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The relationship between individual creativity and team creativity: aggregating across people and time

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Summary This paper investigates how the creativity of individual team members is related to team creativity, and the influence of climate for creativity in the workplace on individual and team creativity. A multilevel theoretical model is proposed, and the authors report a study which tests the model using a sample of 54 research and development teams. The results showed that team creativity scores could be explained statistically by aggregation processes across both people and time. Team creativity at a particular point in time could be explained as either the average or a weighted average of team member creativity; the creativity of project outcomes was explained by either the maximum of or average of team creativity across time-points. According to the model, failure to account for aggregation across time as well as across individuals can result in misleading empirical results, and can result in the erroneous conclusion that team climate influences team creativity directly rather than indirectly via individuals. Copyright © 2004 John Wiley & Sons, Ltd.

Introduction

In considering the theme of this journal issue on the consequences of workplace creativity, our attention has been captured by a simple yet elusive question: In interdependent teams striving to produce creative outcomes, of what consequence is the creativity of individual team members? More specifically, what is the relationship between individual creativity and overall team creativity, and at which of these levels do contextual factors have an influence?

Many organizations have turned to team-based work systems to increase their responsiveness and their ability to foster innovation (cf. Mohrman, Cohen, & Mohrman, 1995). Such organizations need to be concerned not only with fostering creativity and innovation among individual employees, but also with developing creative and innovative *teams*. However, it is unclear how organizational support for creative teams differs (if at all) from support for creative individuals. Researchers have tackled this issue either by focusing on the contributions of individual team members (e.g., Scott & Bruce,

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1994), focusing on the team processes and broader contextual influences (e.g., Bain, Mann, & Pirola-Merlo, 2001; Burningham & West, 1995), or by examining the interaction between member contributions and group processes (e.g., Taggar, 2002). These studies tend to use as outcomes either individual creativity or group creativity/innovativeness, and each of these approaches has limitations: using only individual-level performance measures can lead to atomistic fallacies if the findings are used to make inferences about team-level relationships (Kozlowski & Klein, 2000); using only team-level performance measures sheds little light on the specific mechanisms (at the micro-level) by which team-level relationships operate. The present study uses both individual-level and team-level measures of creativity to investigate the relationship between creativity at these two levels, as well as the impact of organizational and team climate for creativity/innovation. We first describe a selection of theories that explain workplace creativity at the individual and team levels, as well as describing previous theoretical and empirical work linking individual to group performance. We then develop a multilevel model which describes team creativity as the aggregate of team member creativity over time. Finally, we report the findings from a study that tests this model's assumptions and predictions.

Theories of Individual and Group Creativity

Creativity has been defined as a judgment of the novelty and usefulness (or value) of something (Bailin, 1988; Ford, 1996; Mumford & Gustafson, 1988). Psychological research on creativity has tended to focus on individuals and intra-individual factors (e.g., motivation; Amabile, 1982). Researchers from other domains, particularly sociology, have focused on more macro issues concerning the influence of the environment on creativity (Ford, 1996). The macro perspective has also been associated with an interest in innovation, 'the intentional introduction and application . . . of ideas, processes, products or procedures, new to the relevant unit of adoption, designed to significantly benefit' (West & Farr, 1990, p. 9). Because innovation involves newness and usefulness (benefit), it can be seen to incorporate creativity, in addition to adoption/implementation (Ford, 1996). These definitions explain how researchers define and differentiate creativity and innovation. However, we acknowledge that popular use of the terms creativity and innovation does not necessarily adhere to these definitions. In particular, in the context of research and development (R&D) organizations, 'innovation' refers to the *production* of something that is new and useful. The processes involved in implementing that thing (usually in a client's organization) are usually considered a separate manner, dealt with after the 'innovation.'

While researchers focusing on creativity from either a micro or macro perspective have made significant advances, the two approaches have tended to remain separate. It is only relatively recently that considerable theoretical advancements have been made in linking the macro and micro levels, the work environment with intra-individual components. One important theory linking contextual factors with intra-individual factors is Amabile's (1988, 1997) Componential Model of Organizational Innovation. This identifies three intra-individual factors important for creativity: domain-relevant knowledge, creativity-relevant skills, and motivation. The Componential Model also describes characteristics of the work environment in an organization that impact on individual creativity via the above three intra-individual components: (1) organizational motivation to innovate; (2) resources; and (3) management practices.

Ford's (1996) Theory of Creative Individual Action also links the work environment with intra-individual factors to explain individual creativity. Ford's theory describes three individual characteristics which overlap conceptually with the components of Amabile's (1988, 1997) model, viz: *sense* *making*, *motivation*, and *knowledge and ability*. These factors interact with the individual's context to determine whether the individual engages in creative versus habitual actions. From this it follows that in any given situation or moment in time, either creative or habitual actions may be observed in an individual (setting aside the role of context in determining which actions are considered creative). Ford (1996) uses the term 'behavioral episode' to describe the moments that make up an individual's experience with reference to some goal or desired outcome. Thus, Ford's (1996) theory implicitly models the creativity of a final product or outcome as some form of aggregate of the creativity versus habitual action across behavioral episodes.

The final theory of creativity discussed here is West's (1990) model of team climate for innovation. Just as the concept of *organizational climate* has been studied in relation to specific reference points, such as *climate for service quality* (Schneider & Chung, 1996), team climate also has been studied in reference to team creativity and innovation. West identifies four team climate factors important for innovation: (1) vision, referring to a shared commitment to clear objectives; (2) participative safety, a sense that team members can participate in decision making and can share ideas without fear of ridicule or ostracism; (3) task orientation, which refers to a shared concern of team members for achieving a good standard of performance; and (4) support for innovation, which refers to the expectation of—and support for—innovation in the team. These four factors have been found to predict creative performance in a number of empirical studies (cf. Agrell & Gustafson, 1994; Bain et al., 2001; Burningham & West, 1995). West's (1990) model is multilevel in the sense that through shared experiences team climate emerges from shared perceptions of the team environment by team members. However, it is single-level in its treatment of the outcome (group creativity or innovation) as a global unit property. That is, team climate is modeled as impacting on group outcomes, but not necessarily via individuals and individual outcomes.

Individual Contributions to Team Performance

There has been little attention given to the relationship between group performance and the individual contributions of members. This is actually not surprising, because that relationship depends on the nature of the group task, and so findings with one type of group working on a particular type of task cannot be generalized to others. Steiner (1972) described a typology of tasks based on the relationship between member performance and group performance. For example, a disjunctive task in Steiner's typology is one where group performance is determined by the performance of the best (most able) member. An additive task, by contrast, is one where group performance is simply the sum of its members' performances, such as a relay-race team whose performance (total time) is the sum of the times from each individual leg.

In addition to describing taxonomies of task structure, researchers have examined the relationship between individual contributions and group performance in a variety of ways. For example, group diversity research has examined the relationship between group composition (e.g., in terms of personality and ability of members) and performance (West, Borrill, & Unsworth, 1998). Stevens and Campion (1994, 1999) took a novel approach to studying group member characteristics by conceptualizing a set of cognitive abilities, 'teamwork KSAs,' that determine how well an individual can work productively with others in a team. These characteristics have been associated with individual performance in team tasks (Stevens & Campion, 1999; Kickul & Neuman, 2000). However, there has been no support for the hypothesis that teamwork KSAs are associated with *team* performance (Kickul & Neuman, 2000).

One study that attempted to link individual creativity to group creativity, and to show the impact of group processes on each of these, was reported by Taggar (2002). This study showed that aggregated (summed) peer ratings of group members' creativity were predictive of externally rated group creativity ($r = 0.56$, $p < 0.01$) among students working on assignments in teams. Further, there was an interaction effect such that team creativity was highest when teams had high ratings of individual creativity and also of creativity-relevant processes (e.g., team citizenship, effective communication). One limitation of this study was the use of creativity ratings at the individual level that did not match those at the team level, both in terms of the rating scale used and also the time period: team creativity on weekly tasks was externally rated and feedback given each following week, but individual creativity was rated at the end of the 13-week period, when peers rated each other's creativity in general over the whole period. It is not unlikely that the feedback on team creativity during the 13 weeks influenced members' ratings of their peers' individual creativity, collected at the end of the study.[1] It was also at this final stage of the study that ratings of individual behaviors, which were aggregated to form the measure of team creativity-relevant processes, were obtained. These also may have been influenced by the history of feedback.

Team Creativity as an Aggregate of Creativity across Individuals and Time

Research and development projects, or indeed any type of project for which multidisciplinary teams are formed in organizations, typically require input from different members and different areas of knowledge. Further, these teams usually interact to share and develop ideas, as well as to integrate different components of a task that were developed independently. Thus, creativity can occur as individuals work separately on components of the larger project, and can also occur as members interact with each other, as they share, build upon, and critique/filter ideas together. Such interactions may stimulate creative ideas among the individuals, but these creative contributions can still be attributed to specific individuals. That is, group interaction may influence individual creativity, but the relationship between the creativity of these individuals and the creativity of group-produced outcomes may be simple nonetheless. One likely possibility is that group creativity is an additive type of task, where each individual's creativity adds to the group's. Alternatively, group creativity may resemble a disjunctive type of task, where the most creative ideas (which may originate from a particular individual) are adopted by the group and determine group creativity (Steiner, 1972). Another plausible alternative lies somewhere between these two types, where each individual makes a contribution, but the importance of that contribution to the creativity of the group product is weighted in some way (e.g., the most creative member's contribution is most important).

The proposal that team creativity is influenced and to some extent determined by individual creativity seems uncontroversial. However, an important question that is far less clear is whether team creativity is *completely* determined by individual creativity. That is, is team creativity the same thing as the total of the team members' creativity?

Taggar's (2002) findings that team creativity-relevant processes accounted for additional variance in team creativity beyond that already accounted for by individual creativity suggests that group

[1]Except for one item, which used a within-group rating metric (how creative has this individual been relative to others in the group); however, this item, being group-referenced, cannot be used for hypothesis testing about influences on group creativity.

creativity is not completely determined by individual creativity; rather, group creativity might emerge synergistically when members interact in certain ways. This evidence suggests that individual creativity can provide the raw material of novel and useful ideas, but that team member interactions and team processes play an important role in determining how this raw material is developed into group-level creativity. In other words, this evidence seems anomalous, in a Kuhnian sense, to the position that team creativity is completely determined by individual creativity. We argue, however, that it is possible to account for Taggar's (2002) findings without necessarily accepting that group creativity is more than the aggregated creativity of group members.

We propose a multilevel model of team creativity which views team creativity as the simple aggregate of individual creativity, but which can explain the apparent anomaly discussed above. Our intention is not to *disprove* the view that group creativity is synergistic in nature, but rather to show that alternative explanations are also consistent with existing evidence. The model we propose is shown in Figure 1. This multilevel model is proposed as a possible explanation of how creativity unfolds in teams over time, and how this is influenced by climate for creativity. The components of the model are explained below.

The left-hand side of Figure 1 represents climate for creativity as a team-level factor which emerges from the shared perceptions of team members. Thus, a compositional form of emergence is assumed, in which the group-level manifestation of the construct shares an isomorphic relationship with its manifestation at the individual level (Kozlowski & Klein, 2000).

The middle part of Figure 1 represents the relationship between team creativity and team member creativity. Team creativity is depicted in our model as resulting from a fuzzy-compositional form of emergence (Bliese, 2000). Individuals working on independent or interdependent tasks may achieve those tasks with various degrees of creativity. Some of these tasks may be peripheral, having little bearing on project outcomes, and others may be more central or core. Thus, individual creative contributions will be integrated or combined in some way, which may be determined by the task structure itself, and perhaps also by team members and notably team leaders. The way these task components are integrated will determine the specific form of emergence for group-level performance. Because the way the individual contributions are integrated may vary from team to team and from project to project, a particular form of emergence that applies to creativity in all teams cannot be specified. However, we suggest that in typical interdependent project teams team creativity emerges as a combination of lower-level elements (individual creativity). Because these elements and their *combination* produce the group-level construct (team creativity), it is distinct from the compositional form of emergence which is characterized by an isomorphic relation between the expressions of a construct across levels (Kozlowski & Klein, 2000). The nature of the aggregation function is not specified here, but two reasonable assumptions for creativity in a typical project team are either an averaging function (i.e., group creativity is the average or sum of individual creativity) or a weighted averaging function (where certain individuals' creative contributions are more important than others').

The model draws on Ford's (1996) view of creativity as occurring in behavioral episodes which unfold over time. For any particular behavioral episode, the model defines team creativity as the aggregate of the individual members' creativity as described above. The depth dimension indicated by the time axis in Figure 1 represents the unfolding of sets of behavioral episodes over time. Each task or component of an R&D project could be conceptualized as a behavioral episode. Our model proposes that the creativity of the final project outcomes produced by the team is determined by the creativity demonstrated by the team at each of the behavioral episodes comprising the project. That is, creativity of project outcomes shows some form of fuzzy-compositional emergence across time, analogous to the relationship between individual and team creativity described above. Again, the specific form of emergence is not specified here, but it would be reasonable to assume that overall project creativity is the sum of creativity in the component tasks, or else is the weighted sum where certain parts of a project

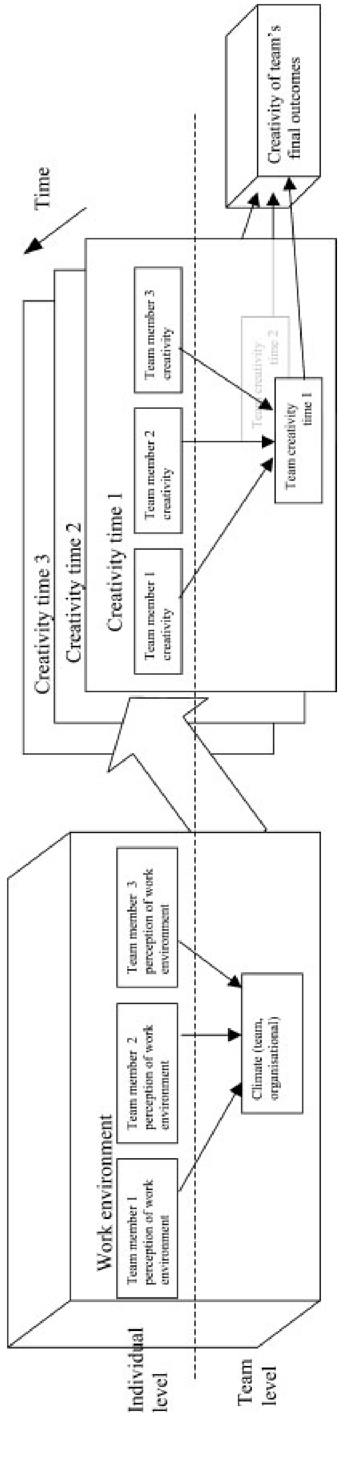

Figure 1. Proposed model of creativity aggregated across individuals and time

(e.g., initial planning phase, in which the objectives are clarified and the general technical approach towards them is established) have more bearing on the final outcome creativity than others.

Although we have conceptualized R&D projects as linked sets of behavioral episodes, in practice it would be very difficult to nominate the boundaries separating one episode from another. Therefore, in the remainder of this paper, we use time in an approximately similar way to 'slice' a project into smaller parts. This enables us to study the activities in a team during a series of time intervals, and to view the overall project as the total work that takes place during those intervals.

The final component of the model is the relationship between climate and creativity. A reasonably large body of evidence has accumulated supporting a relationship between climate (team or organizational) and team creativity (cf. Amabile et al., 1996; Bain et al., 2001; Burningham & West, 1995). Our model proposes that team creativity is simply the aggregated creativity of team members. Therefore, group-level phenomena, such as team climate (West, 1990) or team creativity-relevant processes (Taggar, 2002) should have a measurable impact on individual team member creativity. For example, a climate of participative safety will increase the likelihood that a team member will contribute an idea that is unusual or risky. Thus, climate could facilitate individual creativity, and therefore indirectly (via that individual) have a positive influence on team creativity. Therefore, Figure 1 includes a link from team climate to individual creativity and, importantly, does *not* link team climate directly to team creativity. As discussed above, it is not our intention to *prove* that climate has no direct link to team creativity, but rather to show that such a link is *not essential* in accounting for previous evidence such as that reported by Taggar (2002).

We assume that perceptions of the work environment, while subject to some change, tend to be relatively stable over time. Thus, these factors exert a relatively constant influence on individual creativity as the behavioral episodes unfold over time. Although the authors are unaware of any published evidence for the stability of West's (1990) team climate factors or Amabile et al.'s (1996) work environment for creativity factors, the way these constructs manifest at the group level via interactions over time suggests that they tend to be relatively slow-changing (Kozlowski & Klein, 2000)—at least compared to individual perceptions. An implication of this is that climate may show larger effects on those measures of creativity that encompass long time periods (e.g., how creative are the final outcomes produced by a team) than on measures encompassing shorter periods (e.g., how creative were the team's achievements over the last four weeks).

Testing the Aggregation Model of Team Creativity: An Empirical Study

A study of R&D project teams was conducted to test the model shown in Figure 1, which depicts team creativity as the aggregate of individual creativity, and creativity of team products as the aggregate of team creativity over time. Under the following subheadings, we discuss each component of the proposed model and explain our approach to testing it.

Emergence of team climate

Because we assumed that team climate manifests at the group level via compositional emergence, we first attempted to support this by demonstrating group-level variance and within-group inter-rater agreements for measures of climate.

Hypothesis 1: Measures of climate for creativity will show high within-group agreement and significant variance attributable to team membership.

The impact of climate on individual creativity

Hierarchical linear modeling was used to test (1) whether there was significant between-groups variance in team member creativity scores (i.e., whether an individual's team membership had an impact on their individual creativity rating); and (2) whether shared team climate was predictive of the between-groups variance in individual creativity ratings.

Hypothesis 2: Team-level measures of climate for creativity will significantly predict ratings of team member creativity.

The relationship between team member creativity and team creativity

Firstly, the relationship between individual and group creativity during a specific time period was investigated. As discussed previously, it was expected that a rating of team creativity for a specific time period would be highly correlated with the average of ratings of team member creativity for the same period. Alternative types of aggregating function were also examined and correlations used to identify which showed the strongest relationship with team creativity. The functions tested were: the average of team members' creativity, minimum team member creativity, maximum team member creativity, and a weighted average of team member creativity. This last function tested the view that the creativity of each team member is important to team creativity, but the most creative members have a disproportionately large influence on team creativity. Each team member's creativity rating was multiplied by their within-team percentile rank on the same variable. This new product variable was then averaged across team members to produce the weighted average for the team. The average, maximum, and minimum aggregation functions correspond to the view that team creativity is an additive, disjunctive, or conjunctive task type respectively (Steiner, 1972). The fourth function (the weighted average) was used because it conceptually corresponds to a system that is somewhere in between a completely additive task and a completely disjunctive one. This function also has the advantage of being computationally simple. Although different aggregating functions were explored, we based our hypothesis on the average function, as this is conceptually and computationally the simplest.

Hypothesis 3: Team creativity will be positively correlated with average team member creativity.

Secondly, we tested whether team processes account for significant unique variance in a time-general measure of team creativity (i.e., assessment of overall team creativity that was not referenced to the recent time period), after accounting for recent individual creativity (aggregated). This is an attempt to replicate findings reported by Taggar (2002). Those findings appear to suggest that team creativity is *more than* the sum of its members' creativity. Therefore, we wished first to replicate the finding in the current sample, in order to subsequently show that our aggregation model (Figure 1) can account for such a result while still depicting team creativity as completely emergent from individual creativity.

Hypothesis 4: Scores on climate for creativity will have a significant relation with a time-general measure of team creativity, even after accounting for the effect of recent team member creativity.

It was noted previously that there was a mismatch between the timing of individual and team creativity scores in Taggar's (2002) study. Similarly, the analysis described above uses a time-general rating of creativity at the group level but a time-specific rating of individual creativity. We argue that this mismatch is responsible for the finding that group process factors are incrementally predictive of team creativity even after accounting for individual creativity. This is because the overall (time general) creativity of a team's work is made up in some way from the team's creativity at several specific time periods. Thus, overall creativity will not be explained completely by any particular time-specific rating of creativity if that specific period is only a small proportion of the total time the team has worked on the project.[2] However, because team climate is a relatively stable characteristic, it is expected to correlate to some degree with creativity at each of the time periods—that is, it exerts a relatively stable influence. The apparent incremental predictive validity of team climate (predicting team creativity) is an illusion: team climate, we argue, is merely acting as an imperfect indicator of the team's creativity from all of the specific time-periods *not* already accounted for. Thus, it is to be expected that team climate will incrementally predict overall project creativity even after accounting for creativity from a single point in time (whether measured at the individual or group level).

According to our argument above, if time-specific ratings of both individual and team creativity are used (from the same point in time), then the incremental predictive validity of climate for creativity will disappear. We tested this in two ways: first, we used the same approach as the above regression analysis, except that individual and team creativity ratings that were referenced to the same point in time were used. We predicted that in this analysis group processes would *not* account for significant variance in team creativity, once individual creativity has been accounted for. Although this essentially is a hypothesis of 'no effect,' it was tested as though an effect was expected, consistent with the standard approach to statistical testing. A confidence interval was also calculated in order to draw conclusions about whether any observed effect was negligible. Secondly, we used hierarchical linear modeling to conduct a similar analysis. This identified the proportion of variation in team member creativity that was attributable to team membership, and then tested how much of this variance could be predicted by the team climate, after accounting for team creativity.

Hypothesis 5a: Climate for creativity will *not* significantly predict recent team creativity after accounting for the effect of recent team member creativity.

Hypothesis 5b: Climate for creativity will *not* significantly predict recent team member creativity after accounting for the effect of recent team creativity.

The aggregation of monthly creativity towards the creativity of project outcomes

Finally, the aggregation model described above assumes that work environment perceptions remain relatively stable over time, and that overall project creativity is the average or sum of team creativity across time periods or behavioral episodes. This leads to the prediction that a team's climate for creativity will show a stronger relationship with ratings of overall project creativity than with team creativity in a specific (relatively short) time period. Further, overall project (outcome) creativity will have a positive correlation with the average of team creativity ratings obtained across several measurement periods, and have relatively smaller correlations with team creativity ratings from any single measurement period. However, testing for differences in correlations is very difficult in analyses based on team-level data, due to difficulties obtaining sufficient power. Thus, we simply hypothesize:

[2]Two exceptions to this statement are apparent: one is the case where that particular time period involved the most crucial part of the team's work, and hence creativity during that time completely determines how creative the overall project outcomes are. The second is the case where there team creativity has a perfect autocorrelation across time points, which seems quite improbable.

Hypothesis 6: The creativity of final project outcomes will be positively correlated with monthly ratings of team creativity, and with the average of monthly creativity ratings.

Organizational Context

Timing and Location of the Study

The 56 teams were drawn from 15 divisions of four large R&D organizations in Australia. Starting dates for participation in the study differed for each organization, from November 1996 to July 1997. The final project outcome measures were obtained in April–December 1998.

Types of R&D Projects Studied

The 56 teams worked on a wide variety of project types, from technical service projects funded by external customers, to blue-sky research funded internally by the organization. Two teams described their projects as mainly basic research, 22 as mainly applied research, 16 as mainly development, and 2 as mainly technical services. The remaining 14 projects were described as equally research and development activity.

Characteristics of Participating Teams

According to team leaders, the core team members had worked together on the current project or previous related projects for between zero and 10.5 years (mean = 21 months). The sample was highly qualified (as is typical of R&D staff), with 3 per cent holding a high school certificate or equivalent, 23 per cent with bachelor's degrees, and the remaining 74 per cent with postgraduate diplomas or degrees (including 28 per cent with PhDs). Most teams (75 per cent) were multidisciplinary. On average, team members were attached to the projects for 74 per cent of their time, with a range of 5–100 per cent.

Method

Sample

Fifty-six R&D project teams, comprising 47 females and 272 males (five female project leaders and 51 male project leaders) agreed to participate in the study. The teams had been working on their projects for between 12 months and 12 years ($M = 3$ years and 4 months). These teams were drawn from four large R&D organizations: two large public sector research organizations in the areas of science and defense technology, and two commercial organizations in the resources and industrial products industries. Each of these organizations had a number of separate R&D divisions, reflecting either the type of science (e.g., chemical polymers) or the type of client and project work (e.g., army-related projects as distinct from airforce-related projects). The divisions each operated from their own laboratories/work sites, and effectively functioned as distinct organizations in themselves. The sample of 56 teams was drawn from 15 such divisions.

Of the 56 teams, two had only one member respond to the initial questionnaire (from which climate measures were obtained) and so were eliminated, leaving an effective sample of 54 teams. The average team size, determined by the project leader's listing of all people he or she considered members (including the project leader), was 6.9, with a median value of 6.0. The range was from two team members (four projects) to 18 team members. All were sent a set of questionnaires (see below) each month over a period of 12 months. However, several teams had completed their projects, and response rates were very poor during the final 3 months, so only the first nine measurements are reported. The initial questionnaire (including climate measures) was responded to by an average of 4.8 members per team (a median of 4.0 per team). The average within-team response rate was 75 per cent. Response rates fell in an approximately linear fashion over subsequent months, probably partly due to fatigue, but also largely due to projects finishing during the period of study and to several projects losing some team members. By month 9, nine teams had disbanded/ceased project work. At this measurement period, team creativity scores were obtained for 30 of the 54 teams that had responded initially, and the number of responses had dropped to an average of 2.4 members per team, a within-team response rate of 38 per cent.

Measures of climate for creativity and of individual and team creative performance were obtained at time 1. Only creativity measures were collected during the subsequent months of the study. Thus, the falling response rate may have affected analyses concerned with relationship between creativity of project outcomes and month-by-month creativity. Lower responses per group would be expected to produce less reliable group scores (due to missing values within groups), and thus creativity measured at later months might show lower correlations with other measures. Also, fewer group-level data points would reduce statistical power, making tests less likely to detect effects (i.e., have greater chance of type II error) for analyses involving the later data points.

Measures

1. Team climate for innovation

The Team Climate Inventory (TCI; Anderson & West, 1998) was used to measure the four components of West's (1990) model of team climate for innovation, viz: participative safety (e.g., 'people feel understood and accepted by each other'); support for innovation (e.g., 'people in this team are always searching for fresh, new ways of looking at problems'); task orientation (e.g., 'do you and your colleagues monitor each other so as to maintain a higher standard of work?'); and vision (e.g., 'how clear are you about what your team objectives are?'). This was included in the initial (time 1) questionnaire only.

2. Organizational encouragement of innovation

This factor, corresponding with the organizational motivation to innovate factor in Amabile's (1988, 1997) Componential Model, measures a perceived organizational climate that values innovation and encourages open sharing of ideas. This seven-item measurement scale is part of a questionnaire developed by Pirola-Merlo (2000) and uses a five-point response scale, with 1 = 'strongly disagree' and 5 = 'strongly agree.' Example items are 'This organization recognizes and welcomes innovativeness in its employees' and 'The path to success in this organization is to play it safe and stick with tried and tested methods' (reverse-scored). Instructions indicated that respondents should answer questions about 'this organization' with reference to the division in which their team worked. The scale reliability was 0.85 (based on the sample from the present study). This scale was also completed at time 1 only.

3. Individual and team creativity

A number of different ratings of creativity were obtained. First, recent team member (individual) creativity was measured using self-ratings. Respondents were first asked to recall the work they had done on the project in the last month, and were asked various descriptive questions about it to aid recall. They were then provided with a definition of innovation from West and Farr (1990, p. 9) 'ideas, processes, products or procedures, new to the relevant unit of adoption'—and were asked to rate how innovative their own work on the project in the previous month had been, on a scale from 0 ('not at all innovative') to 10 ('highly innovative'). This rating used the term 'innovative' rather than 'creative' because pilot interviews indicated that this sample was more comfortable with the term innovativeness, and its use by this sample and the definition provided are consistent with the definition of creativity as something new and useful (cf. Bailin, 1988; Ford, 1996). In addition to self-ratings of recent individual creativity, ratings by team leaders were also obtained. Leaders were provided with a similar set of stimulus questions to aid recall of the different components of the project that the team members had worked on in the previous month. They were then given the above definition of innovation and asked to rate the innovativeness of each team member using the same response scale as the self-rating. Additionally, team leaders rated each member's performance on the project in the previous month using an equivalent 11-point scale (0 = not at all well, 10 = extremely well). The average of the self-rating and the leader's two ratings of each individual was computed to create the variable 'recent team member creativity.' This measure had a Cronbach's alpha of 0.63. This measure was obtained each month.

Recent team creativity was measured by asking project leaders to rate the overall innovativeness of the work on the project that had been completed in the last month (by all members) using the same 11-point response scale. This measure was also obtained at each month of the study.

Time-general creativity (in contrast with the 'recent team creativity' measure above) was measured by asking all team members to rate the extent of their agreement with the item 'this team has developed innovative solutions to problems'[3] using a 5-point Likert scale ('strongly disagree' to 'strongly agree'). This measure was obtained in the initial questionnaire, at the same time as the climate measures.

Creativity of project outcomes was also measured. Six months after the conclusion of the study (i.e., 18 months after the first measurement period), project leaders were asked to indicate how many (a) new products or processes and (b) patents or patent applications had resulted from the project to date. They were also asked to rate the project's outcomes in terms of their (i) novelty, (ii) usefulness, (iii) creativity, and (iv) innovativeness using 5-point response scales (e.g., from 'not at all novel' to 'very novel'). Scores from these four items were averaged to create the scale *final project creativity* (Cronbach's alpha = 0.71).

Analyses

Data aggregation

Analyses conducted entirely at the team level used aggregated data created by averaging team member responses, except for the monthly team creativity rating and for the ratings of project outcomes, for which the team leader's responses were used as the team scores. Intra-class correlation coefficients (ICC) and the within-group inter-rater agreement measure, r_{wg} (James, Demaree, & Wolf, 1993), were used to support aggregation of climate measures to the team level.

[3]This item was chosen in preference to more generally worded items because it reflects the creativity or innovativeness of the team's own work rather than innovativeness inherent in the nature of the task. Note also that this item used the term 'innovative' rather than 'creative' because this is the terminology generally accepted and used by the R&D scientists and engineers. As discussed above, the authors interpret this item as a measure of team creativity.

The relationship between climate and individual creativity was tested using hierarchical linear modeling (HLM). This technique fits regression models at the individual level, and then uses team-level predictors to account for between-groups variance at the individual level. The general HLM approach described by Hofmann, Griffin, and Gavan (2000) was used and is described in the results section.

The relationship between individual creativity and team creativity was tested first by examining correlations between different forms of aggregated recent team member creativity with recent team creativity. Subsequently, stepwise regressions were performed: one using recent team creativity (time 1) as the dependent variable, and the other using time-general team creativity. Recent team member creativity at time 1 was used as the predictor in the first step. A second step entered the teams' scores on the climate measures and the change in R^2 was tested. Additionally, HLM was used to predict between-group variation in recent team member creativity scores (time 1) from recent team creativity and team climate (both measured at time 1).

Correlations were used to investigate the relationship between team creativity ratings obtained each month over 9 months with time-general measures of team creativity. Two additional variables representing the average and maximum of each team's monthly creativity were created, and these were also correlated with the ratings of overall project creativity and team climate.

Results

Emergence of team climate

Some teams had low r_{wg} values (<0.70) for one or more measures of climate. Because some of these teams had high r_{wg} values for other climate measures, only those variables with low r_{wg} values were deleted from these teams, in order to maximize sample size through subsequent pairwise deletion of missing values. This affected five teams. After deletion of missing values (above), the average r_{wg} values for the climate scales ranged from 0.94 (task orientation) to 0.97 (participative safety). ICC(1)s ranged from 0.14 (task orientation) to 0.30 (participative safety)—all were significantly larger than zero according to chi-square tests ($p < 0.001$ for each ICC). These values of ICC(1) are moderate to large compared to values typically found in organizational research using multilevel modeling (Bliese, 2000). Although the organizational encouragement of innovation scale has 'the organization' (division) as the referent, a three-level partitioning of variance attributable to individual, team, and organization levels showed that 18 per cent of variance was at the team level ($\chi^2(19) = 47.54$, $p < 0.01$). A separate 14 per cent of variance was attributable to organizational (i.e., division) membership. Thus, this measure was treated as a team-level variable and conceptualized, along with the TCI scales, as a component of the climate for creativity that teams experience within the workplace.

The impact of climate on individual creativity

The correlations between the aggregated climate variables and average *individual* creativity and team creativity measures are shown in Table 1, along with descriptive statistics. Note that throughout this article we identify results that are significant at $p < 0.01$, $p < 0.05$ and $p < 0.10$ using the markers **, *, and † respectively.

The results of the hierarchical linear modeling are shown in Table 2. The one-way ANOVA model indicated that 11 per cent of variance in team member creativity ratings resides between groups

Table 1. Correlations between individual creativity, team creativity and climate for creativity

	Mean	SD	Correlations 1	2	3	4	5	6	7	8	9	10	11
Initial measures													
1. Participative safety	3.79	0.41		53	53	53	53	53	41	48	35	32	43
2. Support for innov.	3.73	0.37	0.79**		53	53	53	53	41	48	35	32	43
3. Vision	3.96	0.36	0.35**	0.50**		53	53	53	41	48	35	32	43
4. Task orientation	3.38	0.38	0.74**	0.73**	0.43**		53	53	41	48	35	32	43
5. Organizational encour. of innov.	3.57	0.36	0.21	0.36**	−0.01	0.27†		53	41	48	35	32	43
6. Recent team memb. creativity (team average)	5.01	1.57	0.18	0.26†	0.14	0.14	0.45**		41	48	35	32	43
7. Recent team creativity	5.64	1.83	0.10	0.22	0.07	0.23	0.32*	0.84**		39	29	27	36
8. Time-general team creativity	3.77	0.50	0.36**	0.49**	0.18	0.48**	0.51**	0.54**	0.49**		31	28	49
Measured 18 months later													
9. New products/processes[a]	2.94	3.56	0.17	0.34*	0.33*	0.28†	0.16	0.05	0.22	0.22		29	33
10. Patents[a]	1.52	2.27	0.16	0.26	0.13	0.18	0.24	0.56**	0.64**	0.45*	0.33†		31
11. Final project creativity	3.83	0.63	0.16	0.20	0.16	0.05	0.21	0.42**	0.41**	0.29†	0.51**	0.65**	

Note: numbers above the diagonal represent pairwise *n*s.
[a]Spearman correlations were used for relationships involving the variables indicated due to skewed distributions.
$^{*}P < 0.05$; $^{**}P < 0.01$; $^{\dagger}P < 0.10$.

Table 2. Results of hierarchical linear models

	Parameter estimates[a]				
	γ_{00}	γ_{01}	γ_{02}	σ^2	τ_{00}
Model 1: One-way ANOVA	5.57**			3.18	0.38**
L1: Member creativity $= \beta_{0j} + r_{ij}$					
L2: $\beta_{0j} = \gamma_{00} + U_{0j}$					
Model 2a: Intercepts as outcomes	1.00 n.s.	1.29**		3.12	0.29*
L1: Member creativity $= \beta_{0j} + r_{ij}$					
L2: $\beta_{0j} = \gamma_{00} + \gamma_{01}$(org. encour.) $+ U_{0j}$					
Model 2b: Intercepts as outcomes	−0.56 n.s.	1.04**	0.66†	3.11	0.27*
L1: Member creativity $= \beta_{0j} + r_{ij}$					
L2: $\beta_{0j} = \gamma_{00} + \gamma_{01}$(org. encour.) $+ \gamma_{02}$(suppt. for innov.) $+ U_{0j}$					

[a]Parameters defined as shown in the formulas in Table 2 and estimated for each team j; σ^2 = variance in level 1 residual (r_{ij}); τ_{00} = variance in level 2 residual (i.e., variance in U_{0j}).
*$P < 0.05$; **$P < 0.01$.

($\rho = 0.376/(3.179 + 0.376) = 0.11$; $\chi^2(52) = 87.19$, $p < 0.01$). Because there was significant between-groups variation in the outcome, an intercept-as-outcomes model was justified. Model 2a used organizational encouragement of innovation (aggregated scores from team members) as a level 2 predictor of the between-groups variance in recent team member creativity scores (from time 1). This climate variable was used as a predictor because it had the highest correlation with average team member creativity (see Table 1). The significant γ_{01} value indicates that this climate measure was a significant predictor. The τ_{00} value, although slightly lower than in Model 1, was still significant, indicating that significant between-group variance in the outcome remains to be explained. Model 2b entered support for innovation (a scale of the TCI) as a second team-level predictor (this had the next largest correlation with team member creativity). In this model, organizational encouragement of innovation was a significant predictor, and support for innovation was significant only according to a one-tailed test. The addition of further climate predictors led to non-significant loadings and small *increases* in τ_{00} values (i.e., unexplained group-level variance), and so these models are not reported.

The relationship between team member creativity and team creativity

The results in Tables 1 and 2 show that average recent team member creativity was strongly correlated with the leader's assessment of recent team creativity for the same period of time ('the last month'). In order to explore other forms of relationship between individual and team creativity, further correlations were conducted. Table 3 shows correlations between recent team creativity and: (i) the average of team

Table 3. Correlations between recent team creativity and various aggregations of recent member creativity

	1	2	3	4	5
1. Recent team creativity		41	41	41	41
2. Average of recent team member creativity	0.84		53	53	53
3. Maximum recent team member creativity	0.71	0.77		53	53
4. Minimum recent team member creativity	0.58	0.77	0.30*		53
5. Weighted average of team member creativity	0.73	0.89	0.61	0.75	

Note: All correlations were significant at $p < 0.01$, except for the one indicated with an asterix ($p < 0.05$).
Values above the diagonal indicate pairwise n.

Table 4. Coefficients for the final regression model predicting time-general team creativity

	Beta	Sig.
Constant		0.45
Avg team memb. creativity (recent)	0.34	0.01
Org. encour. of innov.	0.25	0.06
Support for innov.	0.29	0.02

members' recent creativity; (ii) the maximum of the team members' recent creativity scores in each team; (iii) the minimum recent team member creativity score; and (iv) a simple weighted average of team member creativity scores. This last variable was created by multiplying each team member's recent creativity rating by their within-team percentile rank on the same variable. This new product variable was then averaged across team members to produce the weighted average for the team.

In order to test Hypotheses 4 and 5, two stepwise regression analyses were conducted. In the first, time-general team creativity was used as the dependent variable. The team average of recent individual creativity was entered in the first step, followed by the climate measures in subsequent steps (one predictor per step), with these entered in order of their correlations with the dependent variable (from Table 1). With the entry of the first climate factor, organizational encouragement of innovation, the R^2 value rose significantly from 0.31 to 0.39 ($F_{1,45} = 6.10$, $p < 0.05$). The entry of the next predictor, support for innovation, resulted in another significant increase in R^2 to 0.46 ($F_{1,44} = 5.72$, $p < 0.05$). None of the remaining climate measures resulted in significant changes to R^2. Table 4 shows the values of the beta coefficients for the model with the three predictors: individual creativity, organizational encouragement, and support for innovation.

The second multiple regression was performed in a similar fashion, except that the measure of recent ('in the last month') team creativity (at time 1) was used as the dependent variable, rather than time-general team creativity. The first step, in which the dependent variable was regressed onto average recent team member creativity, resulted in a significant model with an R^2 of 0.70 ($F_{1,39} = 91.68$, $p < 0.01$) and a beta value of 0.84 ($t(39) = 9.58$, $p < 0.01$). The second step entered the measures of organizational encouragement of innovation and support for innovation, the two climate measures that produced significant increases in R^2 in the previous regression. This step produced an increase in the value of R^2 of 0.01, which was not significant ($F_{2,37} = 0.69$, n.s.). It is noteworthy that the beta coefficient for recent team member creativity in this model was 0.90 ($p < 0.01$), while the beta weights of the climate measures, organizational encouragement of innovation and support for innovation, were -0.12 and 0.00 respectively (both non-significant). A confidence interval for this change in R^2 was calculated using the non-central F distribution, in a procedure described by Smithson (2003). The 90 per cent confidence interval for the change in R^2 was [0.00, 0.14].

The remaining climate predictors had negative partial correlations with the criterion, and so their addition in subsequent steps also produced non-significant increases in R^2. The model with all six predictors (recent team member creativity plus the five climate measures) had an R^2 value of 0.73, and the adjusted R^2 of 0.68 was slightly *smaller* than the original R^2 with the single predictor ($R^2 = 0.70$). Thus, the model with the climate factors was poorer overall than the model with only team member creativity as the predictor.

Hierarchical linear modeling was also used to address the question of whether team creativity is simply the average of team members' creativity. However, because hierarchical linear modeling requires a level 1 (i.e., individual-level) outcome, this question was asked in reverse: *Is the between-groups variation in team member creativity ratings accounted for by the overall team creativity?* Thus, the team average for recent team member creativity (time 1) was the dependent variable

Table 5. Results of hierarchical linear models

	Parameter estimates[a]					
	γ_{00}	γ_{01}	γ_{02}	γ_{03}	σ^2	τ_{00}
Model 3: One-way ANOVA						
L1: Member creativity $= \beta_{0j} + r_{ij}$	5.61**				3.04	0.48**
L2: $\beta_{0j} = \gamma_{00} + U_{0j}$						
Model 4a: Intercepts as outcomes						
L1: Member creativity $= \beta_{0j} + r_{ij}$						
L2: $\beta_{0j} = \gamma_{00} + \gamma_{01}$ (team creativity) $+ U_{0j}$	2.65**	0.51**			2.75	0.17 n.s.
Model 4b: Intercepts as outcomes						
L1: Member creativity $= \beta_{0j} + r_{ij}$						
L2: $\beta_{0j} = \gamma_{00} + \gamma_{01}$ (team creativity) $+$ γ_{02} (org. encour.) $+ \gamma_{03}$ (suppt. for innov.) $+ U_{0j}$	−0.46 n.s.	0.46**	0.58*	0.37 n.s.	2.75	0.14 n.s.

[a]Parameters defined as shown in the formulas in Table and estimated for each team j; σ^2 = variance in level 1 residual (r_{ij}); τ_{00} = variance in level 2 residual (i.e., variance in U_{0j}).
*$P < 0.05$; **$P < 0.01$.

(level 1). Because recent team creativity was rated by leaders only, and some leaders did not respond to the questionnaire, this analysis had a smaller sample size than the previous HLM. Therefore, the one-way ANOVA model was tested again (Model 3). As before, this showed that there was significant between-groups variance in the dependent variable ($\rho = 0.477/(0.477 + 3.040) = 0.14$; $\chi^2(40) = 77.66$, $p < 0.01$). Subsequently, Model 4a entered recent team creativity as a team-level predictor. Finally, Model 4b entered an additional two predictors: organizational encouragement of innovation and support for innovation. These were entered because they were found to be predictive in the previous HLM. The results are shown in Table 5. These indicate that in Model 4a the unaccounted team-level variation in the dependent variable (0.17) was no longer significant. However, in Model 4b, organizational encouragement of innovation was shown to contribute significantly to the prediction of the dependent variable, and the chi-square value (corresponding to the size of the level 1 residual) was reduced from 44.43 (Model 4a) to 38.63 (Model 4b; degrees of freedom = 39 and 37 respectively). By examining these chi-square values, we can make inferences about the relative fit of these two models (in terms of minimizing the level 1 residual) in the same way that the relative fit of structural equation models is often assessed. The change in chi-square was just outside significance ($p < 0.06$), indicating that Model 4b was *not* significantly better than Model 4a.

The aggregation of monthly creativity towards the creativity of project outcomes

Correlations between the average team members' creativity at each month and climate for creativity scores obtained at month 1 were calculated. For the sake of simplicity, a single score for team climate was created by averaging the four TCI scale scores for each team. Statistically, this was justified on the basis of large inter-scale correlations among TCI scales, which at the team level ranged from 0.36 (participative safety with vision) to 0.79 (participative safety with support for innovation). Cronbach's alpha for the team climate score, calculated at the team level as a four-item scale (TCI scales treated as items), was 0.85. Organizational encouragement of innovation, although an aspect of climate which was seen to exhibit group-level variation (see above), has a different referent (the organization) than does team climate. Thus, this was retained as a separate scale. Correlations between monthly creativity ratings and creativity measures of final project outcomes (measured 18 months after the initial measurement) were also calculated. The results are shown in Table 6.

Table 6. Correlations between team member creativity scores from each month and (i) climate measures and (ii) overall team creativity measures

	Team member creativity (self ratings)										
	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Av'ge of months 1–9	Max. of months 1–9
Month 1											
Team climate	0.22 (53)	0.42** (50)	0.01 (51)	0.16 (49)	0.17 (49)	0.19 (47)	0.12 (46)	0.05 (39)	0.08 (40)	0.20 (53)	0.17 (53)
Org. encour.	0.45** (53)	0.28* (50)	0.14 (51)	0.31* (49)	0.29* (49)	0.22 (47)	0.17 (46)	0.11 (39)	0.10 (40)	0.33* (53)	0.33* (53)
Overall project creativity	0.56** (48)	0.41** (46)	0.22 (46)	0.39** (45)	0.39* (45)	0.19 (44)	0.36* (43)	0.13 (36)	0.22 (37)	0.37** (48)	0.39** (48)
Month 18											
New products/processes[a]	0.05 (35)	0.18 (3$)	0.01 (35)	0.17 (34)	0.22 (34)	0.33† (34)	0.29† (32)	0.35† (30)	0.30† (31)	0.34* (35)	0.14 (35)
Patents[a]	0.54** (32)	0.49** (31)	0.27 (32)	0.60** (31)	0.52 (31)	0.26 (31)	0.36† (30)	0.45* (28)	0.45* (28)	0.53** (32)	0.45* (32)
Final project creativity	0.41** (43)	0.19 (42)	−0.07 (43)	0.36* (42)	0.27† (42)	0.22 (42)	0.24 (40)	0.22 (34)	0.24 (35)	0.30* (43)	0.20 (43)

Note: *n*s indicated in brackets.
[a]Spearman correlations were used for relationships involving new products/processes and patents due to skewed distributions.
$*P < 0.05$; $**P < 0.01$; $^{\dagger}P < 0.10$.

Table 7. Correlations between team creativity scores from each month and (i) climate measures and (ii) overall team creativity measures

	Overall team creativity (rated by leader)										
	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Av'ge of months 1–9	Max. of months 1–9
Month 1											
Team climate	0.19 (41)	0.20 (39)	0.02 (35)	0.07 (32)	−0.01 (31)	0.05 (38)	−0.02 (38)	−0.02 (29)	−0.31† (29)	0.18 (50)	0.15 (50)
Org. encour.	0.32* (41)	0.02 (39)	0.28 (35)	0.09 (32)	0.22 (31)	0.27† (38)	0.36* (38)	0.35† (29)	0.12 (29)	0.32* (48)	0.20 (48)
Overall project creativity	0.50** (39)	0.23 (36)	0.53** (33)	0.44* (31)	0.42* (29)	0.20 (35)	0.36* (35)	0.06 (26)	0.24 (26)	0.47** (45)	0.32* (45)
Month 18											
New products/processes[a]	0.21 (29)	0.03 (29)	0.25 (24)	0.04 (21)	0.24 (22)	−0.14 (31)	−0.07 (29)	0.32 (23)	0.25 (24)	0.19 (35)	0.36* (35)
Patents [a]	0.65** (27)	0.26 (26)	0.44* (23)	0.55* (20)	0.46* (23)	0.10 (26)	0.44* (25)	0.37† (21)	0.32 (20)	0.48** (32)	0.46** (32)
Final project creativity	0.41* (36)	0.18 (33)	0.32† (29)	0.43* (28)	0.38* (29)	0.18 (35)	0.32† (33)	0.43* (25)	0.51** (26)	0.51** (43)	0.50** (43)

Note: *n*s indicated in brackets.
[a]Spearman correlations were used for relationships involving new products/processes and patents due to skewed distributions.
$*P < 0.05$; $**P < 0.01$; $^{\dagger}P < 0.10$.

For the average team member creativity scores (aggregated), the autocorrelations between consecutive months ranged from 0.66 (between months 1 and 2 and also between months 2 and 3); to 0.81 (between months 6 and 7). All consecutive autocorrelations for individual creativity were significant at $p < 0.01$.

The same correlations as those above were calculated using monthly ratings of team creativity (rather than monthly team member creativity). The results are shown in Table 7. For monthly team creativity, the autocorrelations between consecutive months ranged from 0.28 (months 7 and 8) to 0.94 (months 4 and 5). All but two were significant at $p < 0.01$.

Discussion

The first hypothesis, pertaining to the compositional emergence of team climate, was supported: the r_{wg} statistics supported aggregation of climate scores to the team level for the vast majority of teams (a total of five teams showed poor inter-rater agreement on at least one climate measure). The average r_{wg} values for the five climate scales analyzed were all very high. Additionally, the ICCs were moderate and significant, and indicated that between 14 per cent and 30 per cent of variance in these scores was due to between-group variation.

The expected impact of climate on individual creativity (Hypothesis 2) had mixed support from the team-level correlations, with organizational encouragement of innovation the only climate variable significantly correlated with average recent team member creativity (a relationship that appears to be stable across months, as shown in Table 6). The HLM analysis showed that team climate impacts on team member creativity: organizational encouragement of innovation was a significant predictor of the between-groups variance in team member creativity ratings. Support for innovation (a scale of the TCI) was also a significant predictor according to one-tailed tests. Together these predictors accounted for 29 per cent of the between-groups variance in the dependent variable.

It is worth noting that most of the variance in recent team member creativity ratings was not attributable to group membership. Thus, although team climate influences team member creativity, there is still significant variance in the creativity of individuals within teams. The sources of this variation are beyond the scope of this article, but likely causes are different within-team roles and/or individual differences in creativity-relevant characteristics such as expertise and motivation (Amabile, 1997; Ford, 1996). Individual differences in perceptions of climate (i.e., psychological climate rather than team climate) may also explain some of the within-group variance in individual creativity. Also, measurement error including response sets and biases may have increased individual-level variance in individual creativity ratings.

Regarding the question of whether team creativity is simply the aggregate of team member creativity, the correlations in Table 3 show that most of the variance in recent team creativity was accounted for by the average recent team member creativity ($r^2 = 0.71$). Thus, Hypothesis 3 was supported. The weighted average of team member creativity, which gives more weight to the most creative team members compared with the less creative members, was the next best predictor of team creativity ($r^2 = 0.53$).

The stepwise regression showed a similar finding to that reported by Taggar (2002), and supported Hypothesis 4: support for innovation and organizational encouragement together accounted for significant variance in a time-general measure of team creativity, even after first entering recent team member creativity as a predictor. The significance of these climate factors after first entering individual creativity shows that there is still systematic (i.e., non-error) variance in team creativity that can be accounted for after controlling for individual creativity. This seems to suggest that team creativity is *not* simply the aggregated team member creativity. However, Hypothesis 5 predicted that this result would not be found if a time-specific measure of recent team creativity ('in the last month') was used as the dependent variable. This was indeed the case: the observed inability of climate scores to account for unique variance in recent team creativity (above recent individual creativity) is consistent with our prediction. However, as discussed previously, this is a prediction of 'no effect,' and therefore we need to consider statistical power when drawing conclusions. This was addressed by computing a confidence interval for the change in R^2, which was shown to extend up to 0.14 (a moderate effect, according to Cohen, 1992). This suggests that we do not have sufficient evidence to conclusively say that there is no effect, although it is noteworthy that the contribution of organizational encouragement in this equation was *negative* rather than positive (as would be expected). Nonetheless, we are left with the frustrating position of being unable to show conclusive evidence supporting our prediction, despite the fact that we did observe 'no effect' as predicted.

The final piece of evidence concerning the question of whether team creativity is more than aggregated individual creativity comes from the second HLM analysis. These showed that by accounting for team creativity the unexplained between-group variance in team member creativity was reduced from 0.48 to 0.17. That is, the predictor accounted for 65 per cent of the between-group variance in team member creativity. Entering the climate measures further reduced the unexplained (between-groups) variance to 0.14. However, this benefit was not statistically significant. Thus, the HLM results are consistent with the regression analysis discussed above: both indicate that after accounting for the relationship between team member creativity and team creativity from the same period of time, there is no further variance explained by climate for creativity.

Considering the results from these regression analyses, a possible interpretation of the findings discussed above is that for a given behavioral episode or a specific, short time interval, team creativity is simply the aggregated team member creativity. At each of these points in time, team climate exerts a modest influence on team creativity via team member creativity—modest because there may be a great deal of random influences on creativity at any given moment. However, when assessing the team's creativity without reference to work from a specific time-based interval, such as the time-general team creativity measure, then climate shows a stronger relationship. This argument is analogous to the observation in psychometrics that for a given strength of inter-item relationship adding more items produces a more reliable scale (i.e., more variance in scale scores is systematic and accountable; Kline, 2000). Similarly, for a given (even modest) relationship between climate and time-specific creativity, adding more points in time produces an aggregate relationship that is stronger (accounts for more variance).

The result from the first stepwise regression was also doubtless influenced by the fact that only the team creativity from one particular month was controlled for before entering the climate variables. If we had a time-general assessment of each team members' creativity, then perhaps climate would not have accounted for additional variance in overall team creativity. Taggar (2002) used the aggregation (sum) of time-specific team creativity: specifically, the sum of student teams' creativity ratings for several weekly assignments. The individual creativity scores from that study were time-general: peer evaluations of each member's creativity over the duration of the assignments, collected in the last week of the study. Thus, our first stepwise regression is not really a replication of Taggar's (2002) result, and thus those results still present a potential anomaly to the aggregation model proposed in this article. Our response is to offer two potential explanations. Firstly, Taggar's stepwise regression findings may have been caused by the use of general ratings of individual creativity, which may have been influenced by peers' general perceptions of one another, perhaps based on experiences outside the assignment tasks. Therefore, these ratings may partly reflect the creative ability or creative potential of team members rather than their actual exhibited creativity on the assignments. This would explain why team processes explained additional variance in team creativity scores. Secondly, the feedback given to team members about team creativity from week to week may have influenced the team processes (either tangibly or merely their perception). Thus, team processes shared a great deal of variance with team creativity.

The final issue examined in this paper was the aggregation of creativity over time into overall creativity of team-produced outcomes. The correlations reported in Tables 6 and 7 show considerable variation across months (except for correlations between recent team member creativity and organizational encouragement, which appear relatively stable). However, as predicted in Hypothesis 6, the average monthly team creativity significantly predicted the creativity of final project outcomes (at least for two of the three measures: the subjective rating and the number of patents produced). Also of interest is the observation that the correlations of the predictors with the total monthly creativity (months 1–9 averaged) tended to be approximately as large as the largest correlation of each predictor with the monthly creativity ratings. That is, for each row in Tables 6 and 7, the value in the second-last cell tends to be approximately as large as the largest of the previous cells in that row. For example, the correlation between organizational encouragement and the average of team creativity from months 1 to 9 was 0.33 (Table 6), even though the average of the nine correlations between this climate factor and monthly team creativity was 0.18. This observation is consistent with our model's prediction that time-general measures of creativity will show larger relationships with contextual predictors (such as climate) due to the nature of the aggregation across time. It also suggests that generalizing about predictors of performance based on time-specific performance measures risks committing an atomistic fallacy in the same way as generalizing conclusions to teams based on individual-level analyses (Kozlowski & Klein, 2000). That is, a factor's relationship with time-specific creativity may not be the same as its relationship with overall creativity of outcomes.

It is also noteworthy that in Table 7 the *maximum* of the monthly team creativity ratings was seen to have virtually the same correlation with creativity of final outcomes as did the *average* monthly team creativity. This indicates equal support for the alternative views of total project creativity as either an additive or disjunctive type of task (in terms of its relation to monthly team creativity). That is, the highest monthly team creativity is as good as average monthly creativity in predicting how creative the project outcomes are assessed overall.

We have dedicated significant attention in this article to the hypothesis that team creativity at a particular point in time is determined by team member creativity (aggregated). We have argued, based on the results of correlations and multiple regressions, that there is support for this position. On the face of available evidence, our model and its assumptions are plausible. However, as with all research, we cannot unequivocally conclude the superiority of this model above alternative models. To begin with, the correlation between team creativity and aggregated team member creativity was not perfect, suggesting that not all variance in team creativity was explained by that of its members. We suggest that incomplete data from all members of a team, as well as measurement error in the ratings (particularly because they were based on single item scales) may have constrained these correlations, but we also acknowledge that this result may support the opposing view: that team creativity is more than the sum of members' creativity. Additionally, the difficulties inherent in research of this type, particularly sample size at the team level and response rates over time, resulted in analyses that were less powered than desirable, particularly for multi-level analyses. Notwithstanding statistical and methodological issues, the biggest limitation to the generalizability of our model is a conceptual one. As we pointed out in the introduction, the relationship between individual and group performance is determined by the type of task and the way it is structured and divided among group members. Therefore, we cannot suggest that this model of team creativity as an aggregation across team members and across time is generally true; there are doubtless tasks that can be devised for which this model is not true.

Rather, what we have attempted to show is that in real organizations, for the types of projects that real R&D teams work on, our model of aggregated creativity is a plausible one that enjoys empirical support and has the capacity to make important contributions to the research literature. Firstly, it is the first model of group creativity that explicitly describes the nature of multi-level relationships, with climate manifesting via compositional emergence and team creativity via fuzzy compositional emergence (or some form of emergence between the two extremes of composition and compilation). Secondly, it adopts Ford's (1996) notion of behavioral episodes as a convenient way of describing how creativity unfolds over time and relates to the final outcome, again via fuzzy composition or a similar type of emergence. Thirdly, we have shown that the type of creativity measure used (individual/team, time-specific/time-general/final outcomes) influences the size of the relationship between creativity and contextual factors (such as climate). We have also demonstrated that even though team climate can account for variance in team creativity after controlling for team member creativity, this does not necessarily mean that teams with good climates or processes can make up for deficits in individual creativity. That is, the view that a champion team will outperform a team of champions, at least when it comes to creativity in R&D teams, is not necessarily true. Our study suggests a justifiable alternative view that, although influenced by team processes, it is the individual creativity that compiles into the creativity of the team's outcomes or products.

Thus, returning to the questions posed in the opening paragraph, we have shown the profound consequence of individual creativity for project teams; it is via individual creativity that creative team products emerge in a dynamic process that unfolds over time. Although a single member of a team may feel on a particular day or week or month that their creativity makes little difference, our model shows how each member's contribution is important. Over time these contributions add up and ultimately shape the team's outcomes. In the same way that waves, over time, can shape whole coastlines, so can individual team members shape the innovativeness of even long-distant project deliverables.

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