1-2018

The temporal pattern of creativity and implementation in teams

Kathrin ROSING
University of Kassel

Ronald BLEDOW
Singapore Management University, RBLEDOW@smu.edu.sg

Michael FRESE
National University of Singapore

Nataliya BAYTALSKAYA
Caliper Corp

Johanna Johanna JOHNSON LASCANO
Infor Talent Science

See next page for additional authors

Citation

ROSING, Kathrin; BLEDOW, Ronald; FRESE, Michael; BAYTALSKAYA, Nataliya; JOHNSON LASCANO, Johanna Johanna; and FARR, James L.. The temporal pattern of creativity and implementation in teams. (2018). *Journal of Occupational and Organizational Psychology*. 91, (4), 798-822.
Available at: https://ink.library.smu.edu.sg/lkcsb_research/6015

Published in Journal of Occupational and Organizational Psychology,
Vol 91, Issue 4, December 2018, Pages 798–822
DOI 10.1111/joop.12226

The temporal pattern of creativity and implementation in teams

Kathrin Rosing[1]*, Ronald Bledow[2], Michael Frese[3,4], Nataliya Baytalskaya[5], Johanna Johnson Lascano[6] and James L. Farr[7]

[1]Institute of Psychology, University of Kassel, Germany
[2]Lee Kong Chian School of Business, Singapore Management University, Singapore
[3]National University of Singapore Business School, Singapore
[4]Institute of Management and Organization, Leuphana University of Lueneburg, Germany
[5]Caliper Corp., Research and Development, Princeton, New Jersey, USA
[6]Infor Talent Science, Dallas, Texas, USA
[7]Department of Psychology, Pennsylvania State University, University Park, Pennsylvania, USA

Two broad sets of activities underlie team innovation: the creation and the implementation of new ideas. Despite the prevalence of this distinction, the temporal dynamics of creativity and implementation in teams and their relation to successful team innovation are not well understood. Building on and integrating linear phase models and complexity perspectives on the innovation process, we propose a temporal pattern of creativity and implementation that is linked to team innovation. We examine this temporal pattern in a longitudinal study of 76 project teams. Results show that teams engage in creativity throughout the entire life cycle of team projects; however, innovative teams refrain from focusing on implementation in early time frames and increase their focus on implementation over the course of the project. Episodes of unconstrained creativity in early time frames of a project appear to be a critical factor for team innovation. Our research provides a foundation for future research on team innovation that explicitly considers the temporal interplay of creativity and implementation.

Practitioner points

- Creativity is a critical factor for team innovation that is relevant not only in the beginning of a team project but throughout its entire life cycle.
- Teams achieve innovative outcomes if they refrain from focusing on implementation early on and instead allow for prolonged episodes of unconstrained creativity.
- Innovative teams pay attention to the timing of implementation activities and increase their focus on implementation around the mid-point of a project.

*Correspondence should be addressed to Kathrin Rosing, Institute of Psychology, University of Kassel, Hollaendische Str. 36-38, 34127 Kassel, Germany (e-mail: rosing@uni-kassel.de).

For many teams in organizations, innovation is a core component of performance (Choi & Chang, 2009; George, 2007; Shalley, Zhou, & Oldham, 2004). The necessity to innovate is not limited to teams that were formed for the primary purpose of innovating, such as research and development (R&D) teams, but extends to many other types of teams, for example, project and service teams who accomplish non-routine tasks (Pearce & Ensley, 2004). As competition among organizations increases and change within organizations accelerates, teams and individuals are expected to contribute to organizational innovation more and more (Baer, Leenders, Oldham, & Vadera, 2010; Madjar, Greenberg, & Chen, 2011). However, not all teams are able to deliver highly innovative outcomes. Some teams fail at innovating because they focus on generating ideas and fail to move forward and realize their ideas, while others fail because they move ahead too quickly and do not create anything original. To be successful, teams need to balance between developing original ideas and focusing on getting things done.

The distinction between creating ideas and getting things done is reflected in the definition of innovation as the generation and implementation of new and useful ideas (Amabile, 1988; West & Farr, 1990; Woodman, Sawyer, & Griffin, 1993). In accordance with this definition, most researchers agree that two broad sets of activities underlie team innovation: Creativity refers to the generation, evaluation, and selection of ideas; implementation involves acting upon and realizing ideas (e.g., Amabile, 1988; Farr, Sin, & Tesluk, 2003; Kanter, 1988; West, 2002b). To achieve team innovation – which we understand as innovative outcomes teams produce, such as original and useful new products or services – teams need to engage in both types of activities. However, the temporal pattern of creativity and implementation through which teams achieve highly innovative outcomes is neither well understood nor has it been subject to a detailed empirical examination.

Theoretical models of the innovation process outline how the timing of (and changes in) creativity and implementation may be related to team innovation. On a general level, two theoretical perspectives can be distinguished that offer competing descriptions of the temporal pattern of creativity and implementation. The linear perspective assumes a sequence of distinct phases that presumably follow each other step-by-step from creativity to implementation (e.g., Amabile, 1988; Farr *et al.*, 2003), whereas the complexity perspective assumes that creativity and implementation are intertwined and unfold in a cyclical and chaotic manner (e.g., Schroeder, Van de Ven, Scudder, & Polley, 1989). There appears to be implicit agreement in the literature that both perspectives contain some validity and that innovation processes exhibit linear as well as chaotic features. However, this implicit agreement does not specify in which respect both perspectives are valid. Moreover, empirical studies have not yet disentangled the interplay between creativity and implementation (Baer, 2012; Peralta, Lopes, Gilson, Lourenço, & Pais, 2015). Indeed, most empirical studies treat innovation as an outcome rather than a process (Knight, 2015) and do not distinguish between creativity and implementation. Moreover, innovation as a process (i.e., creativity and implementation activities) is often confounded with innovation as an outcome (i.e., team innovation, such as innovative products). Consequently, evidence on how teams manage creativity and implementation in such a way that innovative outcomes emerge is sparse. Finally, the few empirical studies that provide a detailed examination of innovation processes have taken a descriptive approach (Cheng & Van de Ven, 1996; Eindhoven & Vinacke, 1952; King, 1992), but do not offer a rigorous test of how different patterns of creativity and implementation relate to team innovation as an outcome.

To address this gap and to further the understanding of how innovation emerges in teams, this article critically analyses the assumptions underlying current models of the innovation process. We argue that the complexity and the linear perspective both shed light on the innovation process and that each perspective alone is incomplete (Bledow, Frese, Anderson, Erez, & Farr, 2009). The complexity perspective neglects linear-sequential features – most notably that idea creation precedes idea implementation; the linear perspective oversimplifies the innovation process and fails to consider that teams frequently move back and forth between creativity and implementation and can engage in both activities simultaneously. A critical task for research is thus to identify and integrate the features of both perspectives that are valid to predict the emergence of team innovation.

Towards this goal, this study attempts to identify the temporal pattern of creativity and implementation that supports team innovation. We develop hypotheses by drawing from both theoretical perspectives, contrasting their assumptions, and evaluating their theoretical plausibility in the light of psychological research. We test these hypotheses in a longitudinal study with project teams and predict the level of innovation a team achieves with the temporal pattern of creativity and implementation it engages in. The study thereby contributes to the literature in several meaningful ways. First, it makes a theoretical contribution by integrating competing theoretical perspectives on the innovation process. Such an integration is necessary as existing theoretical perspectives highlight different aspects of the innovation process and are based on partly conflicting assumptions. Second, using a longitudinal study design, we provide an empirical test of major assumptions implied by the theoretical perspectives on the innovation process. Such an empirical test is relevant because rigorous empirical tests are scarce despite the long tradition of theoretical models of innovation processes (Cheng & Van de Ven, 1996; Eindhoven & Vinacke, 1952; King, 1992). Third, our study provides relevant information for innovative teams on how to structure innovation processes in terms of the timing of and change in creativity and implementation activities. In the following paragraphs, we first review models of the innovation process and evaluate the empirical evidence. Building on these models, we then draw from research on the psychological underpinnings of creativity and implementation to formulate hypotheses.

Theoretical models of the innovation process

Models of the innovation process usually emphasize one of two perspectives: the linear perspective or the complexity perspective. The linear perspective is expressed by phase models of innovation. These models outline a number of phases that a team has to go through in a linear order to develop innovative outcomes, such as new products and improved processes (Lubart, 2001). For example, the phase model by Farr *et al.* (2003) describes four sequential phases that logically build on each other. In the first phase, teams identify and define the problem they need to work on (*problem identification*). In the next step, teams come up with ideas to solve the problem previously identified (*idea generation*). These ideas are then discussed and evaluated to find the idea that best solves the problem (*idea evaluation*). The selected idea is finally put into action and implemented in the last phase of the process (*implementation*). Although phase models differ in the number and the specific content of phases, they all comprise the normative assumption that closely following the defined ideal sequence of phases will result in better outcomes. Most authors of phase models, however, acknowledge a certain circularity or recursiveness of phases and allow for some overlap between different phases (Amabile, 1988; Farr *et al.*, 2003; Lubart, 2001). For instance, the recent revision of Amabile's original componential model of creativity and innovation now explicitly incorporates feedback loops (Amabile & Pratt, 2016).

Despite their intuitive appeal, linear phase models are an oversimplification of the innovation process. Indeed, some authors have questioned the existence of distinct phases altogether and have instead argued that activities such as creativity and implementation are interrelated processes and team innovation is the result of a nonlinear process characterized by chaos and complexity rather than by a predictable sequence of phases (Anderson, De Dreu, & Nijstad, 2004; Bledow *et al.*, 2009; King, 1992; Schroeder *et al.*, 1989; Van de Ven, Polley, Garud, & Venkataraman, 1999). Schroeder *et al.*'s (1989) model of the innovation process exemplifies this complexity perspective. It does not assume a fixed sequence of events, but rather 'convergent, parallel, and divergent streams of activity' (Schroeder *et al.*, 1989, p. 113). Initial ideas often diverge into several different paths that may or may not be conjunctive. In addition, setbacks and surprises are inherent parts of innovation and are critical for the final outcome (Schroeder *et al.*, 1989). The complexity perspective suggests that teams cannot succeed by adhering to a predefined sequence of activities. Rather they need to be prepared to move back and forth between creativity and implementation contingent on an unpredictable pattern of requirements that unfold over time (Bledow *et al.*, 2009; Schroeder *et al.*, 1989).

Despite their differences, the linear and the complexity perspectives share two basic assumptions. First, they both view innovation processes as composed of different sets of activities, at the most basic level creativity and implementation (West, 2002b). Second, these activities are assumed to be at least partly interdependent, with phase model researchers assuming less interdependence than researchers who emphasize complexity. However, when it comes to the temporal management of creativity and implementation (i.e., when and to what extent teams should engage in these activities), the two perspectives differ significantly. While the linear perspective proposes a linear sequence of creativity and implementation, the complexity perspective suggests that both creativity and implementation occur throughout the process and teams constantly cycle through creativity and implementation in an iterative manner (Bledow *et al.*, 2009; Harvey, 2014; Van de Ven & Poole, 1995). Thus, following the complexity perspective, the temporal order of creativity and implementation is unpredictable. Figure 1 contrasts the assumptions about the temporal relation of creativity and implementation according to the linear (Panel A) and the complexity perspective (Panel B). Specifically, the linear perspective implies an increase in implementation and a decrease in creativity over time. In contrast, the complexity perspective implies high levels of both creativity and implementation throughout innovation projects, with many unpredictable fluctuations (as represented by the curves in the trajectories). The few existing studies which try to describe the innovation process empirically are based on a few case studies and can neither confirm or nor reject either model (Cheng & Van de Ven, 1996; Eindhoven & Vinacke, 1952; King, 1992). For example, in two case studies, Cheng and Van de Ven (1996) found that innovation projects started with complex nonlinear patterns of activities and outcomes and ended with periodic (i.e., linear) patterns of the same activities. In seven cases of innovation in a hospital ward, King (1992) found evidence for the complexity perspective, but could not completely reject the linear perspective. The limited empirical evidence thus suggests that there is some truth in both perspectives. Importantly, all the empirical studies mentioned followed a descriptive approach. In other words, none of these studies linked the temporal pattern of innovation activities a team engaged in to the level of innovation in the outcome the team produced.

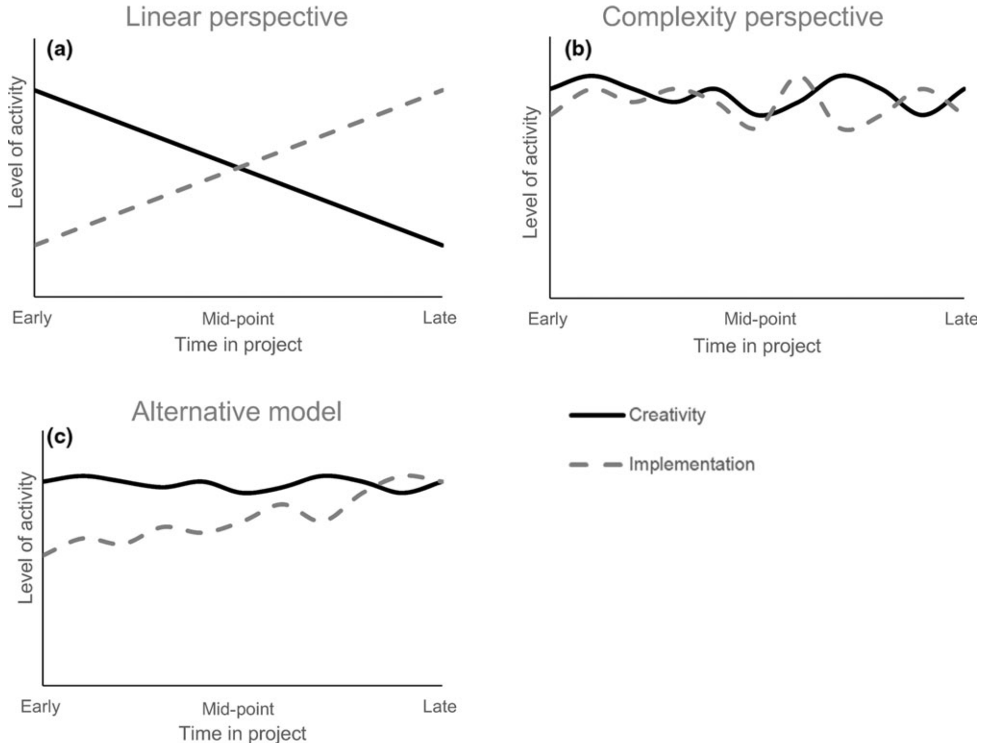

Figure 1. Comparison of theoretical models.

We next integrate features of both perspectives to specify a pattern of creativity and implementation that results in team innovation. Specifically, we argue that the temporal trajectories for creativity and implementation differ (see Figure 1, Panel C). The creativity trajectory is in line with the complexity perspective, but deviates from what is suggested by the linear perspective. Innovative outcomes require that teams engage in a high level of creativity throughout the process and do not reduce creativity once an idea is found that is deemed 'good enough' to be implemented as implied by the linear perspective. The implementation trajectory, on the other hand, is in line with the linear perspective. Teams need to refrain from implementation in early time frames and increase their focus on implementation over time. Teams may thus need to resist the temptation to engage in implementation early on to enable periods of unconstrained creativity that lay the foundation for innovative outcomes. In the following paragraphs, we develop this line of argument in detail and derive hypotheses drawing on research on the psychological underpinnings of creativity and implementation.

Hypotheses development

In the following, we use a broad conceptualization of creativity that comprises the identification of problems or opportunities, the generation of ideas as well as the evaluation of ideas (Amabile, 1983; Montag, Maertz, & Baer, 2012; Mumford, Mobley, Reiter-Palmon, Uhlman, & Doares, 1991). Creativity is supported by an open mindset that allows team members to develop and discuss a variety of problem solutions without rash commitment to any one idea (Fujita, Gollwitzer, & Oettingen, 2007; Heckhausen & Gollwitzer, 1987). As a result, the team can explore a variety of different approaches and directions as they search for a novel solution that is not yet determined. Team members take different perspectives (Grant & Berry, 2011; Hoever, van Knippenberg, van Ginkel, & Barkema, 2012), search for, exchange, and interpret new information (Gong, Cheung, Wang, & Huang, 2012; Li, Maggitti, Smith, Tesluk, & Katila, 2013), recombine and integrate knowledge (Baer, 2010; Mumford, 2000; Mumford & Gustafson, 1988; Zhou, Shin, Brass, Choi, & Zhang, 2009), and consider remote alternatives (Mednick, 1962; Rietzschel, Nijstad, & Stroebe, 2007; Simonton, 2003). Rather than settling on the first ideas that come to mind, team members focused on creativity display ambivalence towards alternative courses of action, discard some ideas, and refine other ideas in an iterative manner. Overall, teams will be oriented towards mastering the challenge of finding original solutions and towards learning from errors and failure (Rivkin & Siggelkow, 2003).

In early time frames, such as the first days or weeks of a project, the foundation is laid for whether or not an innovative outcome will be developed. Teams lay this foundation if they engage in unconstrained creativity and take time to generate many ideas and explore different directions (Diehl & Stroebe, 1987; Simonton, 1997). In these early time frames, teams need to reconfigure and integrate diverse knowledge from different sources, which is necessary to develop something unique and original (Taylor & Greve, 2006; West, 2002b; Zhou *et al.*, 2009). Thus, a high level of creativity early in the project is required for successful team innovation. Indeed, the linear and the complexity perspective concur that creativity is highly relevant in early time frames of innovation projects. Thus, we hypothesize:

Hypothesis 1: The level of creativity in early time frames is positively related to team innovation.

In contrast to creativity, the defining characteristic of implementation is that a team has committed to specific goals which regulate and guide its activity (Locke, 2000). The focus is 'closed' rather than 'open'. That is, implementation is less open to new approaches and new information, but rather supported by an action-oriented mindset that is focused on execution and goal attainment (Gollwitzer, 1990; Gollwitzer, Heckhausen, & Steller, 1990). Such a mindset is closed in the sense that it is narrow and biased in supporting only those processes in a team that lead to attainment of the activated goal and suppressing alternative processes that distract from goal achievement (Beckmann & Kuhl, 1984; Taylor & Gollwitzer, 1995). In other words, new information will be used mainly to confirm decisions instead of openly searching for new information (Rivkin & Siggelkow, 2003). When fully engaged in implementation, a team will not consider remote alternatives and different perspectives as long as they are not of immediate usefulness for the goal that is pursued (Baumann, Kuhl, & Kazén, 2005; Gollwitzer, 2003). In such a mindset, teams focus on getting things done and are more concerned with displaying high performance than with learning (Rivkin & Siggelkow, 2003).

In early time frames of an innovation project, teams will benefit if they refrain from quickly moving to the action-oriented mindset distinctive of implementation. They will then be able to concentrate on unconstrained ideation and the development of highly original ideas. However, it should be noted that refraining from premature implementation does not imply the absence of implementation altogether. In early time frames of a project, teams may display episodes of implementation, for instance, if teams perform systematic tests about the feasibility of previously developed ideas (Kristensson &

Magnusson, 2010; Manske & Davis, 1968). Teams who concentrate on 'getting things done' in early time frames, however, will 'close their mind' and be more likely to settle on first ideas that come to mind. These first ideas are not based on a thorough consideration of alternatives and are unlikely to be highly original (Meadow, Parnes, & Reese, 1959; Osborn, 1953). Moving to closure too early in the process has detrimental effects on creativity. For example, experimental work by Chirumbolo and colleagues (Chirumbolo, Livi, Mannetti, Pierro, & Kruglanski, 2004; Chirumbolo, Mannetti, Pierro, Areni, & Kruglanski, 2005) demonstrated that teams with high need for closure produced fewer ideas as well as less creative ideas than teams characterized by a lower need of closure. This research suggests that a high level of implementation can hinder the simultaneous development of highly original ideas. A closed implementation mindset severely limits the potential of a team to further experiment and explore alternatives. Teams that focus on implementation initially are therefore likely to simply apply existing knowledge using a similar solution to what they have used in the past or copy a solution from someone else. Following the linear perspective, but in contrast to the complexity perspective, we therefore hypothesize:

Hypothesis 2: The level of implementation in early time frames is negatively related to team innovation.

As compared to early time frames of a project, the relevance of implementation increases as a team progresses with a project. In order to deliver an innovative product and not merely an original idea, implementation activities need to gain momentum at some point during the project (Baer, 2012; West, 2002a). Over time, the team's mindset needs to become more and more focused on realizing the solution it has developed. Implementation also serves the function of an elaborate reality check as feedback about the feasibility and deficiencies of ideas (Kristensson & Magnusson, 2010; Manske & Davis, 1968). As a project progresses, these reality checks become increasingly important because the time that remains to make adjustments diminishes. Implementation activities integrate the stream of ideas a team commits to and culminate in the final project outcome. If teams fail to start acting on their ideas at some point, they will not be able to meet project deadlines and present an innovative outcome at the end of the project (Gersick, 1988, 1989). Therefore, following the linear perspective but deviating from the complexity perspective, we hypothesize:

Hypothesis 3: An increase in implementation is positively related to team innovation.

As implementation gains importance over the course of a team project, creativity does not lose importance at an equal rate. While teams work on an idea, this idea is never complete and developed in all its details. It needs to be refined, reshaped, and adapted during the process of implementation (Paulus, 2002). Otherwise, the degree of elaboration and differentiation of an initial idea will be low and it cannot be translated into a deliverable outcome. Thus, our line of reasoning contradicts the assumptions of the linear perspective and especially of Ford and Sullivan (2004) who suggest that creativity after the mid-point of a project hurts team performance. In contrast, we propose that creativity is required even after a team has decided on the one idea they will pursue to adapt and reshape the idea so it may be implemented.

Creativity is also necessary throughout a project because the likelihood of setbacks increases as a team progresses, especially when ideas are highly original and pre-existing schemata of how to realize ideas cannot be utilized (Schroeder *et al.*, 1989).

As innovation processes are inherently risky and uncertain, failure is to be expected (Sharma, 1999). Creativity is thus needed to handle problems and find solutions and ideas for how to solve problems and overcome hurdles (Hargadon & Bechky, 2006). Sometimes teams even need to go back to the drawing board when they find that their initial idea is not feasible or appropriate. For instance, Cheng and Van de Ven (1996) provide evidence for the occurrence of creative and explorative episodes even in later time frames within innovation projects. Moreover, Farh, Lee, and Farh (2010) showed in a study of project teams that team creativity was unrelated to project phase; thus, teams engaged in equal amounts of creativity in earlier and later phases of a project. Although these studies did not explicitly link creativity in later time frames to team innovation, this research shows that, on a descriptive level, creativity does not necessarily decrease over time.

Taken together, in line with the complexity perspective and contradicting the linear perspective, we assume that teams need to maintain a high degree of creativity throughout their projects. Decreasing the degree of creativity over the course of a project will hurt team innovation. Thus, we hypothesize:

Hypothesis 4: A decrease in creativity is negatively related to team innovation.

Method

Sample and design

We tested our model in a sample of applied innovation projects that engineering students worked on for about one semester. We used a repeated measures design with 3 to 6 observations depending on the length of the projects. The number of working days between observations was held constant for each team. In most cases, the time span between two observations was 2 weeks. We only used those observations where at least two team members answered the questionnaire. The mean number of observations was 3.8 per team. Some of our analyses required a constant number of observations between teams. For these analyses, we utilized the three times frames of each team project that are theoretically most relevant: the first 2 weeks (T1), the 2 weeks around the mid-point of each project (T2), and the last 2 weeks (T3). For all other analyses, we utilized all observations that were available per team.

The selection of the right time frame in which behavioural patterns are studied is a critical decision in longitudinal research (Mitchell & James, 2001). To address our research question, we needed to capture systematic changes in creativity and implementation over the entire course of the teams' life cycles. We chose a time frame of 2 weeks and asked team members repeatedly to report their activities during the time frame of the previous 2 weeks. As a result, we were able to examine systematic changes over the course of the entire project on a level of temporal resolution that matches our theoretical line of argument. That is, we did not focus on the rapid fluctuations in creativity and implementation as they unfold for instance in a single team meeting but rather on the overall level of creativity and implementation in a 2-week time frame, in which we expected reliable differences within and between teams.

Our sampling strategy was as follows: We contacted engineering faculty at one public US university whose course requirements included applied innovation projects. We introduced our study during regular class sessions in the courses of the instructors who agreed to participate. Students willing to participate in our study provided us with their email addresses. All questionnaires were administered online, and students were invited to participate by email reminders.

We utilized student teams instead of professional teams in organizations so that we could obtain a more detailed picture of the innovation process with more observations than would have been feasible to obtain in a professional work setting. In addition, as our goal was to map the entire innovation process and not only parts of it, we decided to study the shorter student project cycles which typically lasted only one semester. We needed to study projects with a clear beginning and a clear end to address our hypotheses; the project cycle of professional R&D teams is highly variable and can last from a few weeks to several years. The student teams worked on real-life problems that were otherwise comparable to problems of professional teams. The projects, for example, included developing different types of wind turbines or redesigning electric toothbrushes.

Our sample consisted of 76 teams with 228 engineering students (the 76 teams consisted of 312 team members in total; 73% response rate). Mean team size was 4.1, ranging from 3 to 7 individuals per team. The mean age of the students was 18.8 years (SD = 1.8; range 16–35 years), and 15.7% of the students were female.

Measures

We measured *creativity* and *implementation* with items that we developed from the descriptions of four innovation phases by Farr *et al.* (2003): problem identification, idea generation, idea evaluation, and idea implementation. Using a referent-shift consensus model (Chan, 1998), items referred to the activities a team had performed during the last 2-week period. All items are listed in Appendix. Participants were asked whether the team had engaged in the respective activities in the last 2 weeks and answered on a 5-point scale ranging from 1 = 'very false' to 5 = 'very true'. Scales were aggregated from the individual to the team level for each observation. Indices of agreement for the four scales are reported in Table 1. ICCs were low at T3, due to low between-group variance within the homogeneous sample. However, as $r_{wg(j)}$s were of an acceptable size, aggregation to the group level was justified. Internal reliabilities (Cronbach's α) for the four scales at the individual level were .85 for problem identification, .87 for idea generation, .84 for idea evaluation, and .96 for idea implementation.

We conducted a series of multilevel confirmatory factor analyses to examine the factor structure of the four innovation activities of the Farr *et al.* (2003) model to decide whether

Table 1. Indices of within-group agreement of innovation activities

	T1			T2			T3		
	$r_{wg(j)}$[a]	ICC (1)	ICC (2)	$r_{wg(j)}$[a]	ICC (1)	ICC (2)	$r_{wg(j)}$[a]	ICC (1)	ICC (2)
Problem Identification	.91/.82	.19***	.46	.92/.96	.21***	.49	.91/.98	.05	.13
Idea Generation	.94/.91	.24***	.53	.94/.89	.20***	.47	.94/.86	.03	.07
Idea Evaluation	.91/.75	.13*	.35	.91/.64	.18**	.44	.91/.84	.08	.18
Implementation	.90/.74	.34***	.65	.94/.89	.14**	.37	.94/.82	.11†	.25

Notes. [a]Median $r_{wg(j)}$/Mean $r_{wg(j)}$.
†p < .10, *p < .05, **p < .01, ***p < .001.

the activities could be collapsed into one creativity and one implementation factor to represent the two theoretically relevant variables. Building on broad conceptualizations of creativity that go beyond idea generation and include the formulation of a problem or an opportunity as well as the evaluation and selection of ideas (see, for example, Montag *et al.*, 2012), we expected problem identification, idea generation, and idea evaluation to load on one common creativity factor. Multilevel confirmatory factor analyses were necessary as multiple observations (level 1) were nested within each team (level 2). Several indices were used to assess model fit: standardized root-mean-squared residual (SRMR), Comparative Fit Index (CFI), and root-mean-squared error of approximation (RMSEA). A CFI value of .95 or higher, a SRMR value of .08 or lower, and a RMSEA value of .06 or lower are indicative of good model fit (Hu & Bentler, 1999). To compare models, we used the Bayesian information criterion (BIC). Lower BIC values indicate better model fit (Schwarz, 1978).

First, we specified a four-factor model with problem identification, idea generation, idea evaluation, and implementation as separate factors (Model 1). Second, we specified a hierarchical model with two second-order factors: We combined problem identification, idea generation, and idea evaluation into a second-order creativity factor (Model 2) and implementation as a separate factor. Third, we specified a one-factor model with all items loading on the same factor (Model 3). The four-factor model showed adequate fit, χ^2 (29) = 80.33, $p < .001$; CFI = .98; RMSEA = .08; SRMR = .04, BIC = 2,132.84. However, the second model, combining problem identification, idea generation, and idea evaluation into a second-order factor showed a slightly better fit to the data, χ^2 (31) = 82.74, $p < .001$; CFI = .98; RMSEA = .08; SRMR = .04, BIC = 2,129.51. In contrast, the one-factor model displayed only poor fit, χ^2 (35) = 666.47, $p < .001$; CFI = .70; RMSEA = .25; SRMR = .12, BIC = 3,070.69. Taken together, the two- and four-factor models yielded nearly identical fit to the data. However, in the four-factor model, the factors of problem identification, idea generation, and idea evaluation showed very high intercorrelations (.85 and above). Therefore, we decided to utilize the more parsimonious two-second-order factors model to represent the theoretical constructs of creativity and implementation.

Team innovation was assessed at the end of the project cycle by the instructors of the student courses. We developed items that assessed the novelty and quality of project outcomes based on past research that suggests that both novelty and quality are defining characteristics of innovative outcomes (Amabile, 1983; Anderson, Potočnik, & Zhou, 2014; Oldham & Cummings, 1996). We adapted published scales to fit our research context (Keller, 2006; West & Anderson, 1996; Zhou & Oldham, 2001). Instructors rated the novelty and quality of the project outcome using five items (see Appendix) with a 5-point scale (Cronbach's α = .93). We received ratings of team innovation for a subset of 57 teams (75% of the total sample) because some instructors did not return the questionnaires and some instructor questionnaires could not be matched with the respective team members' questionnaires. Thus, the analyses that included team innovation are based on the subsample of 57 teams. To make sure that the teams with ratings of team innovation did not differ in any significant aspects from teams that lacked these ratings, we compared the two groups of teams on the crucial dimensions of our model: the initial levels of creativity and implementation as well as the slopes of creativity and implementation. None of these comparisons yielded significant differences. Hence, we are confident that our hypotheses tests are not threatened by selection bias.

Results

Preliminary analyses

Means, standard deviations, and intercorrelations of all study variables are displayed in Table 2. The table shows that all three observations of creativity were substantially correlated (rs ranging from .24 to .54), whereas implementation observations over time showed somewhat lower correlations (rs ranging from .27 to .29). Teams that engaged in high levels of creativity in early time frames also tended to engage in high levels of creativity during later time frames. By contrast, the levels of implementation a team engaged in during early time frames, around the mid-point, and at later times were more moderately related. In line with the assumption that creativity and implementation are interdependent, the results reveal strong positive correlations between the two processes at each observation (T1: $r = .57$, T2: $r = .63$, T3: $r = .69$, all ps $< .001$).

The means and standard deviations of creativity and implementation for T1 through T3 in Table 2 describe how the two processes developed over time. Figure 2 displays the actual trajectories of creativity and implementation over time. Neither creativity nor implementation ever approached zero. Rather, in any given time frame there was some degree of both creativity and implementation, and change over time in the engagement in each activity was a matter of degree. The pattern of mean values showed little change in creativity, but an increase in implementation from T1 to T2 ($t = -4.64, p < .001$) and no change from T2 to T3 ($t = .78, p > .10$). These results provide some preliminary support for the pattern suggested by our model (Figure 1, Panel C): Teams maintained a high level of creativity throughout their innovation projects and increased the level of implementation. However, this increase in implementation seemed to take place especially during the first half of the projects.

Hypotheses tests

To test whether the initial level of creativity and implementation as well as change over time in these processes are related to team innovation, we regressed team innovation on intercepts and change in creativity and implementation over time (cf. Chen, Ployhart, Cooper Thomas, Anderson, & Bliese, 2011). In the first step, we regressed both processes on time as the independent variable, using mixed-effect growth models (Bliese & Ployhart, 2002). In these analyses, we obtained empirical Bayes estimates for intercepts and slopes for each team. The estimated Bayes intercepts, which result from these two regressions, represent the initial value of creativity and implementation. In addition, the estimated Bayes slopes represent change over time in each process. The Bayes estimates for both intercepts and slopes vary between teams. In the second step, team innovation was regressed on the empirical Bayes estimates obtained in the first step. With this analysis, we tested whether the initial value and the linear change (i.e., the rise or fall) in creativity and implementation over time were related to team innovation. In these analyses, we controlled for group size. As intercepts and slopes of implementation were very highly correlated ($r = -.76$), including both variables in the same regression analysis caused multicollinearity problems. We therefore used independent analyses to test the effects of initial level and change in creativity and implementation on team innovation (see Table 3 Models 2 and 3, respectively).

The results of these analyses are summarized in Table 3. As predicted by Hypothesis 1, which anticipated a positive relationship between the level of creativity in early time frames and team innovation, the intercept of creativity was significantly related to team

Table 2. Means, standard deviations, and intercorrelations

Variable	Mean	*SD*	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1. Team Innovation	2.90	0.85	–										
2. Creativity at T1	4.15	0.46	.00	–									
3. Creativity at T2	4.25	0.50	.09	.47***	–								
4. Creativity at T3	4.26	0.40	.21	.24*	.54***	–							
5. Implementation at T1	3.61	0.79	−.25†	.57***	.21†	.15	–						
6. Implementation at T2	4.10	0.56	−.05	.60***	.63***	.45***	.29*	–					
7. Implementation at T3	4.03	0.63	.15	.30**	.42***	.69***	.27*	.28*	–				
8. Intercept Creativity	4.13	0.27	.05	.87***	.80***	.42***	.50***	.69***	.41***	–			
9. Intercept Implementation	3.63	0.44	−.22†	.62***	.33**	.22†	.91***	.55***	.22†	.61***	–		
10. Slope Creativity	.01	0.04	.05	−.36**	.19	.68***	−.16	.03	.43***	−.20†	−.17	–	
11. Slope Implementation	.06	0.06	.27*	−.40***	.03	.27*	−.70***	−.22†	.38**	−.26***	−.76***	.50***	–
12. Group Size	4.13	0.75	.07	−.10	.01	.01	−.24*	−.09	.08	−.09	−.33**	.04	.34**

Notes. $N = 76$ (for correlations with team innovation $N = 57$).
†$p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$.

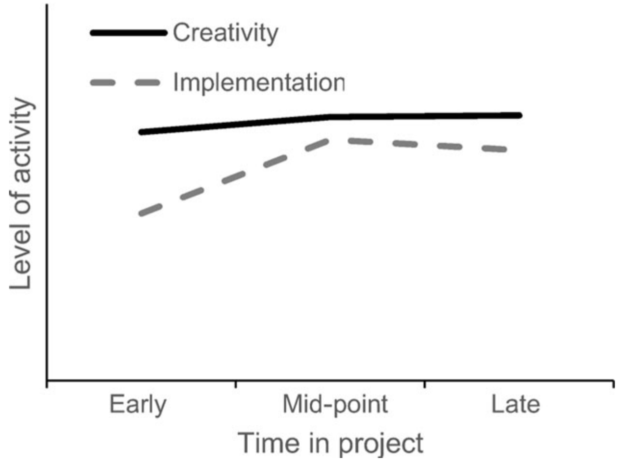

Figure 2. Actual trajectories of creativity and implementation in teams.

Table 3. Regression of team innovation on intercept of and change in innovation activities

	DV: Team innovation			
	Model 1	Model 2	Model 3	Model 4
Group Size	.07	.10	.11	.07
Creativity (Intercept)		.39*		
Implementation (Intercept)		−.49**		
Change in Creativity			−.17	−.16
Change in Implementation			.40*	.41*
Creativity at T3 (Residual)				.24†
R^2	.00	.14†	.13†	.18†
ΔR^2		.13*	.12†	.05†

Notes. $N = 57$. Standardized regression coefficients are reported.
†$p < .10$, *$p < .05$, **$p < .01$.

innovation in a positive direction (Model 2: $\beta = .39$, $p < .05$): The higher the initial level of creativity, the more innovative were the teams. Hypothesis 2 predicted a negative relationship between the level of implementation in early time frames and team innovation. Accordingly, the intercept of implementation was significantly negatively related to team innovation (Model 2: $\beta = -.49$, $p < .01$). The lower the initial level of implementation, the more innovative were the teams, supporting Hypothesis 2. Hypothesis 3 stated that an increase in implementation would be positively related to team innovation. Change in implementation was indeed positively related to team innovation (Model 3: $\beta = .40$, $p < .05$), supporting Hypothesis 3. Thus, the more teams increased the level of implementation during the projects, the more innovative they were. Finally, Hypothesis 4 stated that a decrease in creativity over time is negatively related to team innovation. Accordingly, the slope of creativity should be positively related to team innovation. However, change in creativity was unrelated to team innovation (Model 3: $\beta = -.17$, $p > .10$), so Hypothesis 4 was not supported. Yet, Table 2 shows a positive correlation, albeit non-significant, between creativity at T3 and team innovation ($r = .21$,

Table 4. Regression of team innovation on intercept of and change in innovation activities for the first and second halves of projects

	DV: Team innovation		
	Model 1	Model 2	Model 3
First half of projects (T1 until T2)			
Group Size	.07	.08	.07
Creativity (Intercept)		.39*	
Implementation (Intercept)		−.53**	
Change in Creativity			−.05
Change in Implementation			.30*
R^2	.00	.19*	.09
ΔR^2		.18**	.09†
Second half of projects (T2 until T3)			
Group Size	.07	.05	.04
Creativity (Intercept)		−.05	
Implementation (Intercept)		−.09	
Change in Creativity			.06
Change in Implementation			.08
R^2	.00	.01	.01
ΔR^2		.01	.01

Notes. $N = 57$. Standardized regression coefficients are reported.
†$p < .10$, *$p < .05$, **$p < .01$.

$p = .13$). To explore this relationship further, as a post hoc analysis, we included creativity at T3 as a predictor in the regression analysis. As creativity at T3 is part of the creativity slope, we used the residual of creativity at T3 when regressed on the slope of creativity to avoid problems of non-independence. As Table 3 shows, creativity at T3 was positively related to team innovation (Model 4: $\beta = .24, p = .08$). Thus, this analysis suggests that a high level of creativity at later times in the innovation process is beneficial for team innovation.

Additional analyses

The mid-point has been previously found to be an important concept in theories on team dynamics (Gersick, 1988, 1989). In addition, our descriptive results revealed that the increase in implementation mainly took place in the first half of projects. Therefore, we reanalysed our data using only observations from the beginning of the projects until the mid-point as well as observations from the mid-point until the end of the projects in separate analyses. The intercepts of the analyses using the second half of the projects represent the level of creativity and implementation at the mid-point. Interestingly, results were nearly identical to the original results for the first half of the projects (see upper part of Table 4 for details), but none of the intercepts or slopes of creativity and implementation yielded significant results for the second half of the projects (see lower part of Table 4). That is, while the level of creativity and implementation in early time frames is related to team innovation, the same is not true for the level of creativity and implementation around the mid-point of projects. Similarly, while change in implementation from the beginning until the mid-point is related to team innovation, change in implementation after the mid-point has no impact on team innovation.

Discussion

In this article, we specified and tested a temporal pattern of creativity and implementation in the life cycle of team projects that we expected to result in team innovation. In support of our hypotheses, teams delivered innovative outcomes if they started out with a high level of creativity and refrained from an early focus on implementation. Before the mid-point of projects, there was an increase in implementation activity in those teams who eventually delivered innovative outcomes. Contrary to our expectation, we could not show that a decrease in creativity was negatively related to team innovation. However, further analyses confirmed a positive relationship between creativity at later time frames and team innovation, supporting the assumption that creativity is critical throughout the life cycle of team projects.

The temporal pattern of creativity and implementation we derived theoretically and tested empirically informs the literature on team innovation. Our findings suggest that the linear perspective on innovation processes overemphasizes the temporal separation of creativity and implementation into distinct phases, while the complexity perspective on innovation processes neglects that some degree of separation is necessary. More specifically, a partial separation of creativity from implementation in early time frames of a team project is critical for team innovation (Amabile, 1988; Farr *et al.*, 2003). This separation allows for episodes of unrestricted creativity which are critical if something unique and truly original is to be created. Teams that focus on implementation too early are likely to merely apply available knowledge and adapt existing ideas such that conventional outcomes, or at best incremental innovations, result. While this finding confirms a central tenet of linear phase models, it deviates from a complexity perspective that questions the existence of predictable sequences of activities.

In line with the complexity perspective, on the other hand, high levels of creativity at later time frames showed a weak positive association with team innovation. This finding underlines the assumption of the complexity perspective that innovation projects incorporate unpredictable developments and setbacks that require new ideas (Schroeder *et al.*, 1989). Interestingly, the descriptive results of our study show that the mean level of creativity was never lower than the mean level of implementation. This observation clearly contradicts the linear perspective, which assumes a strong focus on implementation towards the end of a project, which would be indicated by a higher level of implementation than creativity. In contrast, our results support the assumption of the complexity perspective that in the course of a project, an idea is never 'ready' in the sense that teams can completely concentrate on implementation without refining or revising the idea (Paulus, 2002). Thus, contrary to suggestions by Ford and Sullivan (2004) as well as the finding by Knight (2015) that exploratory search after the mid-point hinders team performance, we did not find any evidence that a decrease in creativity is necessary for high levels of team innovation.

This discrepancy might be due to different conceptualizations of creativity or different types of ideas. Whereas Ford and Sullivan's (2004) argument refers to new contributions that fundamentally alter the main project outcome, our broader conceptualization of creativity includes many different kinds of ideas. More specifically, creativity in early and later time frames may be focused on different types of ideas. While early creativity will likely concern the general product idea that guides the project, later ideas will more likely be supportive of implementation. For example, later ideas might be developed to change the product in such a way that implementation is feasible. Additionally, whereas early ideas may be more radical, later ideas might be incremental in nature. However, as we did not assess the type or radicalness of ideas in our study, future research needs to explore how ideas might change over a project's life cycle. The type and function of ideas can be studied, for example, by utilizing observational study designs or by directly asking teams to provide examples of ideas they are currently working on.

It needs to be noted that the results of our study concerning implementation are more robust than the results concerning creativity. Specifically, we did not find any zero-order correlations between the starting level of creativity (i.e., the intercept of creativity and creativity at T1) and team innovation. Only when controlling for the level of implementation, did we find support for the assumption that high levels of creativity in early time frames are related to team innovation. Thus, it seems that the level of creativity relative to implementation is more relevant for team innovation than the absolute level of creativity. In addition, the slope of creativity was unrelated to team innovation. Taken together, it seems that the timing of implementation activities is much more important for team innovation than the timing of creativity. This is surprising given the predominance of studies concentrating on creativity and the scarcity of research on implementation, both at the team (West, 2002a) and the individual level (Baer, 2012). In line with earlier calls for research on the implementation side of innovation, our study highlights the importance of explaining not only the antecedents of implementation, but also the trajectory of implementation over time.

Interestingly, our results seem to be especially relevant for the first half of innovation projects. Separate analyses for the first and the second halves of projects revealed that the level of creativity and implementation was relevant for team innovation only at the very beginning of the projects. In contrast, the level of these activities seemed to be irrelevant around the mid-point. Moreover, an increase in implementation seemed to be important especially until the mid-point of the project, whereas an additional increase after the mid-point did not further improve team innovation. This latter result is in line with earlier work by Gersick (1988, 1989) on team dynamics that shows that successful teams use a consistent approach to their work after the mid-point. Our research extends Gersick's work insofar as we add a content perspective by focusing on specific innovation activities (Gersick, 1988, 1989). As we did not hypothesize these differential effects within the first and second halves of innovative projects, future research needs to focus on additional temporal aspects of the innovation process. Indeed, the interplay between creativity and implementation can be analysed at time scales different from the 2-week time interval that was the focus of this study (Mitchell & James, 2001). One can further 'zoom in' and examine the pattern of creativity and implementation in shorter time intervals, for example by studying in detail the activities during a team meeting. Such a more detailed analysis will offer additional insights into the interplay of creativity and implementation. For example, it is possible that the intercorrelation of creativity and implementation will be much lower or even negative in shorter time intervals as it is more difficult to engage in both behaviours within the same minute than within the same week. In contrast, it is also possible to 'zoom out' and study the interplay of creativity and implementation at a larger time scale of months or years. For example, teams might migrate between different projects that are focused on either incremental or radical innovations. We suggest that testing our theoretical assumptions using different time scales will provide additional valuable insights into the temporal pattern of creativity and implementation.

Limitations and future research

We would like to highlight some potential limitations of this study. First, the sample was comprised of university students whose work closely mirrored teams in other settings. The student teams worked on applied projects with ill-defined problems as is often the case in professional teams (Mumford, Scott, Gaddis, & Strange, 2002). Project outcomes were graded by the team supervisors and teams were able to enter school-wide competitions when they performed highly. Thus, the projects had meaningful consequences for team members. Nevertheless, particularities of the sample need to be taken into account when generalizing results. The teams worked together for only up to 4 months, and the pattern of creativity and implementation is likely more complex in teams with longer project lifespans and especially in teams that work together on an ongoing basis. In addition, student teams only had to convince the instructor of the value of their project outcomes. In contrast, professional teams need to convince a number of external stakeholders about the value of their products, such as organizational decision makers and eventually customers. Thus, the student teams were less dependent on external support and championing of others outside the team to bring a product to market. In contrast to organizational settings, implementation in the student teams focused on building prototypes, but did not include the actual production or diffusion of the product. Nevertheless, the student teams were instructed to keep potential customers in mind. Furthermore, the educational setting of the study might have influenced the innovation process insofar that instructors introduced structure, feedback, and the necessity to hand in deliverables during the process. However, such an influence may also be comparable to an organizational context where team or project leaders ask questions, give feedback, and require teams to meet deadlines for different milestones.

A second potential limitation concerns the differentiation of creativity and implementation. We use these concepts as a parsimonious differentiation between two broad categories of innovation activities. However, innovation models often use more detailed differentiations of processes or activities. For example, Perry-Smith and Mannucci (2017) differentiate between idea generation and idea elaboration as well as idea championing and idea implementation. Farr *et al.* (2003) distinguish between problem identification, idea generation, and idea evaluation instead of using a broader concept of creativity. Due to high intercorrelations between these activities, we could not separate them in this study. Future research might need to focus on shorter time frames to be able to distinguish between the specifics of different aspects of creativity. Such an analysis should reveal additional information about how the dynamic interplay of innovation activities produces original outcomes. Similarly, this study did not distinguish between different activities related to implementation. For example, some models of the innovation process distinguish between promoting and realizing ideas (Janssen, 2000) or between championing and implementing ideas (Perry-Smith & Mannucci, 2017). Utilizing a more detailed differentiation of implementation behaviours will be helpful in understanding whether there are systematic differences in the internal structure of creativity and implementation. Additionally, it might be insightful to examine how the engagement in different implementation activities changes over time.

Finally, the high correlation between the intercept and slope of implementation made it impossible to test the impact of the starting level of and change over time in implementation simultaneously. This is a problem insofar that we do not know which of the two factors – initial level or increase, or the combination of both – is the driving force for team innovation. However, the high correlation may not be a statistical artefact of our sample but an accurate representation of reality in innovative teams. That is, the starting level of and the change in implementation are likely to go hand in hand. For teams that start out with a high level of implementation there will not be a need, or even a possibility, to increase the level of implementation over time; the product might just not be very innovative. In contrast, teams that start out with only a little implementation are required to increase the level of implementation in order to deliver any product at all, whether innovative or not. In order to study the impact of initial level of and change over time in implementation separately, experimental studies that independently manipulate both factors are necessary.

A focus on the pattern of creativity and implementation that results in team innovation holds promising and challenging avenues for future research. First, our line of work informs research on factors which differentially influence creativity and implementation (Axtell *et al.*, 2000; Baer, 2012; Somech & Drach-Zahavy, 2013). It might be interesting, for example, to study how team composition influences the trajectories of creativity and implementation over time, advancing the knowledge on how team composition is related to team innovation (Miron-Spektor, Erez, & Naveh, 2011; Perretti & Negro, 2007). Importantly, to comprehensively understand team innovation, research needs to move away from studying innovation as a homogenous construct (Baer, 2012) or only as an outcome (Knight, 2015), and focus on the underlying processes – that is, creativity and implementation – in more detail. For example, factors that are especially relevant for the implementation of innovation in organizations, such as social support or social networks (Axtell *et al.*, 2000; Baer, 2012), may affect the trajectory of implementation by helping teams to increase implementation over time. Moreover, when studying the antecedents or consequences of creativity and implementation, it is not sufficient to focus on distinct temporal phases of the innovation process, such as the first or second half of the project. In contrast, creativity and implementation need to be studied as activities in relation to when they take place. Finally, our research points to the necessity to not only examine differential antecedents of the level of creativity and implementation but to also identify the self-regulatory mechanisms through which teams effectively transition between creativity and implementation.

Moreover, for many teams in organizations, it needs to be considered that teams often work together for much longer periods of time on projects that have no clear beginning or end (Hackman, 1990). In such situations, episodes of unrestricted creativity cannot be confined to an early time frame. Rather, a team may need to slow down its implementation activities repeatedly to allow for the formation of new ideas and the reorientation of the direction in which it is heading. Such performance episodes may appear to outside observers and team members as unproductive because teams do not pursue a clear goal in a streamlined manner (Gersick, 1988, 1989). Teams may even be tempted to hastily jump to implementation to avoid ambiguous states in which no progress can be observed. However, such performance episodes may lay the foundation for innovative outcomes of high originality, which should materialize if teams also have the capability to initiate well-timed episodes of implementation. Thus, future research needs to establish to what extent our results hold in other settings than project teams.

Practical implications

Our study suggests that teams can improve their ability to deliver innovative products by paying attention to when they engage in creativity and implementation and how they manage transitions between these activities (Marks, Mathieu, & Zaccaro, 2001). Teams who seek to innovate might be tempted to reduce the complexity of the innovation process by hastily moving to action to quickly deliver results. An environment of increasing competition and an accelerating pace within organizations will likely amplify this tendency. This study highlights the downsides of the tendency in teams to focus on getting things done early on in a project's life cycle. In contrast, teams might also generate numerous ideas without ever being satisfied with any of them and consequently fail to act on their ideas. We suggest that both strategies – focusing on getting things done too early or never – will result in low team innovation. Teams are better advised to slow down their implementation activities in early time frames of a project to allow for prolonged periods of creativity, but then change their focus to implementation once the foundation for highly original innovations has been laid. However, a rather quick change to implementation seems to be important, as increasing implementation seems to have an especially strong impact before the mid-point of projects.

Acknowledgement

This research was supported by a research grant by the Volkswagen Foundation (II/82 408).

References

Amabile, T. M. (1983). The social psychology of creativity: A componential conceptualization. *Journal of Personality and Social Psychology*, *45*, 357–376. https://doi.org/10.1037/0022-3514.45.2.357

Amabile, T. M. (1988). A model of creativity and innovation in organizations. In B. M. Staw & L. L. Cummings (Eds.), *Research in organizational behavior* (Vol. 10, pp. 123–167). Greenwich, CT: JAI Press Inc.

Amabile, T. M., & Pratt, M. G. (2016). The dynamic componential model of creativity and innovation in organizations: Making progress, making meaning. *Research in Organizational Behavior*, *36*, 157–183. https://doi.org/10.1016/j.riob.2016.10.001

Anderson, N. R., De Dreu, C. K. W., & Nijstad, B. A. (2004). The routinization of innovation research: A constructively critical review of the state-of-the-science. *Journal of Organizational Behavior*, *25*, 147–173. https://doi.org/10.1002/job.236

Anderson, N. R., Potočnik, K., & Zhou, J. (2014). Innovation and creativity in organizations: A state-of-the-science review, prospective commentary, and guiding framework. *Journal of Management*, *40*, 1297–1333. https://doi.org/10.1177/0149206314527128

Axtell, C. M., Holman, D. J., Unsworth, K. L., Wall, T. D., Waterson, P. E., & Harrington, E. (2000). Shopfloor innovation: Facilitating the suggestion and implementation of ideas. *Journal of Occupational and Organizational Psychology*, *73*, 265–285. https://doi.org/10.1348/096317900167029

Baer, M. (2010). The strength-of-weak-ties perspective on creativity: A comprehensive examination and extension. *Journal of Applied Psychology*, *95*, 592–601. https://doi.org/10.1037/a0018761

Baer, M. (2012). Putting creativity to work: The implementation of creative ideas in organizations. *Academy of Management Journal*, *55*, 1102–1119. https://doi.org/10.5465/amj.2009.0470

Baer, M., Leenders, R. T. A. J., Oldham, G. R., & Vadera, A. K. (2010). Win or lose the battle for creativity: The power and perils of intergroup competition. *Academy of Management Journal*, *53*, 827–845. https://doi.org/10.5465/AMJ.2010.52814611

Baumann, N., Kuhl, J., & Kazén, M. (2005). Left-hemispheric activation and self-infiltration: Testing a neuropsychological model of internalization. *Motivation and Emotion*, *29*, 135–163. https://doi.org/10.1007/s11031-005-9439-x

Beckmann, J., & Kuhl, J. (1984). Altering information to gain action control: Functional aspects of human information processing in decision making. *Journal of Research in Personality*, *18*, 224–237. https://doi.org/10.1016/0092-6566(84)90031-x

Bledow, R., Frese, M., Anderson, N. R., Erez, M., & Farr, J. L. (2009). A dialectic perspective on innovation: Conflicting demands, multiple pathways, and ambidexterity. *Industrial and Organizational Psychology: Perspectives on Science and Practice*, *2*, 305–337. https://doi.org/10.1111/j.1754-9434.2009.01154.x

Bliese, P. D., & Ployhart, R. E. (2002). Growth modeling using random coefficient models: Model building, testing, and illustrations. *Organizational Research Methods*, *5*, 362–387. https://doi.org/10.1177/109442802237116

Chan, D. (1998). Functional relations among constructs in the same content domain at different levels of analysis: A typology of composition models. *Journal of Applied Psychology*, *83*, 234–246. https://doi.org/10.1037/0021-9010.83.2.234

Chen, G., Ployhart, R. E., Cooper Thomas, H., Anderson, N., & Bliese, P. D. (2011). The power of momentum: A new model of dynamic relationships between job satisfaction change and turnover intentions. *Academy of Management Journal*, *54*, 159–181. https://doi.org/10.5465/AMJ.2011.59215089

Cheng, Y.-T., & Van de Ven, A. H. (1996). Learning the innovation journey: Order out of chaos? *Organization Science*, *7*, 593–614. https://doi.org/10.1287/orsc.7.6.593

Chirumbolo, A., Livi, S., Mannetti, L., Pierro, A., & Kruglanski, A. W. (2004). Effects of need for closure on creativity in small group interactions. *European Journal of Personality*, *18*, 265–278. https://doi.org/10.1002/per.518

Chirumbolo, A., Mannetti, L., Pierro, A., Areni, A., & Kruglanski, A. W. (2005). Motivated closed-mindedness and creativity in small groups. *Small Group Research*, *36*, 59–82. https://doi.org/10.1177/1046496404268535

Choi, J. N., & Chang, J. Y. (2009). Innovation implementation in the public sector: An integration of institutional and collective dynamics. *Journal of Applied Psychology*, *94*, 245–253. https://doi.org/10.1037/a0012994

Diehl, M., & Stroebe, W. (1987). Productivity loss in brainstorming groups: Toward the solution of a riddle. *Journal of Personality and Social Psychology*, *53*, 497–509. https://doi.org/10.1037/0022-3514.53.3.497

Eindhoven, J. E., & Vinacke, W. E. (1952). Creative processes in painting. *Journal of General Psychology*, *47*, 139–164. https://doi.org/10.1080/00221309.1952.9710660

Farh, J.-L., Lee, C., & Farh, C. I. (2010). Task conflict and team creativity: A question of how much and when. *Journal of Applied Psychology*, *95*, 1173–1180. https://doi.org/10.1037/a0020015

Farr, J. L., Sin, H.-P., & Tesluk, P. E. (2003). Knowledge management processes and work group innovation. In L. V. Shavinina (Ed.), *The international handbook on innovation* (pp. 574–586). New York, NY: Elsevier Science.

Ford, C., & Sullivan, D. M. (2004). A time for everything: How the timing of novel contributions influences project team outcomes. *Journal of Organizational Behavior*, *25*, 279–292. https://doi.org/10.1002/job.241

Fujita, K., Gollwitzer, P. M., & Oettingen, G. (2007). Mindsets and pre-conscious open-mindedness to incidental information. *Journal of Experimental Social Psychology*, *43*, 48–61. https://doi.org/10.1016/j.jesp.2005.12.004

George, J. M. (2007). Creativity in organizations. *The Academy of Management Annals*, *1*, 439–477. https://doi.org/10.1080/078559814

Gersick, C. J. G. (1988). Time and transition in work teams: Toward a new model of group development. *Academy of Management Journal*, *31*, 9–41. https://doi.org/10.2307/256496

Gersick, C. J. G. (1989). Marking time: Predictable transitions in task groups. *Academy of Management Journal*, *32*, 274–309. https://doi.org/10.2307/256363

Gollwitzer, P. M. (1990). Action phases and mind-sets. In E. T. Higgins & R. M. Sorrentino (Eds.), *Handbook of motivation and cognition: Foundations of social behavior* (Vol. 2, pp. 53–92). New York, NY: Guilford Press.

Gollwitzer, P. M. (2003). Why we thought that action mind-sets affect Illusions of control. *Psychological Inquiry*, *14*, 261–269. https://doi.org/10.2307/1449686

Gollwitzer, P. M., Heckhausen, H., & Steller, B. (1990). Deliberative and implemental mind-sets: Cognitive tuning toward congruous thoughts and information. *Journal of Personality and Social Psychology*, *59*, 1119–1127. https://doi.org/10.1037/0022-3514.59.6.1119

Gong, Y., Cheung, S.-Y., Wang, M., & Huang, J.-C. (2012). Unfolding the proactive process for creativity integration of the employee proactivity, information exchange, and psychological safety perspectives. *Journal of Management*, *38*, 1611–1633. https://doi.org/10.1177/0149206310380250

Grant, A. M., & Berry, J. W. (2011). The necessity of others is the mother of invention: Intrinsic and prosocial motivations, perspective taking, and creativity. *Academy of Management Journal*, *54*, 73–96. https://doi.org/10.5465/AMJ.2011.59215085

Hackman, J. R. (1990). *Groups that work (and those that don't): Creating conditions for effective teamwork*. San Francisco, CA: Jossey-Bass.

Hargadon, A. B., & Bechky, B. A. (2006). When collections of creatives become creative collectives: A field study of problem solving at work. *Organization Science*, *17*, 484–500. https://doi.org/10.1287/orsc.1060.0200

Harvey, S. (2014). Creative synthesis: Exploring the process of extraordinary group creativity. *Academy of Management Review*, *39*, 324–343. https://doi.org/10.5465/amr.2012.0224

Heckhausen, H., & Gollwitzer, P. M. (1987). Thought contents and cognitive functioning in motivational versus volitional states of mind. *Motivation and Emotion*, *11*, 101–120. https://doi.org/10.1007/BF00992338

Hoever, I. J., van Knippenberg, D., van Ginkel, W. P., & Barkema, H. G. (2012). Fostering team creativity: Perspective taking as key to unlocking diversity's potential. *Journal of Applied Psychology*, *97*, 982–996. https://doi.org/10.1037/a0029159

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*, 1–55. https://doi.org/10.1080/10705519909540118

Janssen, O. (2000). Job demands, perceptions of effort-reward fairness and innovative work behaviour. *Journal of Occupational and Organizational Psychology*, *73*, 287–302. https://doi.org/10.1348/096317900167038

Kanter, R. M. (1988). When a thousand flowers bloom: Structural, collective, and social conditions for innovation in organization. In B. M. Staw & L. L. Cummings (Eds.), *Research in organizational behavior* (Vol. 10, pp. 169–211). Greenwich, CT: JAI Press Inc.

Keller, R. T. (2006). Transformational leadership, initiating structure, and substitutes for leadership: A longitudinal study of research and development project team performance. *Journal of Applied Psychology*, *91*, 202–210. https://doi.org/10.1037/0021-9010.91.1.202

King, N. (1992). Modelling the innovation process: An empirical comparison of approaches. *Journal of Occupational and Organizational Psychology*, *65*, 89–100. https://doi.org/10.1111/j.2044-8325.1992.tb00487.x

Knight, A. P. (2015). Mood at the midpoint: Affect and change in exploratory search over time in teams that face a deadline. *Organization Science*, *26*, 99–118. https://doi.org/doi:10.1287/orsc.2013.0866

Kristensson, P., & Magnusson, P. R. (2010). Tuning users' innovativeness during ideation. *Creativity and Innovation Management*, *19*, 147–159. https://doi.org/10.1111/j.1467-8691.2010.00552.x

Li, Q., Maggitti, P. G., Smith, K. G., Tesluk, P. E., & Katila, R. (2013). Top management attention to innovation: The role of search selection and intensity in new product introductions. *Academy of Management Journal*, *56*, 893–916. https://doi.org/10.5465/amj.2010.0844

Locke, E. (2000). Motivation, cognition, and action: An analysis of studies of task goals and knowledge. *Applied Psychology*, *49*, 408–429. https://doi.org/10.1111/1464-0597.00023

Lubart, T. I. (2001). Models of the creative process: Past, present and future. *Creativity Research Journal*, *13*, 295–308. https://doi.org/10.1207/S15326934CRJ1334_07

Madjar, N., Greenberg, E., & Chen, Z. (2011). Factors for radical creativity, incremental creativity, and routine, noncreative performance. *Journal of Applied Psychology*, *96*, 730–743. https://doi.org/10.1037/a0022416
Manske, M. E., & Davis, G. A. (1968). Effects of simple instructional biases upon performance in the unusual uses test. *Journal of General Psychology*, *79*, 25–33. https://doi.org/10.1080/00221309.1968.9710449
Marks, M. A., Mathieu, J. E., & Zaccaro, S. J. (2001). A temporally based framework and taxonomy of team processes. *Academy of Management Review*, *26*, 356–376. https://doi.org/10.1080/00221309.1968.9710449
Meadow, A., Parnes, S. J., & Reese, H. (1959). Influence of brainstorming instructions and problem sequence on a creative problem solving test. *Journal of Applied Psychology*, *43*, 413–416. https://doi.org/10.1037/h0043917
Mednick, S. (1962). The associative basis of the creative process. *Psychological Review*, *69*, 220–232. https://doi.org/10.1037/h0048850
Miron-Spektor, E., Erez, M., & Naveh, E. (2011). The effect of conformists and attentive-to-detail members on team innovation: Reconciling the innovation paradox. *Academy of Management Journal*, *54*, 740–760. https://doi.org/10.5465/AMJ.2011.64870100
Mitchell, T. R., & James, L. R. (2001). Building better theory: Time and the specification of when things happen. *Academy of Management Review*, *26*, 530–547. https://doi.org/10.5465/AMR.2001.5393889
Montag, T., Maertz, C. P., & Baer, M. (2012). A critical analysis of the workplace creativity criterion space. *Journal of Management*, *38*, 1362–1386. https://doi.org/10.1177/0149206312441835
Mumford, M. D. (2000). Managing creative people: Strategies and tactics for innovation. *Human Resource Management Review*, *10*, 313–351. https://doi.org/10.1016/s1053-4822(99)00043-1
Mumford, M. D., & Gustafson, S. B. (1988). Creativity syndrome: Integration, application, and innovation. *Psychological Bulletin*, *103*, 27–43. https://doi.org/10.1037/0033-2909.103.1.27
Mumford, M. D., Mobley, M. I., Reiter-Palmon, R., Uhlman, C. E., & Doares, L. M. (1991). Process analytic models of creative capacities. *Creativity Research Journal*, *4*, 91–122. https://doi.org/10.1080/10400419109534380
Mumford, M. D., Scott, G. M., Gaddis, B., & Strange, J. M. (2002). Leading creative people: Orchestrating expertise and relationships. *The Leadership Quarterly*, *13*, 705–750. https://doi.org/10.1016/S1048-9843(02)00158-3
Oldham, G. R., & Cummings, A. (1996). Employee creativity: Personal and contextual factors at work. *Academy of Management Journal*, *39*, 607–634. https://doi.org/10.2307/256657
Osborn, A. F. (1953). *Applied imagination*. Oxford, UK: Scribner's.
Paulus, P. B. (2002). Different ponds for different fish: A contrasting perspective on team innovation. *Applied Psychology*, *51*, 394–399. https://doi.org/10.1111/1464-0597.00973
Pearce, C. L., & Ensley, M. D. (2004). A reciprocal and longitudinal investigation of the innovation process: The central role of shared vision in product and process innovation teams (PPITs). *Journal of Organizational Behavior*, *25*, 259–278. https://doi.org/10.1002/job.235
Peralta, C. F., Lopes, P. N., Gilson, L. L., Lourenço, P. R., & Pais, L. (2015). Innovation processes and team effectiveness: The role of goal clarity and commitment, and team affective tone. *Journal of Occupational and Organizational Psychology*, *88*, 80–107. https://doi.org/10.1111/joop.12079
Perretti, F., & Negro, G. (2007). Mixing genres and matching people: A study in innovation and team composition in Hollywood. *Journal of Organizational Behavior*, *28*, 563–586. https://doi.org/10.1002/job.464
Perry-Smith, J. E., & Mannucci, P. V. (2017). From creativity to innovation: The social network drivers of the four phases of the idea journey. *Academy of Management Review*, *42*, 53–79. https://doi.org/10.5465/amr.2014.0462
Rietzschel, E. F., Nijstad, B. A., & Stroebe, W. (2007). Relative accessibility of domain knowledge and creativity: The effects of knowledge activation on the quantity and originality of generated ideas.

Journal of Experimental Social Psychology, *43*, 933–946. https://doi.org/10.1016/j.jesp.2006.10.014
Rivkin, J. W., & Siggelkow, N. (2003). Balancing search and stability: Interdependencies among elements organizational design. *Management Science*, *49*, 290–311. https://doi.org/10.2307/4133927
Schroeder, R. G., Van de Ven, A. H., Scudder, G. D., & Polley, D. (1989). The development of innovation ideas. In A. H. Van de Ven, H. L. Angle & M. S. Poole (Eds.), *Research on the management of innovation: The Minnesota studies* (pp. 107–134). New York, NY: Oxford University Press.
Schwarz, G. (1978). Estimating the dimension of a model. *The Annals of Statistics*, *6*, 461–464. https://doi.org/10.1214/aos/1176344136
Shalley, C. E., Zhou, J., & Oldham, G. R. (2004). The effects of personal and contextual characteristics on creativity: Where should we go from here? *Journal of Management*, *30*, 933–958. https://doi.org/10.1016/j.jm.2004.06.007
Sharma, A. (1999). Central dilemmas of managing innovation in large firms. *California Management Review*, *41*, 146–164. https://doi.org/10.2307/41166001
Simonton, D. K. (1997). Creative productivity: A predictive and explanatory model of career trajectories and landmarks. *Psychological Review*, *104*, 66–89. https://doi.org/10.1037/0033-295X.104.1.66
Simonton, D. K. (2003). Scientific creativity as constrained stochastic behavior: The integration of product, person, and process perspectives. *Psychological Bulletin*, *129*, 475–494. https://doi.org/10.1037/0033-2909.129.4.475
Somech, A., & Drach-Zahavy, A. (2013). Translating team creativity to innovation implementation: The role of team composition and climate for innovation. *Journal of Management*, *39*, 684–708. https://doi.org/10.1177/0149206310394187
Taylor, S. E., & Gollwitzer, P. M. (1995). Effects of mindset on positive illusions. *Journal of Personality and Social Psychology*, *69*, 213–226. https://doi.org/10.1037/0022-3514.69.2.213
Taylor, A., & Greve, H. R. (2006). Superman or the fantastic four? Knowledge combination and experience in innovative teams. *Academy of Management Journal*, *49*, 723–740. https://doi.org/10.2307/20159795
Van de Ven, A. H., Polley, D., Garud, R., & Venkataraman, S. (1999). *The innovation journey*. New York, NY: Oxford University Press.
Van de Ven, A. H., & Poole, M. S. (1995). Explaining development and change in organizations. *Academy of Management Review*, *20*, 510–540. https://doi.org/10.5465/amr.1995.9508080329
West, M. A. (2002a). Ideas are ten a penny: It's team implementation not idea generation that counts. *Applied Psychology - An International Review*, *51*, 411–424. https://doi.org/10.1111/1464-0597.01006
West, M. A. (2002b). Sparkling fountains or stagnant ponds: An integrative model of creativity and innovation implementation in work groups. *Applied Psychology: An International Review*, *51*, 355–387. https://doi.org/10.1111/1464-0597.00951
West, M. A., & Anderson, N. R. (1996). Innovation in top management teams. *Journal of Applied Psychology*, *81*, 680–693. https://doi.org/10.1037/0021-9010.81.6.680
West, M. A., & Farr, J. L. (1990). Innovation at work. In M. A. West & J. L. Farr (Eds.), *Innovation and creativity at work: Psychological and organizational strategies* (pp. 3–13). Chichester, UK: John Wiley & Sons.
Woodman, R. W., Sawyer, J. E., & Griffin, R. W. (1993). Toward a theory of organizational creativity. *The Academy of Management Review*, *18*, 293–321. https://doi.org/10.2307/258761
Zhou, J., & Oldham, G. R. (2001). Enhancing creative performance: Effects of expected developmental assessment strategies and creative personality. *The Journal of Creative Behavior*, *35*, 151–167. https://doi.org/10.1002/j.2162-6057.2001.tb01044.x

Zhou, J., Shin, S. J., Brass, D. J., Choi, J., & Zhang, Z.-X. (2009). Social networks, personal values, and creativity: Evidence for curvilinear and interaction effects. *Journal of Applied Psychology*, *94*, 1544–1552. https://doi.org/10.1037/a0016285

Received 27 June 2017; revised version received 22 May 2018

Appendix : *Innovation activities*

Creativity	
	We figured out what we needed to do to be successful[a]
	We developed a better understanding of problems we need to solve[a]
	We collected ideas[b]
	We discussed what a solution should look like[b]
	We came up with new ideas or problem solutions[b]
	We discussed what ideas we should follow[c]
	We evaluated different ideas[c]
Implementation	
	We put our plan into action
	We implemented our plans/ideas
	We put our ideas into action

Note. [a]Problem identification, [b]Idea generation, [c]Idea evaluation.

Team innovation

Compared to other student projects in our field, this product (project outcome). . .				
Is a usual and conventional solution (1)	Is a solution that features only a few novel aspects (2)	Has a balance between conventional, usual, and novel aspects (3)	Is a solution that features mostly novel aspects (4)	Is completely novel and does not at all rely on conventional solutions (5)
Is not creative at all (1)	Is somewhat uncreative (2)	Is neither creative nor uncreative (3)	Is somewhat creative (4)	Is very creative (5)
Is insufficient in terms of quality standards (1)	Falls somewhat below the quality standards (2)	Is acceptable in terms of quality standards (3)	Meets the quality standards very well (4)	Exceeds the quality standards (5)
Cannot be applied in the 'real world' (i.e., in professional settings) (1)	Can be applied in the 'real world' with major modifications (2)	Can be applied in the 'real world' with some modifications (3)	Can be applied in the 'real world' with little modifications (4)	Can readily be applied in the 'real world' (5)
Compared to professional projects in our field, this product (project outcome). . .				
Is a usual and conventional solution (1)	Is a solution that features only a few novel aspects (2)	Has a balance between conventional, usual, and novel aspects (3)	Is a solution that features mostly novel aspects (4)	Is completely novel and does not at all rely on conventional solutions (5)