded)	1 'strongly disagree' – 5 'strongly agree' (5-point Likert scale)
19	L have found that I can adjust my behavior to meet the	1 'strongly disagree' – 5 'strongly agree' (5-point Likert scale)
10.	requirements of any situation I find myself in.	
20.	Even when it might be to my advantage, I have difficulty putting up	1 'strongly disagree' – 5 'strongly agree' (5-point Likert scale)
	a good front. (reverse coded)	
21.	Once I know what the situation calls for, it's easy for me to regulate	1 'strongly disagree' – 5 'strongly agree' (5-point Likert scale)
	my actions accordingly.	
	Sensitivity to expressive behavior of others (6-items) (not used)	
22.	I am often able to read people's true emotions correctly through	1 'strongly disagree' – 5 'strongly agree' (5-point Likert scale)
	their eyes.	
23.	In conversations, I am sensitive to even the slightest change in the	1 'strongly disagree' – 5 'strongly agree' (5-point Likert scale)
24	facial expression of the person I'm conversing with.	1 (strongly disagree) 5 (strongly agree) (5 point Likert scale)
24.	understanding others' emotions and motives	stioligiy disagree - 5 stioligiy agree (5-point Likert scale)
25.	I can usually tell when others consider a joke to be in a bad taste.	1 'strongly disagree' – 5 'strongly agree' (5-point Likert scale)
	even though they may laugh convincingly.	
26.	I can usually tell when I've said something inappropriate by reading	1 'strongly disagree' – 5 'strongly agree' (5-point Likert scale)
07	it in the listener's eyes.	
27.	If someone is lying to me, I usually know it at once from that	1 strongly disagree – 5 strongly agree (5-point Likert scale)
	person's manner of expression.	
	Job crafting (Petrou et al., 2012)	
	Seeking resources (not used)	
28.	I ask others for feedback on my job performance.	1 'strongly disagree' – 5 'strongly agree' (5-point Likert scale)
29.	l ask colleagues for advice.	1 'strongly disagree' – 5 'strongly agree' (5-point Likert scale)
30.	I ask my supervisor for advice.	1 strongly disagree – 5 strongly agree (5-point Likert scale)
32	I contact other people from work (e.g. colleagues, supervisors) to	1 'strongly disagree' – 5 'strongly agree' (5-point Likert scale)
02.	get the necessary information for completing my tasks.	
33.	When I have difficulties or problems at my work, I discuss them	1 'strongly disagree' – 5 'strongly agree' (5-point Likert scale)
	with people form my work environment.	
	Cooking shallongoo (not used)	
34	Lask for more tasks if I finish my work	1 'strongly disagree' – 5 'strongly agree' (5-point Likert scale)
35.	l ask for more responsibilities.	1 'strongly disagree' – 5 'strongly agree' (5-point Likert scale)
36.	I ask for more odd jobs.	1 'strongly disagree' – 5 'strongly agree' (5-point Likert scale)
	-	, <u> </u>
07	Reducing demands (not used)	
37.	I try to ensure that my work is emotionally less intense.	1 'strongly disagree' – 5 'strongly agree' (5-point Likert scale)
30. 30	I make sure that my work is mentally less intense.	 suongiy uisagree – o suongiy agree (o-point Likert scale) strongly disagree' – 5 (strongly agree' (5-point Likert scale)
40.	I try to simplify the complexity of my tasks at work.	1 'strongly disagree' – 5 'strongly agree' (5-point Likert scale)
	Job autonomy (Bakker, 2004) (not used)	····
41.	I have tlexibility in the execution of my job.	1 'strongly disagree' – 5 'strongly agree' (5-point Likert scale)
42. 43	I nave control over now my work is carried out.	 strongly disagree - 5 strongly agree (5-point Likert scale) 1 'strongly disagree' - 5 'strongly agree' (5-point Likert scale)
το.	. can participate in accision making regarding my work.	. Sublight and gross of sublight agree (o-point Lineit Sodie)

Problem-solving demands (Morgeson & Humphrey, 2006)

- 44. My job involves solving problems that have no obvious correct answer.
- My job requires me to be creative. 45.
- 46. My job often involves dealing with problems that I have not met before.
- 47. My job requires unique ideas or solutions to problems.
- Advice network (Cross et al., 2001) Indicate the extent to which you have turned to each of the following people within the last month for answers to fairly specific 48. or detailed questions at work.
- 1 'strongly disagree' 5 'strongly agree' (5-point Likert scale)
- 1 'strongly disagree' 5 'strongly agree' (5-point Likert scale) 1 'strongly disagree' 5 'strongly agree' (5-point Likert scale)
- 1 'strongly disagree' 5 'strongly agree' (5-point Likert scale)

For each colleague within the department:

0: 'I have not turned to this person the last month', 1: 'I have turned to this person 1-2 times during the last month', 2: 'I have turned to this person 3-4 times during the last month', 3: 1 have turned to this person 5-6 times during the last month', 4: 1 have turned to this person 7 or more times during the last month'. 'This is me'.

Comments

49. If you have any additional remarks or comments, please use the box below.

Open field

Appendix B. Scales – Daily questionnaires

Questic	on/Statement	Answer format		
1.	Did you work for [this company] today?	Yes/No		
2.	<i>Idea generation (adapted from Tierney et al., 1999)</i> Today I demonstrated originality in my work.	1 'strongly disagree' – 5 'strongly agree' (5- point Likert scale)		
3.	Today I tried out new ideas and approaches to problems.	1 'strongly disagree' – 5 'strongly agree' (5- point Likert scale)		
4.	Today I generated novel, but operable work-related ideas.	1 'strongly disagree' – 5 'strongly agree' (5- point Likert scale)		
5.	Work engagement (not used) (Schaufeli, Bakker & Salanova, 2006) Today I felt strong and vigorous.	1 'strongly disagree' – 5 'strongly agree' (5- point Likert scale)		
6.	Today I was very resilient, mentally.	1 'strongly disagree' – 5 'strongly agree' (5- point Likert scale)		
7.	Today I was bursting with energy.	1 'strongly disagree' – 5 'strongly agree' (5- point Likert scale)		
8.	<i>Work pressure (not used)</i> Today I had to work at speed.	1 'strongly disagree' – 5 'strongly agree' (5- point Likert scale)		
9.	Today I had too much work to do.	1 'strongly disagree' – 5 'strongly agree' (5- point Likert scale)		
10.	Today I had to work under time pressure.	1 'strongly disagree' – 5 'strongly agree' (5- point Likert scale)		
11.	Interactions On [Tuesday], who were the people you had work-related one-on-one contact with?	Drop-down list with all colleagues of the department or open-field. Max. 20 interactions.		
	I his includes all kinds of one-on-one contacts such as talking/meeting, that occurred face-to-face, over the phone, on the internet or by other means of communication of at least 10 minutes.			
	Please fill in your interactions in <u>chronological order</u> starting with your first interaction of [Tuesday].			
12. 13.	Not from this department (removed on day 2) Please indicate for each person below [who is not in your department] from which department he/she is. How many times have you turned to this person within the last month for answers to fairly specific or detailed questions at work?	Drop-down list of departments within the company. 0: 'I have not turned to this person the last month', 1: 'I have turned to this person 1-2 times during the last month', 2: 'I have turned to this person 3-4 times during the last month', 3: 'I have turned to this person 5-6 times during the last month', 4: 'I have turned to this person 7 or more times during the last month'.		
14.	Energizing This question refers to your interactions on [Tuesday].	Per interaction: 1 'strongly disagree' – 5 'strongly agree' (5-		
	People can affect the energy and enthusiasm we have at work in various ways. Interactions with some people can leave you feeling drained; whereas others can leave you feeling enthused about possibilities. How did your interactions with the following people affect your energy level?*	point Likert scale)		
	*The responses are completely confidential and strictly for research purposes. After collection, the responses are anonymized. If you prefer not to answer this question, please go to the next one.			
15.	Idea generation This question refers to your interactions on [Tuesday].	Per interaction: 1 'strongly disagree' – 5 'strongly agree' (5-		
	Please indicate to what extent you agree with the following statement for each interaction.	point Likert scale)		
	During this interaction, I came up with novel, but operable work-related ideas			
16.	Seeking resources This question refers to your interactions on [Tuesday].	Per interaction: 1 'strongly disagree' – 5 'strongly agree' (5-		
	Interactions or meetings can provide you with resources for your work. Resources can be anything that helps you in your work or that stimulates your personal growth or development (e.g. feedback, advice, new work-related information or social support).	point Likert scale)		
	To what extent did you <u>actively seek such resources</u> during the following interactions?			
17.	Seeking challenges This question refers to your interactions on [Tuesday].	Per interaction:		

	Interactions or meetings can bring you in to contact with challenges in your work (e.g. by exposing you to new, work-related problems or more complex work tasks).	1 'strongly disagree' – 5 'strongly agree' (5- point Likert scale)
	To what extent did you actively seek such challenges during the following interactions?	
	Reducing demands	
18.	This question refers to your interactions of [Tuesday].	Per interaction:
	Your work can be mentally, emotionally or physically straining.	point Likert scale)
	To what extent did you <u>actively try to make your work less straining</u> during the following interactions?	
19.	Comments Did you have any other important interactions, meetings, events or activities on [Tuesday] that were not captured in this survey?	Open field
	If so, please give a short description of these events below. If not, you can go to the	
20.	If you have any additional remarks or comments, please use the box below.	Open field

Appendix C. Set-up of questionnaires

The following two figures show examples of how the questionnaire was set-up. In this case, it is about the mobile version of the questionnaire that was anonymized. The desktop version was almost the same but could fit more text on one page. The questionnaires were constructed within Qualtrics.

Left: a picture of the question about the advice network. It was structured per team, in alphabetical order and their corresponding job functions were depicted. The default option was set to 0.

Right: the question about the interactions per day. Participants could choose from a drop-down list for people from within the department (DT) that was ordered on alphabetical order. If the interaction was with someone outside the department, they could use the open field (which is just outside this figure).

0%				100%		0%	100%	8
TII/-	EINDHOV	EN					OVEN	
IU/e	JNIVERSI	TY OF OGY					OLOGY	
Your personal	netwo	ork at v	work			One-on-o	one contacts	
You are at the very l	last quest	ion!				On Thursday, v	who were the people you h	nad
This question is struct	ured per te	am to ma	ake it easy	/ for you t	o fill in.	work-related	one-on-one contact with?	
So for every team yo	ou'll have	the same	e questio	n.		This includes all	kinds of one-on-one contac	cts such
The default response i	is set to 0,	but pleas	e select i	the corre	ct	as talking/meet over the phone,	on the internet or by other m	ace, neans of
option						communication	of at least 10 minutes .	
It takes approximately	5 minute	es to com	plete this	part of th	ie	Please fill in you	ur interactions in <u>chronolog</u>	<u>ical</u>
questionnaire. This mo	ay seem lik	e a tediou	us task, bu	it it is actu	Jally	<u>order</u> starting v Thursday.	with your first interaction of	
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	Indi	cate the e	extent to w	hich you l	nave	maximum of	10, please leave the rest of the fields i	blank
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	0	1-2	3-4	5-6	7 or		People from DT	If the per indice
	times	times	times	times	more times			
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owner)		0	0	0	0	One-on-one 3		
Name 3 (analyst)	\bigcirc	0	0	0	0	One-on-one 4		
Name 4 (developer)	\bigcirc	0	0	0	0	One-on-one 5	•	
Name 5 (developer)	\bigcirc	0	0	0	0	One-on-one 6	•	
Name 6 (developer)	\bigcirc	0	0	0	0	One-on-one 7		
Name 7 (developer)	\bigcirc	0	0	0	0	One-on-one 8		

One-on-one 9

One-on-one 10

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Name 8 (product

design)

Appendix D. Visualizations of networks

On the next pages one can find visualizations of the social networks gathered within this research. Within all visualizations the size of the nodes indicate the degree of centrality based on indegree; nodes that are bigger in size have a higher in-degree score. This in-degree score was calculated one time only and was based on a measurement on the advice network. The size between nodes is not directly comparable between graphs as visualizations were resized. In most visualizations the colour represents a distinct job function. A legend can be found in Figure 9. Visualizations were made with Gephi software (Bastian M., Heymann S., Jacomy M., 2009).



Figure 9. Legend of the colours used in the visualizations of the networks.

General network - job function

"Indicate the extent to which you have turned to each colleague within your department within the last month for answers to fairly specific or detailed questions at work"



In this network, one can see the different types of jobs, their corresponding in-degree, and how they are connected.

General network - team

"Indicate the extent to which you have turned to each colleague within your department within the last month for answers to fairly specific or detailed questions at work"



Colour is different from legend. In this visualisation, colour represents a team. The colour that is most present (blue-ish), does not belong to a specific team. From this network, one can conclude that many participants did not belong to a specific team.

General network – Participation

"Indicate the extent to which you have turned to each colleague within your department within the last month for answers to fairly specific or detailed questions at work"



Colour represents whether the participant filled in the general questionnaire. Red indicates that the participant did not fill in the general questionnaire. From this network, one can conclude that many of the participants that did not fill in the general questionnaire, had lower in-degree scores (smaller node sizes)

Daily network - Tuesday

"On Tuesday, who were the people you had work-related one-on-one contact with?"



Daily network – Wednesday

"On Wednesday, who were the people you had work-related one-on-one contact with?"



Daily network – Thursday

"On Thursday, who were the people you had work-related one-on-one contact with?"



Daily network – Friday

"On Friday, who were the people you had work-related one-on-one contact with?"



Daily network – Monday

"On Monday, who were the people you had work-related one-on-one contact with?"



Daily network – all days combined

"Who were the people you had work-related one-on-one contact with?"

