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Heterogeneity and Performance in Innovation Idea Networks

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HETEROGENEITY AND PERFORMANCE IN INNOVATION IDEA NETWORKS

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ABSTRACT

This paper addresses the influence of heterogeneity on the creativity performance of formal and informal groups when generating innovation ideas. Data on all innovation ideas generated at a company during three years have been gathered and analyzed. The empirical results showed that heterogeneity in formal groups has a positive influence on the quality of the ideas generated. However, after a certain amount of heterogeneity the performance drastically decreased, showing that there is an optimum for when heterogeneity influences the performance of the formal groups positively. The informal groups did not show the same results.

Managerial implications of the findings are that both the strategic input to ideation and its organizing need to be considered.

Keywords: Heterogeneity, Performance, Innovation, Ideas, Informal groups, Project teams, Ideation

1. INTRODUCTION

Continuously innovating firms need a constant flow of innovation ideas to develop and exploit. Consequently, they need to generate and access ideas from a variety of sources. Even though much emphasis has lately been put on bringing in innovation ideas from outside firms (e.g. Chesbrough, 2004), ideas originating from internal organization members still constitute the main source of innovation in many industrial firms. Ideas for innovation can emerge in different ways, but it is clear that the act of ideation frequently involves some measure of creativity, an area that has been thoroughly investigated in the field of innovation studies. The creativity of individuals and teams has also been pointed out as a key driver of innovation within organizations (Amabile, 1997). To handle the need for innovation ideas, forward-looking firms actively involve their employees in bringing out innovation ideas.

It is well known that the interaction between individuals with different knowledge sets and perspectives can increase creativity and thereby impact innovation in a positive way (Nonaka, 1994). Project teams are often referred to as an arena for creative activities, especially in literature on cross-functional work in product development. However, ideation is not restricted to formally decided constellations of people; as is well known from earlier studies of innovation, it also takes place in the informal dimension of the organization (Allen, 1976). The social networks of individuals arguably influence their access to information and knowledge, and consequently their possibilities for ideation. When it comes to individuals' informal social networks, little is known regarding the effect of heterogeneity on creativity performance. Studies that have been made on innovation in networks primarily focus on communities (e.g. Brown and Duguid, 1991),

which are rather homogeneous in terms of their members' shared views and repertoires (Wenger and Snyder, 2000).

The output in terms of new ideas for innovation within the firm is thus the output from various activities within and outside organizations, and it emerges from single inventors as well as groups – both in more formal contexts, such as project teams, and in spontaneously formed collaborations. Innovation idea networks in firms, where ideas are generated by persons within and from different departments and units in both formal and informal constellations, constitute an area not yet extensively explored. From a management perspective, insights about how cross-boundary knowledge combination in the formal and informal innovation idea networks affects the performance are important in order to understand how innovation ideas are generated within the firm. This paper explores the influence of heterogeneity on ideation in both formal and informal groups within an organization.

2. RECEIVED THEORY

The process of innovation focuses on the activities that take place over time in developing and implementing new ideas from concept to concrete reality. Ideas are continuously generated and actualized during the innovation process (Schroeder et al., 2000). Hence ideation is not only an initial step in innovation. Nevertheless, innovation initiatives always start with some kind of idea(s) coming from individuals' and groups' creative endeavours. In this section, an exposition of previous research on the creative performance of individuals and groups is made. One variable that influences the creativity of groups, namely heterogeneity, is explored in more detail, and finally the specific research questions of this study are presented.

2.1 CREATIVITY, HETEROGENEITY AND INNOVATION

In the seminal work of Koestler (1989), it is suggested that the creation of ideas occurs in the intersection of existing planes of understanding. This view of ideation underlines the role of the individual as the original source of ideas, and the ability to think laterally (de Bono, 1970) consequently stands out as a factor distinguishing more creative individuals from less creative ones. However, individuals are embedded in a social context, comprising a web of formal and informal connections that continuously modify and add to the individuals' knowledge sets. For innovation, creative cooperation rather than individual undertaking is important, and conscious social interaction facilitates the creativity activity (Leonard and Sensiper, 1998). Leonard and Sensiper (1998, p.15) further stress that “creative ideas do not arise spontaneously from the air but are born out of conscious, semiconscious, and unconscious mental sorting, grouping, matching and melding. Moreover, interpersonal interactions at the conscious level stimulate and enhance these activities; interplay among individuals appears essential to the innovation process”. Hence, membership in formal and informal groups in this sense ought to hold a potential to contribute positively to individuals' capacity to generate ideas. Different such connections have been put forward in existing theory. While some authors have upheld the importance of more peripheral contacts, so-called weak ties (Granovetter, 1973), others have mainly focused on the role of more closely connected networks. One such type of networks are communities of practice (Brown and Duguid, 1991; Wenger and Snyder, 2000; Wenger, 2001) or communities of knowing (Boland and Tenkasi, 1995), in which individuals exchange knowledge openly with each other in intra- or inter-organizational constellations that are normally created informally. While distant

connections in networks have a larger potential to bring about radically novel information, closer contacts are more likely to hold similar knowledge.

Also more formal organizational structures have been suggested to influence creativity and innovation. Team-based organizational structures have become widely popular and, although teams offer great potential for innovation activities, the potential is not always realized (Jackson, 1996). There are numerous things that affect the performance of formal groups. One that has received much attention is the communication pattern; research has shown that this is a determinant of team creativity performance, and that a too high frequency of communication and the formation of subgroups tend to decrease the creative performance of innovation teams (Kratzer et al., 2004).

As the complexity of products and services increases, teams are organized to include all different types of knowledge and expertise needed. Jackson (1996, p.68) describes that “in the longer term, diversity partly determines team performance and membership stability” and that “the dynamics of diversity becomes increasingly important”. This increasing complexity makes it necessary to recall some fundamental ideas from systems theory, which can provide fruitful input to our understanding of creativity in groups. Heterogeneous groups, with a higher variety in the group and diversity of skills, are more adaptable than homogeneous groups (Murray, 1989). Variety is the number of distinct elements that can be distinguished in a given set of elements (Ashby, 1956). Ashby (1956) introduced the law of requisite variety: the larger the variety of actions available to a control system, the larger the variety of perturbations it is able to compensate. A heterogeneous group also implies a larger variety of knowledge for the group to draw upon in order to find solutions to problems or come up with new ideas, and hence could be more adaptable. In line with this, also Nonaka (1994) argues that one prerequisite for knowledge creation and innovation is requisite variety. Drawing upon examples of more radical innovation projects, Nonaka and Takeuchi (1995) describe how different planes of thinking were combined in the development of new products, using heterogeneous project teams and guiding their thinking through the use of e.g. metaphors, slogans and the forbidding of known solutions.

Also research looking into the more general performance of groups has addressed the issue of heterogeneity. Guzzo and Dickson (1996) raised three open issues that appear to be important for understanding the performance of groups, namely diversity, familiarity and team boundaries. Focusing on the first issue, it has been recognized that diversity in organizational groups can affect group performance positively (Milliken and Martins, 1996; Moore, 1999). Heterogeneity in groups has thus received a lot of attention, but increased diversity in groups is not an automatic solution for success (Moore, 1999). Milliken and Martins (1996) describe diversity as a double-edged sword, since either it may be a boost for creativity and increase performance or the group members may fail to identify themselves with the group resulting in integration problems. The created dissatisfactions can generate tensions and communication problems and affect the group’s possibility to perform well (Milliken and Martins, 1996).

The relation between diversity in groups and the performance of groups has often been linked in previous research with conflicts; diversity in groups shapes conflicts in groups, and this in turn shapes the performance of groups (Pelled et al., 1999). Kratzer et al. (2006) have studied this further in an innovation context and seen that polarity, i.e. conflict potential, influences the creativity in innovation teams. Polarity influences the creativity performance of the team positively when the team is in the conceptualization

phases; but when the degree of complexity is less, or in later phases of the development process, the polarity affects the creativity performance negatively (Kratzer et al., 2006).

Summarizing the exposition above, it seems that the heterogeneity in groups and teams, regardless of whether they are formally constructed or spontaneously emergent in informal networks, is an important aspect when it comes to the creative performance of all groups. While smaller differences in perspectives, knowledge and information arguably facilitate communication and reduce the risk of misunderstandings, more substantial distances in understanding hold a greater potential for generating the creative intersections mentioned by Koestler (1989), given that communication difficulties can be overcome.

2.2 RESEARCH QUESTIONS

Collaboration between individuals is very important for the innovation process. The collaboration may be conducted in formal settings, e.g. project teams – and as previous research has shown, the heterogeneity in these groups has an impact on their performance. The social networks of individuals affect how they can access information and knowledge, and this in turn shapes their creative performance. Collaboration also takes place continuously in more informal ways within each individual's social network.

Drawing on existing theory in innovation, creativity, and knowledge management, a predominant view is that groups possessing a larger knowledge base from different units can be expected to come up with better innovation ideas than homogeneous groups. This is reflected in the position taken by e.g. Leonard and Sensiper (1998), who state that intellectually heterogeneous groups are more innovative than homogeneous ones. However, it is also noted in a number of contributions that too much heterogeneity may lead to communication difficulties, misunderstandings and unproductive conflicts. In line with this, some literature streams emphasize the potential positive effects on innovation that derive from seemingly homogeneous informal networks. In sum, there is still no clear understanding of the exact role of heterogeneity in ideation. As a step towards increasing our knowledge, this paper explores the issue of heterogeneity for groups generating innovation ideas in a firm by addressing the following research questions:

RQ1: Are innovation ideas generated by more heterogeneous group constellations better than the innovation ideas generated by more homogeneous ones?

RQ2: Is the influence of heterogeneity in informal groups different from its influence in formal groups?

3. METHODS USED

In order to investigate the stated views and the explorative research questions, extensive in-depth data regarding all innovation ideas at a firm have been gathered from their idea database. In addition to the database, a number of interviews with key individuals within innovation have been conducted in order to create rich contextual knowledge and understand more in detail about the information in the database and how ideas are handled in the company. Data from three consecutive years have been collected, resulting in studying 1740 innovation ideas handed in by persons within the firm. 1112 ideas were generated by individuals and 628 by groups. The innovation ideas are graded by novelty and usefulness on a scale from 1 to 5. According to the grading of the case company, these ideas were divided into two groups, the first being ideas graded 1 and 2 which were considered as low-quality innovation ideas. The second group comprised

ideas that had received points 3, 4 and 5 and were considered high-quality innovation ideas. Performance data in terms of a quality measure on the innovation idea each formation has created are used as a dependent variable for every analysis below, using the ideas as the level of analysis.

The data analysis and process were done in several steps. The initial analysis compared the proportions of high-quality ideas that were generated by individuals and groups respectively. Thereafter the ideas generated by groups were studied in three steps. In the first step the numbers of persons in the groups who generated ideas were considered and divided into three new groups – consisting respectively of two persons, three persons, and the sources of the ideas generated by more than three persons. This division was made because not many ideas were generated by larger numbers; to compare the different group sizes and their possible influence on the quality of ideas generated, this division was considered adequate.

In the second step, the influence of groups' heterogeneity on the performance of the ideas generated was assessed. The heterogeneity was considered as the diversity in the groups in terms of each individual's readily detectable task-related attribute (see Jackson et al. 1995), here the organizational one of belonging within the organization. Thus, the heterogeneity is measured for each idea's group members' organizational belonging, resulting in a heterogeneity index of 1 for the ideas that were generated by individuals from the same organizational unit. For ideas that were generated by groups with individuals belonging to more than a single unit, the heterogeneity index was the number of different units. This yielded a new grouping with three heterogeneity categories: one, two, and more than two. The last category consisted of groups with up to six units, on the same basis as described for the number of persons in each group.

In the third and final analysis, the ideas generated by groups were divided into two categories: ideas generated by project groups and by informal groups. The influence of number of persons and heterogeneity on performance was assessed in the same way as described above.

The results were consequently categorical variables, with a count for the amounts of high-quality and low-quality ideas in each case. To test whether the resulting distribution was independent or not, Chi2 tests were done for all of the results with MATLAB. For the third analysis, the global level of significance has to be considered differently from the first two analyses, since two tests of independence are applied to the same data. According to the Bonferroni correction, the global level of significance thus needs to be divided by the number of tests done.

4. EMPIRICAL RESULTS

In a first step of the analysis, we separated the innovation ideas that were generated by individuals from the innovation ideas that were generated by groups, in order to see the possible difference in performance between individuals and groups. A total of 1112 ideas were generated by individuals and 628 by groups over the period of three years studied. An overall comparison of the ideas from these different sources is presented in Table 1.

Table 1: Comparison of ideas generated by individuals and groups

	Individuals	Groups
<i>High-quality innovation ideas</i>	244 (22%)	148 (24%)

<i>Low-quality innovation ideas</i>	868 (78%)	480 (76%)
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χ^2 test: Q = 0.6068, p = 0.4360

As seen in Table 1, the proportion of high-quality ideas was 22% for individuals while it amounted to 24% for groups, which was thus only marginally higher.

Focusing more specifically on the groups of idea providers, the numbers of persons generating the ideas were studied. A higher number of persons involved in generating ideas would allow drawing upon different views in the ideation process, and the number of individuals involved in generating an idea could thus be seen as a rudimentary measure of heterogeneity. A test was therefore performed to see if a higher number of individuals had a positive effect on the quality of the ideas generated. 355 ideas were generated by groups of two persons, 187 by three persons, and 86 by groups including more than three persons. The distribution of these across the categories high- and low-quality innovation ideas, respectively, is presented in Table 2. The proportion of high-quality ideas decreased with increasing number of persons within the group. Even though the results seem to show that a higher number of people involved in ideation is correlated with a higher proportion of low-quality ideas, it should be underlined that the difference is not statistically significant.

Table 2: Comparison of ideas generated by groups of different sizes

	2	3	>3
<i>High-quality innovation ideas</i>	91 (26%)	42 (22%)	15 (17%)
<i>Low-quality innovation ideas</i>	264 (74%)	145 (78%)	71 (83%)

χ^2 test: Q = 2.7603, p = 0.2515

Not only could the amount of persons influence the different views presented in a group, but the diversity in terms of each individual's personal attributes is a factor that also influences heterogeneity. The next analysis that was performed therefore focused on heterogeneity in the sense of the diversity of organizational belonging in the groups. 339 ideas were generated by groups with the heterogeneity index 1, 239 by groups with heterogeneity index 2, and 50 derived from groups with the heterogeneity index higher than 2. The proportion of high-quality innovation ideas increased from 23% in the least heterogeneous group to 27% in the second group, but thereafter decreased to 10% for the most heterogeneous category. Using a chi-square test, this difference was found to be statistically significant at the 0.05 level.

Table 3: Comparison of ideas generated by groups with different heterogeneity

	1	2	>2
<i>High-quality innovation ideas</i>	79 (23%)	64 (27%)	5 (10%)
<i>Low-quality innovation ideas</i>	260 (77%)	175 (73%)	45 (90%)

χ^2 test: Q = 6.4905, p = 0.0390

In order to address the possible difference between formal and informal groups in ideation, yet another analysis was performed. Out of the 628 ideas that were generated by groups, 353 were created in formal projects, while 275 were created by spontaneously formed groups (see Table 4). For the project groups, the proportion of high-quality ideas was 25% and for informal groups it was 21%. The observed difference was not, however, statistically significant.

Table 4: Comparison of ideas generated by formal project groups and informal groups

	Project groups	Informal groups
<i>High-quality innovation ideas</i>	89 (25%)	59 (21%)
<i>Low-quality innovation ideas</i>	264 (75%)	216 (79%)

χ^2 test: Q = 1.2119, p = 0.2710

How the number of elements and how the number of distinct elements possible could influence the performance of formal and informal groups were then addressed. Table 5 presents the ideas generated in both formal projects and informal groups in relation to the two different dimensions previously used – the number of persons within each group and the heterogeneity of the groups, respectively. The potential negative effect of increasing group size on innovation quality that was observed on the global level (see Table 2) could be seen in both formal and informal groups, but also for the different sub-groups the differences were not significant. The influence of heterogeneity on performance for project teams increased from 23% for groups with heterogeneity index 1 to 31% for teams with heterogeneity index 2 and thereafter decreased to 13 for the most heterogeneous formal groups. Using the Bonferroni method to correct the global significance level, the resulting p-value can be seen as 0.109 (2*0.0545). For the informal groups, a different relationship could be seen. For these groups, the proportion of high-quality ideas decreased from 23% (heterogeneity index 1) to 21% (heterogeneity index 2), and to 0% for the most heterogeneous constellations.

Table 5: Comparison of ideas generated in formal project groups and in informal groups

	Generated in formal project groups			Generated in spontaneously formed (informal) groups		
	<i>Number of persons in group</i>			<i>Number of persons in group</i>		
	2	3	>3	2	3	>3
<i>High-quality innovation ideas</i>	52 (28%)	25 (25%)	12 (19%)	39 (23%)	17 (20%)	3 (14%)
<i>Low-quality innovation ideas</i>	135 (72%)	77 (75%)	52 (81%)	129 (77%)	68 (80%)	19 (19%)
χ^2 test	Q= 2.1121, p= 0.3478			Q= 1.2134, p= 0.5451		
	<i>Heterogeneity</i>			<i>Heterogeneity</i>		
	1	2	>2	1	2	>2
<i>High-quality innovation ideas</i>	40 (23%)	44 (31%)	5 (13%)	39 (23%)	20 (21%)	0 (0%)
<i>Low-quality innovation ideas</i>	131 (77%)	99 (69%)	34 (87%)	129 (77%)	76 (79%)	11 (100%)
χ^2 test	Q= 5.8185, p= 0.0545			Q= 3.3353, p= 0.1887		

5. ANALYSIS

A first observation that can be made about the results is that there was no significant difference in ideation performance, in terms of the proportion of high-quality innovation ideas generated, between groups and individuals. The describing numbers showed that the groups quota of high quality ideas generated were slightly higher (24%) then for individuals (22%). As some authors (e.g. Leonard and Sensiper, 1998) have highlighted the positive impact of cooperation on creative performance, these results may seem somewhat surprising. One reasonable explanation for this lack of significant performance differences is that earlier studies primarily have focused on the

implementation and development of innovation projects and not on the generation of innovation ideas, which is an event that fundamentally takes place at the individual level (Koestler, 1989). It could also be the case that some groups have positive effects on ideation, but that this effect is annulled by other, negative effects of groups on ideation, for instance communication difficulties, conflicts and the striving for consensus.

Furthermore, the results suggested that the number of persons in each group could have a negative impact on the ideation performance of the group. However, the performed test was not statistically significant, and we could not rule out that the seemingly linear correlation was simply coincidental. One reason why there could actually be a negative relationship between group size and ideation performance is that larger groups ought to bring about an increased risk of criticism and conflicts, which could hamper the creation of ideas with a higher degree of newness. While the mere number of elements in a group did not have a significant influence on its ideation performance, group heterogeneity, as measured by differences in organizational belonging, turned out to have a clear effect. The results showed that the performance of the groups increased from 23% high-quality innovation ideas to 27% as the heterogeneity index increased from one to two. For groups with a heterogeneity index over two (more than two persons in the group coming from different organizational units), the percentage of high-quality ideas decreased to no more than 10%. The Chi2 test showed these differences to be statistically significant at the 0.05 level.

Of course, the measures used for group size and heterogeneity are interrelated, as groups of two persons cannot have the highest heterogeneity index. Important to note is that the proportion of high-quality ideas drops as group size increases, while a certain amount of heterogeneity has a positive effect. In order to get these different results, it appears reasonable to assume that the increase of group size in itself is negative due to conflicts, criticism of ideas, consensus-seeking behaviour, etc., while the effect of bringing in different perspectives and knowledge is positive. However, the latter's effect could also be negative if the differences are so big that the individuals have difficulties understanding each other. We can thus conclude that a certain level of heterogeneity appears to be beneficial for the creation of high-quality innovation ideas, while a high level of heterogeneity instead influences ideation performance negatively. These results underscore earlier statements that heterogeneity influences the performance of groups (Milliken and Martins, 1996; Moore, 1999). That a certain level of heterogeneity is fruitful for the creation of ideas can be understood in the light of the theories presented by Koestler (1989). By including people with different sets of knowledge, the propensity for arriving at more radical new insights ought to increase. As regards the drop in performance for more heterogeneous groups, a plausible explanation could also here be that the increased heterogeneity creates conflicts which in turn influence creativity negatively (Pelled et al. 1999; Kratzer et al., 2006).

We now turn to the second research question, to explore possible differences in terms of ideation between formal and informal groups. As regards the effect of group size on innovation quality, no patterns different from the one seen at the global level could be identified for any of the group categories. When investigating the impact of heterogeneity for the different types of groups, a different pattern could however be observed. For formal groups, a certain amount of heterogeneity resulted in a higher proportion of high-quality ideas, which then dropped for high levels of heterogeneity. For informal groups, the pattern was not the same: the percentage instead dropped for each increase in heterogeneity index and the findings for informal groups were not

statistically significant. One possible explanation for why heterogeneity does not affect the informal groups in a similar way to the formal groups can be found in the theories of requisite variety presented by Ashby (1956), and further expressed by Nonaka (1994), that in order to control/support more elements in a given context more control variables need to exist. In a spontaneously formed group, the control variables ought to be harder to identify and there would most likely be less support and control external to the group than there would be for formal project teams. A higher level of freedom within the system demands more control variables and might require coordination, support and/or control that is not necessarily available in the informal setting. It might therefore be harder for an informal group to handle tensions in a positive manner, and the group might therefore fail to fulfill the creative performance potential that increased heterogeneity could induce.

One metaphor that could be used to interpret the findings is that the tensions caused by heterogeneity in a group can be seen as a force field. In line with literature on paradoxes and tensions in organizations (see e.g. Janssens and Steayert, 1996), we would like to argue that a certain amount of tension is positive for ideation. However, too much tension leaves the groups with communication and integration problems resulting in unproductive conflicts and these groups consequently do not perform as well as less heterogeneous ones, much in line with Milliken and Martins (1996). Hence, unlimited increase of heterogeneity does not result in increased performance, but there appears to be a local maximum that is most conducive for ideation. The performed study does not tell us anything about factors that may influence groups' capacity to withstand more or less tension. It may be that some constellations can handle higher levels of heterogeneity by using more effective integration mechanisms. This can be compared to well-established ideas from organization theory as well as more recent ideas concerning management of new ventures. The basic idea of Lawrence and Lorsch (1967), namely that the performance of an organization comes from having both a high level of differentiation and a high level of integration, seems to apply also in this context. To this should be added that too high levels of heterogeneity decrease performance even if this can to some extent be compensated by a proliferation of integration mechanisms (Bhidé, 2000).

Grading of the ideas has been done in terms of usefulness and novelty. Regarding the former dimension, the innovation ideas that are generated in ongoing projects could be of direct use for the projects and their usefulness may therefore be more directly apparent. The ideas that arise in these contexts are within areas the company might know of and hence can grade easier, and could also be solutions to well-known problems in projects. Concerning novelty, the ideas are saved in the company's idea database and during a project the members are promoted to search the databases for ideas within the area of the project. This could also explain why the proportion of high-quality ideas created in formal groups is slightly higher than in the informal groups, since formal groups might have a better understanding of the ideas that already exists within the company and they do not "reinvent the wheel" – come up with ideas that are already known within the company and are for this reason regarded as not novel and graded low. The ideas generated in the project might also be more aligned with the company's strategy and hence viewed as more useful. Naturally this can be, and is in many cases, the correct approach, but there is also a risk that the ideas arising in the informal context can be graded incorrectly. It could be that the potential of innovation ideas that are spontaneously generated in informal groups are harder for the company to understand and pursue, since they might be outside the scope of what they do and know

about. It could also be that some of these ideas actually have large novelty-value that simply is not useful for the company and are therefore discarded, which again may be a correct decision but does not tell the whole truth about creativity performance. In some cases it may even be that the ideas stemming from these groups have huge potential in terms of usefulness, novelty and profit, but are not understood and properly graded (see Chesbrough, 2004). At the same time, it can be seen in the results that informal groups tend to be less heterogeneous than formal groups and the potential to generate radical innovations in informal groups thus ought to be lower. One could expect that the formal groups would suffer in exploring radically new ideas as they normally have a more explicit objective and therefore cannot explore new opportunities freely. However, creativity does not necessarily benefit from unlimited freedom, but may actually be triggered by imposed limitations, such as forbidding known solutions (Nonaka, 1994).

One stream of literature that can help us grasp this observation is that of organizational learning. Boland and Tenkasi (1995) distinguish between two modes of learning: perspective-making and perspective-taking. Perspective-making refers to the learning process that takes place within an established perspective, normally between peers with similar backgrounds and knowledge foci. Perspective-taking is instead the learning process involved in making sense out of information from individuals with different backgrounds, who hold other types of knowledge. In more established terms, perspective-making can be seen primarily as single-loop learning, while perspective-taking rather equals double-loop learning (Argyris and Schön, 1978). Arguably, these different types of learning influence innovation in different ways. Single-loop learning can be seen as fundamental to innovation ideas leading to minor, continuous improvements of existing products, processes and services. Double-loop learning, on the contrary, holds more potential for innovation ideas with a higher degree of novelty. More heterogeneous constellations thus ought to constitute a more fruitful ground than homogeneous ones for radical and discontinuous innovation ideas, and other types of ideas with a higher level of newness. The performed study does not allow us to observe such potential differences in detail, but the ideas with the highest scores in terms of quality were primarily created by formal groups of moderate heterogeneity.

6. DISCUSSION

It appears as though previous research on creativity performance in groups can be split into two distinct streams, one focusing on inter-group dynamics and one primarily addressing the need for broader, complementary sets of knowledge and information. What can also be seen is that the intersection of these two streams remains less explored. Based on the empirical observations, it seems as though the ideas in both these streams are highly relevant to understand what takes place in ideation practice. As a consequence, combining the different theories into a more comprehensive view of the processes at work in ideation groups can be a fruitful approach to provide us with managerially applicable knowledge about how idea generation can be facilitated.

The act of ideation is in its most narrowly defined sense an individual event. However, the discrete event when a new idea is crystallized is normally the outcome of a longer intellectual and social process, in which information is combined with existing knowledge, eventually leading to new insights. In order to manage this process in a fruitful manner, a first important step is to address both the individual and the group level of idea generation. Much research on creativity has emphasized the role of creative individuals, e.g. persons with a high capacity to think laterally (De Bono, 1970), and individuals who have access to important knowledge flows by acting as gatekeepers (e.g.

Allen and Cohen, 1969). The importance of such persons should in no way be underestimated, but in an increasingly interconnected and complex world with increasing needs to identify, access and tap into specialized pools of knowledge (Lane et al., 2006), innovation arguably becomes more distributed and collaborative to its nature, hence requiring an increased need to manage joint ideation processes. From the empirical observations, we can see that there seems to be an unrealized potential here as the case company, as well as many other companies, rely on an ideation approach in which employees are supposed to come up with innovation ideas more or less spontaneously, either individually or in informal constellations, or run creative sessions for larger groups of people.

Taking into account the possible negative effects caused by large groups, as well as the clear negative influence of too low and too high levels of heterogeneity, we would like to suggest the experimentation with more active ideation management techniques. Willingly acknowledging that people cannot be ordered to be creative, but that management intervention in this field is limited to creating prerequisites for ideation, we see that there is room for new ideation approaches. Such approaches should take into account the need for a heterogeneous knowledge base, but at the same time either limit the group size in order to keep tensions deriving from conflicts and communication difficulties at a suitable level, or provide the groups with better facilitation and integration mechanisms. In practice, this would mean that both the strategic input to ideation and its organizing need to be considered. In terms of strategy, it could be fruitful to clearly indicate new and existing business areas where ideas for innovation are needed, in order to reduce uncertainty regarding the type of innovations that are desired, and also create some convergence in terms of search patterns from different parts of the company. While the advantages of running later stages of innovation processes in projects is established since long (see e.g. Clark and Wheelwright, 1992), the search for new ideas is rarely managed in the same deliberate manner. Many companies have embraced the open innovation approach (Chesbrough, 2004), but there appears to be a substantial potential in internal ideation that in many cases is not exploited.

Clearly, the question how companies can improve their ideation processes requires much more research in order to arrive at well-proven solutions, and the performed study only serves as an input to this important work. One dimension that definitely needs to be further investigated is heterogeneity. In this study, we have focused on the variety in only one of the individuals' attributes, namely the organizational belonging of each individual. Other types of variety in personal attributes could also influence the performance of the groups (see Jackson et al., 1995; Jackson, 1996). Future research could therefore compare different groups and different individuals' attributes in order to explore whether some competences are more important than others for ideation, or whether it is the variety itself that is important – not depending on some specific individual's or unit's presence. Other factors such as communication pattern and combination of different forms of knowledge could also increase the understanding of what influences the creativity performance of individuals, formal groups and informal groups when generating innovation ideas.

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