Groups, Teams, and Creativity: The Creative Potential of Idea-generating Groups

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On voit apparaître une nouvelle littérature traitant de la créativité et de l'innovation dans les groupes et les équipes. Bien que de nombreaux facteurs inhibent la créativité des groupes, nos investigations et analyses indiquent que l'interaction dans les groupes et équipes serait une source féconde d'innovations et d'idées créatives. On présente dans cet article un modèle théorique de la créativité dans les groupes producteurs d'idées et l'impact sur le travail en équipe et les recherches à venir.

There is an emerging literature on group and team creativity and innovation. Although there are many factors that appear to inhibit creativity in groups, our review and analysis suggests that interaction in groups and teams can be an important source of creative ideas and innovations. A theoretical model of creativity in idea-generating groups is developed and implications for teamwork and future research are presented.

INTRODUCTION

Working in collaborative groups has become rather a popular approach in organisations. In the 1960s organisations became quite enamoured with quality circles, and today work teams are very common in organisations (Cotton, 1993). Each of these forms of group work is based on reasonable assumptions (Appelbaum & Batt, 1994), and many tasks do require inputs from people with multiple skills and knowledge bases. Moreover, participants in groups and teams tend to rate their experiences quite positively (Cohen & Bailey, 1997; Kramer, Kuo, & Dailey, 1997). However, some scholars view collaborative work forms primarily as fads with little solid empirical basis (e.g. Dunphy & Bryant, 1996; Sinclair, 1992). Consistent with this perspective, research on group task performance has

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highlighted the difficulties of groups in performing effectively (McGrath, 1984).

The main focus of this article will be with the efficacy of idea sharing in groups and teams. Information and knowledge exchange and the development of innovations (applications of ideas) in groups is becoming an increasingly important component of work in this information age (Purser & Montuori, 1995). How effective is this process? Are teams and groups useful for developing creative ideas or should more solitary creative processes be favoured? Do groups or teams stimulate or inhibit creativity? In this article I will evaluate the potential for group and team creativity in light of recent theoretical and empirical developments. I will discuss the basis for poor performance in idea-generating groups and suggest conditions under which high levels of creativity in groups and teams may be realised.

CREATIVITY IN GROUPS AND TEAMS

For our purposes groups can be defined as two or more individuals who have some interdependence or relationship and who have an influence on each other through their interactions (Paulus, 1989; Forsythe, 1999). Teams are groups that work together for a common goal in an organisation (Cohen & Bailey, 1997; Hackman, 1987). Creativity is often defined as the development of novel ideas that are useful (e.g. Amabile, 1996; Kasof, 1995; Mumford & Gustafson, 1988; Sternberg & Lubart, 1995). One popular perspective equates creativity with divergent thinking or the extent to which individuals are able to generate a wide variety of ideas or responses to a particular problem situation (Baer, 1993). Guilford (1967) proposed four basic categories of divergent thinking. Fluency is the ability to generate a large number of ideas. Flexibility is the ability to generate a wide variety of ideas. Originality is the production of unusual ideas, and elaboration involves developing or building on other ideas. Torrance (1974) developed tests of these four skills, but since they correlate very highly most scholars have focused on measuring fluency (Kogan, 1983; Runco, 1990). Another perspective on creativity is that it involves associational skills such as the generation of many or remote associations (Mednick, 1962). However, it is recognised that divergent thinking involves associational processes, so these two perspectives are not incompatible (Baer, 1993; Runco, 1990).

Group creativity can thus be defined as divergent thinking in groups as reflected in ideational fluency (Brown, Tumeo, Larey, & Paulus, 1998). In groups, divergent thinking will be affected by both associational and social processes (Paulus, Larey, & Dzindolet, 2000). Group innovation is the actual implementation of a creative idea or product by the group (West, 1990). Although creativity and innovation represent different stages in the

process of developing novel solutions, most factors that influence the process at one stage are likely to have a similar impact at the other stage (e.g. support for risk taking). Although there are different types of creativity such as perceptual or artistic (Runco & Albert, 1990; Ward, Finke, & Smith, 1995), our focus will be on ideational creativity since this is a key factor in the development and success of organisations and societies (Hill & Amabile, 1993).

Teams or group sessions are often promoted as an important vehicle for the development of creative ideas (Sutton & Hargadon, 1996). A number of scholars have examined group creativity from an organisational perspective and have highlighted some of the factors that influence group creativity or innovation (King & Anderson, 1990; Payne, 1990). For example, Woodman, Sawyer, and Griffin (1993) give a central place to group creative performance in their model of organisational creativity. Organisational creativity is seen as a function of individual characteristics (e.g. abilities and knowledge), group characteristics (e.g. norms, cohesion, and diversity), and organisational characteristics (e.g. culture, resources). Agrell and Gustafson (1996) similarly emphasise the role of organisational context, group climate, and individual abilities in innovation and creativity in work groups. Innovation will be high when organisations provide rewards, some discretion in job activities, and supportive leadership, when groups have a clear vision or goal, norms that support innovation, provide an atmosphere in which it is safe to share novel ideas, and are committed to task excellence (West, 1990), and when individuals have creative abilities and self-confidence. Innovation will be inhibited when organisations are highly centralised or formalised and when groups or individuals tend consciously or unconsciously to resist the innovative process. Amabile and her colleagues (e.g. Hill & Amabile, 1993) have emphasised the importance of environments or leadership that enhance intrinsic or self-based motivation. Factors such as freedom of choice or autonomy, challenge, and support are seen as critical for intrinsic motivation and creative accomplishment.

Although the perspectives of the organisational scholars seem reasonable and have some empirical support, there is considerable inconsistency in the literature. For example, several studies have found that resources are not positively related to creativity (Bennis & Biederman, 1997; Payne, 1990; West & Anderson, 1996). While some studies find that diversity in member characteristics such as competencies and length of tenure may be important for creativity and innovation (e.g. Andrews, 1979; Ancona & Caldwell, 1992), others find that demographic diversity and differences in professional background can hinder innovation (Jackson, May, & Whitney, 1995; Souder, 1987). Furthermore, the effect of leadership style on creativity is rather complicated (Agrell & Gustafson, 1996; Kahai, Sosik, & Avolio, 1997), but there is some support for the notion that a collaborative/

participative style is best for creativity and innovation (Anderson & King, 1993; Hill & Amabile, 1993).

The literature on organisational creativity and innovation has focused primarily on discovering factors that are related to the enhancement or inhibition of creativity and innovation in the organisation in general. The literature on group creativity has focused primarily on understanding the processes that enhance and inhibit creativity in specific groups, and whether the group process is beneficial in comparison to nongroup-based processes. Most of the research on group creativity involves laboratory studies in which precise assessments of the processes and comparisons with noninteractive control groups are possible. In this way it can be determined whether the interaction process itself has "added value" or produced some type of process gains (Gruenfeld & Hollingshead, 1993; Hackman, 1990; Hill, 1982). Studies of team and organisational creativity have not used the types of controls or control groups that allow conclusions about the role of the interaction process. To the extent that organisational innovation processes involve group and team interaction, the research on group creativity can have important implications for organisational innovation and creativity.

Research in my laboratory over the past 10 years has examined the factors that influence productivity in idea-generating groups. In the past few years we have searched for ways to demonstrate that group interaction can in fact facilitate the creative process. In this article I will summarise some findings on group creativity and highlight those factors that inhibit and facilitate creativity in groups and teams.

RESEARCH ON GROUP BRAINSTORMING

Group brainstorming was a procedure developed by Osborn (1957) and focused on ways of increasing the sharing of ideas in groups. Osborn (1957) noted that groups often evaluate ideas as they are shared, which in turn may inhibit group members from sharing ideas that they think might not receive a favourable evaluation. Osborn (1957, 1963) proposed that groups follow a set of rules that emphasise the sharing of as many ideas as possible without evaluating these ideas until some later time period. Individuals were encouraged to share any ideas that came to mind and to build on the ideas of others. Groups that follow Osborn's (1957) rules do indeed generate more ideas than those that do not (Parnes & Meadow, 1959). However, studies have not confirmed Osborn's proposal that the group brainstorming process would lead to higher rates of idea generation than individual sessions (Osborn, 1957). In fact, research has demonstrated that group interaction leads to a much lower level of productivity than does individual brain-storming in terms of both quantity and rated quality of ideas (Diehl &

Stroebe, 1987; Lamm & Trommsdorff, 1973). On the basis of this literature, other scholars and textbooks in social psychology and organisational behaviour usually conclude that group brainstorming or generating ideas in groups is not a good idea if one wants to obtain many ideas (Mullen, Johnson, & Salas, 1991; Simonton, 1988).

Ironically, the beliefs of most people about the effectiveness of group idea generation are quite positive. The majority of people believe they would generate more ideas in groups than if they were alone (Paulus, Dzindolet, Poletes, & Camacho, 1993). Even when individuals participate in group brainstorming sessions, they rate their performance more favourably than when they perform alone (Paulus et al., 1993; Stroebe, Diehl, & Aba-koumkin, 1992). This factor may be partly responsible for the continuing popularity of brainstorming techniques (Rowatt, Nesselroade, Beggan, & Allison, 1997). Brainstorming is frequently recommended as a useful technique in organisations (Kayser, 1995; Tobin, 1998)

Cognitive Interference

Some research on group brainstorming has focused on understanding the basis for the poor performance or production loss of brainstorming groups. There are a number of processes in groups that directly constrain the cognitive processes of idea generation. When others are talking in groups it is not possible to share one's ideas (production blocking, Diehl & Stroebe, 1987, 1991). This time constraint in groups may also lead participants to forget ideas while waiting to share them or to decide that they are no longer relevant. Group discussions may also involve task-irrelevant behaviours when some group members tell stories related to ideas or needlessly elaborate their ideas. The cognitive demands of attending to the ideas presented by others while attempting to generate one's own ideas may further lower individual productivity.

Social Inhibition

There are also a number of social factors that inhibit the productivity of idea-generating groups. Individuals in groups may be apprehensive about sharing their ideas freely even when they are using the brainstorming rules. Even though there may be no overt reactions, individuals may still be concerned about the private reactions of others. Those who are high in social interaction anxiety appear to be most affected by this concern (Camacho & Paulus, 1995). The potential evaluation of ideas by those outside the group can also inhibit idea generation (Diehl & Stroebe, 1987). Another factor that may be important is the tendency of individuals to loaf or be less motivated when individual contributions are combined as a group

product (Diehl & Stroebe, 1987; Paulus et al., 1993). Similarly, one may exert less effort or free ride when high performance levels by others in the group make one's contributions appear to be dispensable (Kerr & Bruun, 1983).

Individuals in groups tend to compare their performance with that of other group members. Therefore, they tend to converge both in the rate of ideas and the type of ideas generated (Camacho & Paulus, 1995; Larey & Paulus, 1999; Paulus & Dzindolet, 1993; Roy, Gauvin, & Limayem, 1996). Moreover, there appears to be a tendency towards downward comparison in that the lowest performers in the group may have the most impact on overall group performance (Camacho & Paulus, 1998; Paulus & Dzindolet, 1993). The social comparison process also seems to play a role in the illusion of productivity (Paulus et al., 1993). Individual performers may have considerable uncertainty about the adequacy of their performance, but in groups most individuals believe that their performance is either superior to that of others or not too discrepant (Paulus, Larey, Putman, Leggett, & Roland, 1996). The sense of adequacy in group performance or the illusion of productivity in groups may further inhibit the efforts exerted by the group members. Fig. 1 summarises the various factors that may play a role in the production loss typically exhibited by idea-generating groups.

Sutton and Hargadon (1996) have argued that there is too much emphasis on the productivity of group brainstorming. They propose that there are a
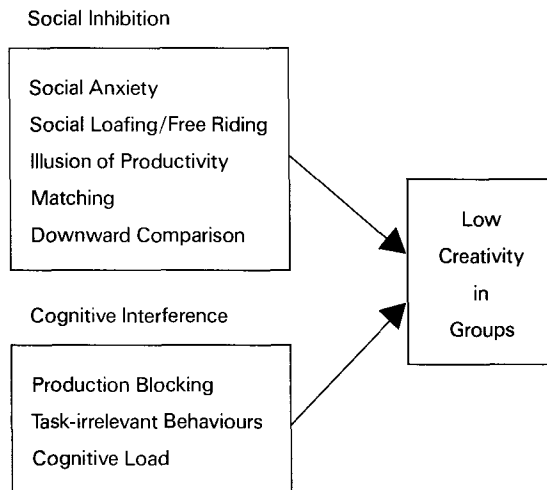

FIGURE 1.   Social and cognitive factors related to low creativity in idea-generating groups.

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number of other criteria that should be considered in evaluating the utility of group brainstorming for organisations. These are client or user satisfaction, enhancement of organisational functioning, and the growth and well-being of the participants. Sutton and Hargadon (1996) cite a case study of a product design firm in which group brainstorming was used on a regular basis. Although there were no objective data on performance or creativity, observations and interviews suggested a number of potential benefits. The participants and clients both had very positive feelings about group brainstorming. Brainstorming facilitated the development of organisational memory, the development and practice of a variety of skills, and the development of appropriate organisational norms. Participants were also able to use brainstorming to earn peer respect or status, impress clients, and provide income for the organisation.

Our own research is consistent with the idea that participants enjoy group brainstorming and will view it very positively (Paulus, Larey, & Ortega, 1995). It is quite possible that group brainstorming activities have a variety of positive effects on groups and organisations independent of the actual utility of this technique for generating good ideas. However, some of these ascribed positive effects may be quite illusory (Paulus et al., 1993; Stroebe et al., 1992), and additional research will be required to assess the merit of Sutton and Hargadon's (1996) interesting suggestions. It would seem important to determine ways to make group brainstorming effective as a tool for creative ideas, regardless of the side benefits of the technique, so that practitioners and leaders will know the most effective means for tapping the creative potential of their groups.

Overcoming Production Loss

The model presented in Fig. 1 suggests a number of strategies for counteracting production loss in idea-generating groups. One obvious technique is to limit production blocking. This can be done in various ways. Groups can be trained by facilitators to generate ideas efficiently by limiting elaborations and off-task behaviours (Offner, Kramer, & Winter, 1996; Oxley, Dzindolet, & Paulus, 1996). Oxley et al. (1996) found that groups with highly trained facilitators were able to function at the level of nominal groups (i.e. groups composed of individuals performing independently). Groups can also exchange ideas by means of written notes or computers. Research on computer-based or electronic brainstorming has found that electronic groups can perform about as well as or better than nominal groups (Dennis & Valacich, 1993; Gallupe, Bastianutti, & Cooper, 1991). With the electronic technology, group members can share ideas simultaneously (no blocking), be anonymous to other group members (low evaluation apprehension), and be accountable for their individual perform-

ance on their station (low social loafing). Insuring individual accountability can enhance performance in groups (Paulus et al., 1993; Shepperd, 1993). The inhibitory effects of social anxiety or evaluation apprehension also can be overcome by using only individuals who have low social anxiety (Camacho & Paulus, 1995).

All of the above strategies have been shown to reduce production loss in idea-generating groups. Yet, there is little evidence for interactive groups being more productive than nominal groups. There are a number of social and cognitive bases for expecting such production gains in groups (Fig. 2).
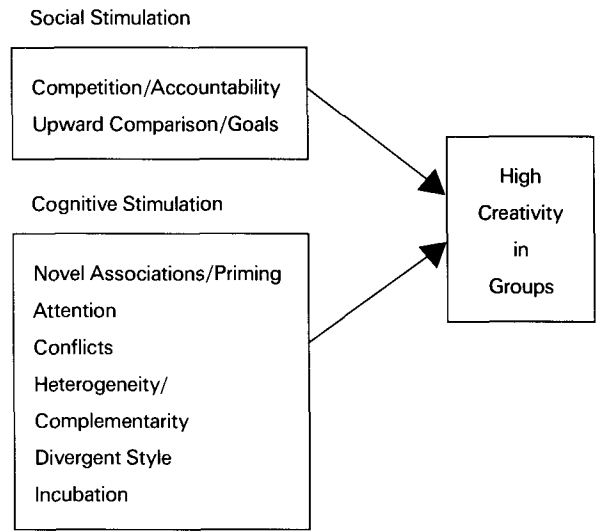
Social Stimulation

Competition/Accountability
Upward Comparison/Goals

Cognitive Stimulation

Novel Associations/Priming
Attention
Conflicts
Heterogeneity/
Complementarity
Divergent Style
Incubation

High
Creativity
in
Groups

FIGURE 2.   Social and cognitive factors related to high creativity in idea-generating groups.

THE CREATIVE POTENTIAL OF IDEA-GENERATING GROUPS

Social Stimulation

One can insure a high motivation level in groups by increasing account-ability for individual performance (Paulus et al. 1993; Shepperd, 1993). When there is an explicit concern about how well one performs relative to others or a comparison group, groups can be motivated to higher levels

of performance by a social comparison process. Providing groups with a comparison standard increases their performance (Paulus & Dzindolet, 1993; Roy et al., 1996; Shepherd, Briggs, Reinig, Yen, & Nunamaker, 1995–96), and providing explicit feedback about individual performance levels throughout the idea-generation session also improves performance (Paulus et al., 1993, 1996). Thus by focusing attention on relative performance levels and performance standards or goals one can induce feelings of competition and a concern with upward comparison. This may provide the motivation for higher levels of performance in groups. Under such conditions increased group size may be related to elevated levels of performance (Paulus, 1983). This would be especially true when the negative social factors of blocking, evaluation apprehension, and social loafing are eliminated. One way this can be accomplished is by having groups share ideas by means of written comments (Paulus & Yang, in press) or an electronic meeting system (Nunamaker, Briggs, & Mittleman, 1995). Feelings of competition may increase with group size, and this may account for the enhanced performance of large groups in electronic brainstorming.

Cognitive Stimulation

I have indicated that some social factors can increase the productivity of groups. There are also a number of cognitive benefits that accrue only from the active exchange of knowledge or ideas in groups. This particular aspect of group interaction has been the focus of much of our recent theoretical and empirical work.

One unique potential benefit of face-to-face or electronic sharing of ideas is mutual stimulation of associations (Nagasundaram & Dennis, 1993; Osborn, 1957). Ideas related to most issues or problems can be roughly divided into conceptual categories (Markman, Yamauchi, & Makin, 1997). For example, when students discuss ways to improve their university they tend to generate ideas in such areas as classes, campus life, buildings, and academic programmes. Of course, ideas within each of these categories can be further organised into still finer categories. Ideas within a category are related in some fashion such as function, domain, or production rules (Anderson, 1983). When one is exposed to an idea from a particular category, it will tend to stimulate ideas within this category since associations tend to follow the rule of similarity (Brown et al., 1998; Paulus, Brown, & Ortega, 1999; Paulus et al., 2000). However, as the group depletes the most obvious associations within a particular category, group members will tend to shift to different categories. Some categories tend to be more dominant or available in that they tend to occur more often during discussions than more cognitively remote categories (Larey, 1994). Thus a significant benefit of sharing ideas with others is that it should increase the

chance that one will come across ideas or categories one would not have thought of in a solitary idea-generation session. These ideas may in turn stimulate additional novel ideas or the use of relatively unique categories. Many creative products involve the unique combinations of ideas or categories (Markman et al., 1997), and such potential combinations are practically endless (Chomsky, 1957). Although there is much potential for cognitive stimulation in groups it is unlikely to be realised unless participants attend to each others' contributions. During group idea-generation, attentional resources can be allocated in various ways to one's own idea-generation processes, to the ideas presented by others, and to the various interaction processes (e.g. turn taking). It is presumed that the more attentive one is to the ideas of other group members, the greater the impact of these ideas (Brown et al., 1998).

Not all individuals will be equally stimulated by group interaction. Some people have a cognitive style that involves staying in a domain that is cognitively similar to the ongoing stimuli, while others tend to shift to cognitively dissimilar domains. These types of people have been given different types of labels such as convergent versus divergent (Torrance, 1974), adaptors versus innovators (Kirton, 1989), and analytical versus intuitive (Simonton, 1988). The cognitively unpredictable types (e.g. divergent) are seen as more creative since they are more likely to come up with ideas or categories that are unique or remote (Mednick, 1962; Brown et al., 1998). Combinations of divergent thinkers in groups may lead to high levels of idea generation (Brown et al., 1998).

One of the main benefits of sharing ideas in groups is that the group members can bring unique knowledge or association structures to the interaction (Stasson & Bradshaw, 1995). Of course this is more likely if the group is heterogeneous with regard to its experience and knowledge base (Jackson et al., 1995; Moreland, Levine, & Wingert, 1996). If there is much overlap in the idea space of the group members, the creative potential of the group should be limited. Stroebe and Diehl (1994) cite evidence for the positive effects of cognitive diversity in idea-generating groups. However, groups that have heterogeneous knowledge sets may not fully explore their full range of ideas (Gigone & Hastie, 1993; Stewart & Stasser, 1995).

If group members have strong feelings about their diverse perspectives, there may be considerable intragroup conflict (Levine & Thompson, 1996). This may inhibit cognitive change as individuals seek to defend their positions. However, change may occur if people are motivated by accuracy and are not pressured to accept a particular perspective (Argote, Gruenfeld, & Naquin, 2000). Conflicts are particularly likely to lead to cognitive change or divergent thinking if the source of the conflict is a vocal minority (Nemeth, 1995).

Although individuals may receive much cognitive stimulation during group idea exchange, it may be difficult to demonstrate the benefits of the exchange process during group interaction. As we have noted, face-to-face groups limit the opportunities for expression of ideas and require a division of attentional resources. However, if group interaction is followed by a solitary idea-generation session, the benefit of group idea exchange may become evident. Ideas from others will have had an opportunity to incubate or activate related associations (Csikszentmihalyi & Sawyer, 1995), and individuals can devote their full attention to integrating these associations with their own network of ideas.

Evidence for Enhanced Creativity in Groups

What evidence exists that groups can in fact facilitate the creative process? More specifically, can it be demonstrated that group interaction is more effective than solitary reflection in the generation of creative ideas? Several studies have generated some encouraging findings. Diehl (1992) found that heterogeneity enhanced group brainstorming, but the heterogeneous groups did not outperform the nominal groups. Electronic brainstorming groups that are fairly large (nine or more members) are sometimes associated with enhanced performance relative to nominal baselines (Valacich, Dennis, & Connolly, 1994), but it is not clear whether these effects reflect social or cognitive factors (Connolly, Routhieaux, & Schneider, 1993). Electronic brainstorming groups of four or six members typically perform about the same as nominal groups (Dennis & Valacich, 1993).

To demonstrate more clearly the creative potential of idea-generating groups my research colleagues have employed a cognitive stimulation paradigm. This involves exposing individuals to ideas from others by means of audio tapes, written notes, or computer messages. In most conditions individuals are asked to generate their own ideas during this exposure process and during a subsequent session in which there is no more exposure to external ideas. The postexposure session allows for an assessment of socially induced incubation or association effects (Csikszentmihalyi & Sawyer, 1995). In some conditions participants are asked to memorise the externally presented ideas in order to enhance attention to these ideas. Research from these studies indicates that exposure to the ideas of others can enhance the number of ideas generated during both the exposure and postexposure sessions (Leggett, 1997; Roland, 1997; Paulus & Yang, in press). These effects are typically enhanced by the use of memorisation instructions. For example, in one study groups of four exchanged ideas on pieces of paper without talking. This exchange process produced more unique ideas than a group of four individual writers (nominal group). In a subsequent solitary writing session, those groups that had exchanged ideas

generated many more additional ideas than those who did not have a prior exchange process (Paulus & Yang, in press).

TEAMWORK AND CREATIVITY

Effectiveness of Work Teams

There is thus some evidence that the idea exchange process in groups can function at a fairly high level and even exceed a nominal group baseline. Is there any evidence of similar effects in work teams? The group literature suggests that interaction in work teams can lead to both positive and negative effects (Hackman, 1990). Therefore, the general effectiveness of work teams and their potential for creativity will be briefly evaluated. Then the relevance of research on idea generating groups to creativity and innovation in work teams will be considered.

The use of teams in organisations has increased over the last few decades and is now prevalent in many industrial societies (Stevens & Campion, 1994). These teams can have many forms. They can vary in the degree of autonomy or self-control, with self-managing teams having a high degree of decision-making power and independence. Some work teams are fairly stable over time while others function only for a limited period. Management teams coordinate their supervisory activities and may meet only periodically.

Reviews of the effectiveness of teams have provided a somewhat mixed picture. Early reports from case studies tended to be quite positive (Cotton, 1993). However, careful analysis of research studies has led to more tentative conclusions. The evidence suggests that quality circles, which are typically manufacturing groups that have brief meetings to develop suggestions for management, are not particularly effective (Cotton, 1993). Some studies have found that traditional teams can increase productivity (Banker, Field, Schroeder, & Sinha, 1996), but most reviews find that only self-managed teams are related to strong perceptions of effectiveness and objective evidence of increased productivity (Cohen & Bailey, 1997; Macy & Izumi, 1993). Although the findings for self-managed teams could be seen as a strong endorsement for the use of self-managing teams, there are a number of reasons to be very cautious. First, in many studies the strongest effects are for perceptions of effectiveness rather than for actual productivity (Cohen & Ledford, 1994; Goodman, Devadas, & Hughson, 1988). Research on groups has demonstrated that group members may perceive that they are productive even though their objective performance is quite low (Paulus et al., 1993). There have been no studies that have used random assignment of employees to different types of teams and controlled other relevant differences in organisational context. One major problem with the field

studies is that there is likely to be considerable selection bias as to which groups become self-managed and which will be traditional (cf. Cohen & Ledford, 1994). Work groups that show the ability to work independently are most likely to be given the freedom of self-management. Many organisational factors are typically confounded with the change to self-managing teams. Change to a participative type of management often involves group level incentives, job enrichment or enlargement, multitasking, and much training (Appelbaum & Batt, 1994; Stevens & Campion, 1994). Individuals who are assigned to self-managed teams instead of traditional teams may know that more is expected from them and thus demonstrate a self-fulfilling prophecy. Finally, even if there were definitive evidence for the productivity-enhancing effect of self-managed teams, one would have to determine whether this effect was sufficient to compensate for the high costs of training and facilitating teamwork (Appelbaum & Batt, 1994).

Creative Potential of Work Teams

It is often presumed that one of the benefits of teamwork is enhanced creativity (Jackson et al., 1995). Yet we do not know of any studies of the creative process in teams. Most studies of work teams have focused on manufacturing or service settings and only a few of these have used objective measures of performance (Cohen & Bailey, 1997). In their review of the literature since 1990, Cohen and Bailey (1997) cite 13 studies of project teams that were concerned with new product development in high technology industries. None of these studies obtained productivity data. West and his colleagues have done a number of studies on team innovation. For example, West and Anderson (1996) examined innovations developed by top management teams in 27 healthcare organisations. They obtained self-report measures of group composition (proportion of innovators) and group process (commitment to objectives, participation, task orientation, and support for innovation). The innovations generated were coded and evaluated by 30 raters. Overall innovation of the team was related to all of the group process variables, with support for innovation being the best predictor. Proportion of innovative members was related to higher ratings of innovations on radicalness and novelty. The theoretical analysis by West and Anderson (1996) of team innovation represents an important advance, and the scope of their study is quite impressive. However, this study was limited by its use of both subjective measures of the process and the outcomes.

Given the rather weak empirical basis for team effectiveness and the paucity of research on team creativity and innovation, is there any reason to expect that teams have creative potential? We have cited many factors in groups that may inhibit their overall effectiveness and their creativity. For teams to be effective these types of problems need to be counteracted. Many

of the suggestions made for reducing production loss and increasing production gain in brainstorming groups should be applicable to teamwork. I will highlight the potential role of two factors which have received some emphasis in the teams literature—heterogeneity and alternation of activities (incubation).

Those who champion teamwork typically emphasise the importance of diversity at both the individual and group level (e.g. Jackson et al., 1995). Although the team members share similar goals, there is often a need for diverse expertise or knowledge. Although the benefits of such diversity seem obvious, there are some potential limitations. Individual creativity may be inhibited as one becomes more knowledgeable in one particular area to the exclusion of others (Ochse, 1990). Team members with different types of expertise and knowledge often speak a "different language", which may make a full or useful exchange of knowledge difficult (Maznevski, 1994). Some degree of knowledge or linguistic overlap is required for a knowledge team to work together effectively. This is also important in order to be able to evaluate the credibility of each others' contributions. What we don't know at this point is what the appropriate combination rule should be for different types of work. Therefore, it is not surprising that the evidence for the beneficial effects of diversity on teamwork is rather mixed (Cohen & Bailey, 1997). It seems to depend on the type of team and type of diversity. At high levels of complexity, it may be optimal to have low within-person diversity (e.g. expertise in one area) but high within-group diversity (a variety of experts). This would include teams that focus on creativity, management, and decision making. At low levels of complexity, high within-person diversity (breadth of knowledge and expertise) and low within-group diversity (similarity in expertise) may be best. Manufacturing and service teams would fall into this category.

One advantage of cognitive diversity in groups is that it increases the potential number of novel combinations that can be developed within the group. However, to attain this potential it is necessary for groups to share this knowledge base in an effective manner. Groups may go off on tangents, may not be fully attentive to ideas from all group members, and they may become overloaded with too much information in a short period of time. There may be external distractions (e.g. other tasks) that make it difficult for group members to develop a consistent focus on one problem or issue for an extended period of time. The tendency of groups to focus on information or knowledge that they have in common (Stewart & Stasser, 1995) may also inhibit the sharing process. To overcome these problems, group members must have some understanding of the knowledge and skill distribution in the group. This will make salient the areas of unique expertise that need to be matched (Stasser, Stewart, & Wittenbaum, 1995). Each group member needs to be motivated for intellectual exchange, to share the relevant

knowledge and to process carefully the pertinent information provided by other group members. External distractions should be minimised and the flow of information should be managed to avoid information overload.

The potentially facilitative role of diversity is evident in a series of studies on creative processes in scientific teams. Scientific research is increasingly being done by teams of researchers with diverse but overlapping skills and knowledge bases. The group often collaborates on the design, execution, and evaluation of the research. Although many tasks may be divided among individual researchers, much of the creative work is done in groups. Often research teams have regular group meetings in which the ongoing research projects are discussed. Csikszentmihalyi and Sawyer (1995) suggest that 99 per cent of the effort in developing innovative ideas is social in nature. The research on scientific teams provides clear support for the important role of social processes at all phases of the creative process (Tenkasi, 1995). Scientific groups thus provide an interesting basis for understanding group creativity. Since studies of the scientific process have been based on observations and interviews, they are subject to a variety of observer and retrospective biases. However, they do provide a useful supplement to controlled research in short-term settings.

Studies of such creative groups have suggested that a number of factors are important to attaining high levels of creative achievement. Creative groups should be diverse. Successful scholars often have had a diversity of experiences and mentors and tend to be interested in more than one area (Simonton, 1995). Groups that contain people with diverse but overlapping knowledge domains and skills are most creative (Dunbar, 1995). Dunbar (1995, 1997) found that heterogeneous groups are more likely to use analogies to make sense of unexpected findings. Successful teams were led by a scientist who was willing to take risks, although often successful groups worked on both a high risk and a low risk project. Risk taking is also emphasised by Stein (1982) and in Sternberg and Lubart's (1995) investment theory of creativity. Sternberg and Lubart (1995) suggest that to optimise creativity one should buy low and sell high. That is, one should seek out ideas that are undeveloped and have growth potential and minimise one's investment in those that have already become valued by society or one's colleagues. This risk-taking bias is consistent with the emphasis in brainstorming on a nonevaluative atmosphere and expressing all ideas that come to mind.

The exact processes by which scientific groups develop creative ideas are not well understood. Several scholars have emphasised that the communication or interaction among members of creative teams is critical. This provides an opportunity for sharing of knowledge and feedback on shared ideas. According to Simonton (1995) the best way to develop creative ideas is to connect ideas from different fields or areas, sometimes in a random

manner. This is, of course, the divergent type of thinking promoted by brainstorming. In a similar vein, Csikszentmihalyi and Sawyer (1995) note that many creative individuals focus on generating a high quantity of ideas from which the good ones are selected for further development.

Analyses of the incubation process suggests that it is important to be involved in a variety of activities. "Individuals who are most prolific in the production of important insights commonly engage in many varied projects simultaneously" (Simonton, 1995, p. 484). They also often schedule idle time to allow for such a process (Csikszentmihalyi & Sawyer, 1995). Similarly, group sessions should be followed by individual idea-generation sessions to fully tap the cognitive benefits of the exchange process. Although such a procedure was recommended by Osborn (1963) and others (Grossman, 1984), it is likely to be overlooked as an option since for most groups it may seem more natural to stay in a group mode for a particular task unless some external event or direction prompts a change (McGrath & O'Connor, 1996). If group sessions are followed by individual sessions, the group will then have to meet again to exchange the additional ideas generated in private prior to moving to a decision-making phase. Present research does not provide much guidance as to the optimal length for group/individual sessions and the relative proportion of time that should be spent in group versus individual idea generation. Nystrom (1979) proposes that group interaction may be most beneficial in the early stages of innovation. Yet we have found that a group-to-alone sequence of idea generation leads to more overall ideas than an alone-to-group sequence (Putman, Paulus, & Leggett-Dugosh, 1999).

The literature on the creativity of research and management teams thus provides support for the hypothesised importance of heterogeneity and alternation of individual and group activities. The consistency of perspectives gained from the groups and teams literature is encouraging. This suggests that the laboratory and field research are converging on a similar model of group creative processes. However, in one area there is a clear divergence between the groups and teams literatures. Only the teams literature has emphasised the importance of autonomy in productivity and innovation (Amabile, 1988; Cohen & Bailey, 1997). However, there have been no systematic studies of this factor on the creative process in teams and groups. Most groups research is laboratory based, involves performance on a single task, and small groups of college students who are randomly assigned to work under some conditions for a short period of time. These students typically do not have any choice in the group tasks or how their efforts should be allocated among a range of tasks. It certainly would be interesting to study laboratory-based groups under conditions similar to those experienced by self-managed teams to determine the impact of autonomy and support for innovation on group processes. This type of

research should be complemented with studies in organisations of the group processes that occur in traditional and self-managed groups. These two lines of research would help to establish a factual basis for understanding the factors related to effectiveness and innovation in autonomous groups and teams and allow for a more definitive assessment of the various theoretical perspectives.

CONCLUSIONS AND APPLICATIONS

The literature on group creativity has suggested a number of guidelines for optimising creativity in groups (Kayser, 1994, 1995; Woodman et al., 1993). The use of challenging goals, structured group interaction, autonomy, and a supportive environment are among some of the factors that seem to facilitate creativity and innovation in groups. Yet it is clear from both experimental and field research that task or workgroups often do not reach their potential (Gigone & Hastie, 1997; Hackman, 1990). When groups collaborate there may be a tendency to loaf, to prematurely evaluate group products, or for some individuals to dominate the group process or distract the group from its goals. Techniques that assure efficient interaction, appropriate leadership, and motivating goals may help groups overcome some of the negative forces. However, such groups may still not exceed the productivity of similar numbers of solitary performers. This is clear from the research on idea generation in groups. Idea generation is an important part of the creative process in groups (Fisher & Fisher, 1998; Kayser, 1994). Controlled studies have shown that often the idea-generation output of groups is less than that of a similar number of individuals generating ideas in isolation (nominal groups). Motivational techniques such as goal setting (Paulus & Dzindolet, 1993; Wegge & Kleinbeck, 1996; Weingart & Weldon, 1991) and increasing accountability (Diehl & Stroebe, 1987) improve performance for both interactive and nominal groups but do not change the relative degree of production loss experienced by groups. Procedures that change the nature of the interaction process such as the use of facili-tators (Oxley, Dzindolet, & Paulus, 1996), writing (Paulus & Yang, in press), and electronic brainstorming (Nunamaker et al., 1995) have been able to completely eliminate the production loss. However, thus far there have been only a small number of demonstrations of the often anticipated production gains in idea generating groups in comparison to nominal groups. We have suggested conditions under which such synergy can be observed. This is particularly likely when groups bring together diverse knowledge and process this information or knowledge carefully. The benefits of such information processing may not be evident until there has been some opportunity to integrate the socially acquired information with one's own knowledge base.

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What are the practical implications of this perspective? The major implication is that we typically underestimate the difficulty of group members reaping a full benefit from the idea exchange process that is part of most decision-making and problem-solving processes in groups. Even if organisations follow the recommendations of the various models of organisational innovation and employ self-managed teams, they often may not effectively harness the creative potential of their groups. The research reviewed and the models presented in Figs 1 and 2 suggest a number of techniques that could be employed to enable groups to reach a high level of creativity.

First, the exchange process should be structured to minimise production blocking, evaluation apprehension and social loafing. This can be done in part by means of facilitators who manage the group interaction process effectively, group training, the development of appropriate group norms, or by the use of a writing or electronic exchange process (e.g. Kayser, 1994). When ideas or information are exchanged, it is important to emphasise the need to attend carefully to the ideas presented by others. Group members may wish to write down particularly novel ideas or the group may institute some type of group recording process (e.g. a flipchart). Group sessions should be followed by an opportunity for solitary reflection before decisions are made.

It is usually presumed that generating a large number of ideas will enable groups to make better decisions or to come up with better quality solutions (Daniels, 1986; Osborn, 1963). This may not be an inevitable result. Groups may find it difficult to process effectively a large number of ideas and to evaluate them according to various criteria such as feasibility or resources. Organised procedures for evaluation and voting may be required to efficiently determine the best alternatives (Kayser, 1995; Van de Ven & Delbecq, 1974; Nunamaker et al., 1995).

Finally, we have suggested that cognitive diversity within a group is one of the primary bases for enhanced idea generation. This belief is echoed by other scholars (Jackson, 1996) and practitioners (Gardenswartz & Rowe, 1994). However, it has yet to be clearly demonstrated in controlled research on idea generation. Although cognitive diversity within groups should be stimulating, it also may produce conflict and may make consensus difficult in the decision-making phase. Moreover, individuals tend to focus on information or knowledge that they have in common rather than their knowledge that is unique to particular group members (Stasser, 1999). So it will be important to manage the group process carefully to enhance the benefits of diversity. This would involve the use of procedures that promote the sharing of diverse information such as encouraging more thorough discussions (Larson, Christensen, Abbot, & Franz, 1996) and making group members aware of each others' expertise (Stasser, in press).

DIRECTIONS FOR RESEARCH

Although there has been considerable progress in understanding the group creativity process, many interesting issues remain to be resolved. Some of them have already been briefly mentioned. However, for the sake of completeness I have provided a listing of these and others that seem worthy of further exploration.

1. How should group and solitary activities be dispersed in the creativity process? Are there some optimal timing and alternation sequences?
2. How beneficial are different types of diversity (e.g. knowledge, personality, opinion) for group creativity? Under what conditions will the potential benefits (e.g. cognitive stimulation, constructive conflict) outweigh the drawbacks (e.g. communication problems, emotional conflicts).
3. Will the various techniques that have been shown to enhance group creativity also facilitate creativity and innovation in work teams? Will work teams benefit from increased attention to others' ideas, electronic interaction, training in effective idea sharing, alternation of group/solitary sessions, high group standards or norms, and so on? If there are positive effects, what are the bases for such effects? Can such effects become entrained or stabilised as part of the group or team culture/norms (Kelly & Karau, 1993)? How much impact will improvement of creativity at the level of groups or teams have on overall organisational innovation?
4. How much will groups benefit at the stage of decision making or prioritisation from a large number of ideas generated during the creativity phase? How well will groups be able to select the best alternatives when they are faced with discussion and evaluation of a large number of ideas? Will the groups that generate the most ideas also tend to come up with the best ones?
5. How important is autonomy or the freedom to choose tasks and to allocate one's time and resources in the group creative process?
6. Do the types of illusions of effectiveness that have been observed in groups also exist for teams and organisations? Under what conditions are these illusions evident? Will reduction of such illusions enhance creativity and innovation?

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