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Time Pressure and Creativity in Organizations: A Longitudinal Field Study

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Time Pressure And Creativity In Organizations:
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Abstract

This study investigated the relationship between time pressure and creativity with a new method for examining daily thoughts, experiences, and events in organizations. Daily electronic questionnaires were obtained over periods of up to 30 weeks from 177 individuals in seven companies as they worked on projects requiring creativity. Narrative reports of events occurring in those projects were used to extract measures of participants' creative cognitive processing, and daily scale-rated items yielded measures of time pressure. Analyses incorporating several controls, including the number of hours worked, indicated that time pressure on a given day negatively predicted creative cognitive processing that day, one day later, two days later, and over longer time periods as well. The relationship may be a direct one; it was not mediated by intrinsic motivation in this study, and prior research suggests that time pressure may directly constrain cognitive processes related to creativity. These results have theoretical implications for understanding how creativity is affected by various aspects of the work environment, and methodological implications for looking inside the "black box" of creative thinking.

Time Pressure and Creativity in Organizations: A Longitudinal Field Study

Time pressure is becoming an increasingly prominent feature of work in America. Both the business press and the organizational literature have identified a "time famine," in which people feel that there are never enough hours in the work day (Perlow, 1999). Indeed, it is likely that anyone reading this paper has a daunting "To Do" list on the current mental agenda. At the same time, with the growth of knowledge work, there is an increasingly urgent need for creative thinking in organizations. Are these two trends at odds? Might increasing time pressure be sabotaging organizational efforts to produce useful new ideas? Researchers have paid scant attention to this question, and lay wisdom includes contradictory views about the effects of time pressure. Some people hold that it spurs them on to their best work; others say that it makes high levels of performance almost impossible. In this paper, we report a study examining the relationship between time pressure and creative thinking. In addition, we introduce a new methodology for observing creative thinking as it occurs in organizations. We suggest that time pressure, although it may spur people on to do *more* work, may undermine precisely the kind of thinking needed to do *creative* work.

Prior research on performance effects has demonstrated clearly that time pressure – defined as either subjectively perceived time pressure or the imposition of a deadline – increases the <u>rate</u> of individual and group performance (Kelly & Karau, 1993, 1999). However, results have been much less consistent on the <u>quality</u> of performance, with evidence of a positive relationship (Kelly & Karau, 1999), a negative relationship (Kelly & McGrath, 1985), a curvilinear relationship indicating an optimal level of moderate time pressure (Isenberg, 1981), and no relationship at all (Bassett, 1979). Importantly, most of this research has focused on the performance of relatively straightforward tasks rather than tasks requiring creativity.

Indeed, there is little research directly examining the effect of time pressure on creativity, which is defined as a novel, appropriate response to an open-ended task (Amabile, 1983). We found only four previous studies, with three showing a negative effect and one showing a positive effect. An experimental study found that products generated by groups working under a 10-minute time limit were rated as less creative than those generated by groups working under a 20-minute time limit (Kelly & McGrath, 1985). A survey study of marketing professionals revealed a negative relationship between perceived time pressure and perceived overall creativity of marketing ideas (Andrews & Smith, 1996). A negative effect was also uncovered in a field study of workload pressure, defined by items concerning both perceived time pressure and perceived workload (which were highly inter-related). This study found suggestive (but weak) evidence that greater workload pressure was associated with less creative group projects in organizations (Amabile, Conti, Coon, Lazenby, & Herron, 1996). One field study, however, obtained opposite results; this study, conducted 30 years ago, found a positive relationship between scientists' reported time pressure at a particular point in time and the supervisor-rated innovativeness of their work five years later (Andrews & Farris, 1972). Thus, although prior research on time pressure and creativity generally suggests a negative relationship, the body of empirical evidence is far from robust. Moreover, none of the few previous studies on time pressure and creativity has presented a strong theoretical framework for understanding how time pressure might have its effects. Most importantly, no research has directly examined the process that presumably underlies the production of creative work – creative thinking. We set out to do so in the present study.

Creative Cognitive Processing

The componential theory of creativity (Amabile, 1983, 1988, 1996) presents a promising framework for understanding the effects of time pressure. This theory, presented in modified form in Figure 1, can be useful in two ways. First, of the three primary theories of organizational creativity (Amabile, 1988; Ford, 1996; Woodman, Sawyer, & Griffin, 1993), it is the only one to include time pressure. Specifically, it predicts that time pressure will have a negative effect on creativity. Second, like other psychological theories of creativity (Campbell, 1960; Simonton, 1999; Sternberg & Lubart, 1991; Wallas, 1926), it outlines the elements of creative thinking, or creative cognitive processing. It suggests two ways in which time pressure might have an effect: by directly affecting creative cognitive processing, and by affecting this processing through a motivational mechanism. Creative cognitive processing is central to creativity theories, because it is this set of various cognitive processes that most immediately determines the creativity of work outcomes. As shown in Figure 1, creative cognitive processing contains four basic elements: (a) identification and understanding of the problem or task, sparked by either an external or an internal stimulus; (b) preparation, involving learning and remembering, which helps to build up, reactivate, and/or incubate relevant information for the particular problem at hand; (c) response generation, or coming up with ideas for solving the problem; and (d) response validation and communication, involving articulating, testing, and trying out the most promising response possibilities. An individual engages in these processes, often cycling repeatedly through the various elements in different sequences, until the problem is solved or the task is completed. To the extent that this process is fostered, outcomes should be more creative.

As essential as creative cognitive processing is to any creativity theory, this "black box" has been virtually ignored by prior research – most likely because looking at this processing, particularly in real-world settings, presents formidable methodological challenges. It is important to develop ways to meet those challenges, in order to fully understand how creativity happens and how it might be affected by time pressure and other features of the work environment. In the present study, we developed a methodology to observe evidence of creative cognitive processes as they were occurring in organizations. We then investigated whether perceived time pressure predicts those processes.

Time Pressure and Creative Cognitive Processing

We propose that time pressure, in the moderate to high levels generally experienced in contemporary organizations, has a direct negative effect on creative cognitive processing. According to the componential theory, creativity is determined by the effects of one extra-individual (outside the person) component and three intra-individual (inside the person) components on creative cognitive processing. The extra-individual component is the external work environment, consisting of several features of the organizational climate, the work group climate, managerial behaviors, and task constraints – including time pressure for getting the work done. The theory focuses on an indirect route by which the work environment might influence creativity – through influences on the intra-individual components. However, although it is not explicitly predicted by the theory, a direct effect of time pressure is suggested by a metaphor in the most recent revision of the theory (Amabile, 1996). According to this metaphor, doing a task or solving a problem is like getting through a maze; the comparison derives from Newell, Shaw, and Simon's (1962) notion that creativity depends on the exploration of the maze of available cognitive pathways. Although satisfactory outcomes can be attained by following a straight path (a familiar task algorithm) out of the maze, creative solutions require exploration of unfamiliar territory. One recent laboratory study designed to examine the applicability of this maze metaphor revealed that people who allocate more time to exploratory task behaviors are more likely to produce work that is rated by observers as creative (Ruscio, Whitney, & Amabile, 1998).

If such cognitive exploration of the maze of possibilities is important to creativity, there must be sufficient time devoted to the cognitive processing involved in intellectually playing with ideas and possible solution paths. Indeed, Einstein once referred to creativity as "combinatorial play" (Einstein, 1949). If people are too busy, they may not allocate the time to engage in this sort of thinking. Campbell's (1960) ground-breaking theory of creative thought proposed that the central process is an evolutionary one, whereby the mind generates more or less blind variations or combinations of ideas, and then selectively retains the most useful novel ideas; Simonton's more recent theory (1999) elaborates on this notion. The more time that is made available for this type of thinking, the more variations that can be generated and evaluated.

There is some suggestive evidence, from prior empirical studies, that successful creative processing is a function of available time. In one laboratory study, participants who were given five minutes to plan their structure-building activity, either by having five minutes to physically play with task materials, or five minutes to simply look at (and mentally play with) the materials, subsequently produced structures that were rated as more creative than those produced by participants who began the structure-building task immediately after being given the materials (Whitney, Ruscio, Amabile, & Castle, 1995).

There is suggestive evidence from the problem-solving and decision-making literatures, as well. In a review, Edland and Svenson (1993) noted that people working under time pressure tend to employ the strategies of "filtering (processing some parts of the information more, and others less), acceleration, and omission (ignoring particular parts of the information)" (p. 28). For example, in a gambling simulation study, Ben Zur and Breznitz (1981) found that individuals under high time pressure focused almost exclusively on negative information (i.e., probability of losing) and accelerated the decision making process, resulting in a preference for low-risk solutions. Janis (1982) attributes this phenomenon to the state of "hypervigilance" (excessive alertness to signs of threat or pressure) that is triggered by the time pressure and other stressful situations. The reasoning is that, because hypervigilance in response to approaching deadlines causes people to increase the selectivity of the information they process and to make a decision without generating all of the available alternatives, it "leads to ill-considered decisions that are frequently followed by postdecisional conflict and frustration" (Janis, 1982, p. 81). These notions are consonant with those of threat-rigidity theory, which proposes that, under threatening situations, individuals and organizations become more likely to rely on familiar algorithms. In sum, the literature suggests that time pressure is likely to result in shallow, narrow, conservative thinking – the opposite of creative thinking.

This shallow, narrow, conservative thinking should affect not only the exploration for new ideas, which is termed “response generation” in the componential theory. (See Figure 1.) It should also affect each of the other elements of creative cognitive processing. Under time pressure, people may be less likely to take the time to understand a problem deeply (“problem or task identification”), or to fully prepare to solve the problem through learning and contemplation of what they have learned (“preparation”), before they delve into response generation. Moreover, they may be less likely to fully think through or talk through the implications of the response possibilities they have generated (“response validation and communication”). In other words, the entire set of elements that make up creative cognitive processing could be adversely affected by time pressure.

Thus, as illustrated in Figure 1 (by the double arrow), we propose an addition to the componential theory, whereby certain aspects of the work environment – in this case, time pressure – can have a direct impact on creative cognitive processing. Specifically, building on the componential theory’s description of this processing, as well as prior research on creativity, problem-solving, and decision making, we predict a direct negative effect of time pressure.

H1: The more time pressure people are under, the less likely they will be to engage in creative cognitive processing.

Intrinsic Motivation

The componential theory explicitly predicts a second way in which time pressure might influence creative cognitive processing – indirectly, through a motivational mechanism. Motivation is one of the three intra-individual components of creativity, which consist of: (a) domain-relevant skills (expertise in the task domain), (b) creativity-relevant skills and processes (flexible cognitive style, openness to new ideas, and persistent exploration of problems), and (c) intrinsic task motivation (a motivation to engage in the task because it is interesting, involving, or personally challenging).

Although the theory suggests that each of the three intra-individual components might be affected by the work environment, it focuses on the motivational component. (See Figure 1.) This focus is based on the assumption that domain-relevant skills and creativity-relevant processes are more temporally stable, and thus less subject to environmental influences, than motivation. The theory's intrinsic motivation principle of creativity states that constraints in the work environment have a negative effect on creativity by undermining intrinsic motivation. Specifically, constraints such as time pressure should lead to lower intrinsic motivation by leading individuals to feel controlled by their environment. When people feel that they are being controlled by some external factor in their work environment, they should attribute their task engagement to that external source. As a result, they should feel less motivated by the work itself, less involved in the work, and less excited about what they are doing; in short, they should have less intrinsic interest in the task. When intrinsic interest is lower, people are less likely to engage in the exploratory behaviors of creative cognitive processing. Rather, they are likely to approach the task more superficially, relying on familiar algorithms.

Previous research has demonstrated a direct link between intrinsic motivation and creativity. For example, in one experiment, participants in whom an intrinsic motivation focus had been induced produced work that was rated as significantly more creative than work produced by participants in whom an extrinsic motivation focus had been induced (Amabile, 1985). Moreover, significant positive correlations have been found between trait intrinsic motivation and several measures of creativity (Amabile, Hill, Hennessey, & Tighe, 1994). Moreover, several experimental studies have supported the basic proposition that constraints in the work environment can lead to lower levels of intrinsic motivation and creativity; these studies have manipulated a variety of constraints (e.g., contracted-for reward (Kruglanski, Friedman, & Zeevi, 1971), expected evaluation (Hennessey, 1989), surveillance (Amabile, Goldfarb, & Brackfield, 1990), constrained choice (Koestner, Ryan, Bernieri, & Holt, 1984), and competition (Amabile, 1982a)). However, this proposition has not been investigated for time pressure, which is often cited by motivation researchers as another task constraint that should have similar effects. Although one study (Amabile, DeJong, & Lepper, 1976) demonstrated a negative effect of time pressure on intrinsic motivation (on a straightforward task that did not allow for creativity), no prior study has simultaneously examined time pressure, intrinsic motivation, and creativity. The present study does so. Given the componential theory's intrinsic motivation principle, we predict an indirect negative effect of time pressure on creative processing, in addition to the direct effect. Partial mediation by intrinsic motivation would demonstrate operation of both the direct and the indirect effects.

H2: Intrinsic motivation will partially mediate the negative relationship between time pressure and creative cognitive processing.

The Need for a New Methodology

As noted earlier, there is no established technique for studying creative cognitive processing in organizations and, thus, no existing methodology for testing these hypotheses. The present study developed a field methodology for glimpsing inside the black box of creative processing, to discover whether and how time pressure might influence it in organizations. This methodology is only justified, however, if indicators of creative cognitive processing do indeed relate to the standard measure of creative outcomes used in the organizational literature. Most recent studies of organizational creativity (e.g., Ford & Gioia, 2000; Shalley & Perry-Smith, 2001; West & Anderson, 1996), as well as creativity in other settings, have relied on the basic approach of the consensual assessment technique (Amabile, 1982b; 1996). This approach is based on the premise that creativity assessments made by appropriate observers, such as peers or experts familiar with the task domain, provide the most stable and reliable measure of the creativity of individuals, products, or work outcomes – as long as those assessments show an acceptable level of agreement. Thus, we set out to first establish a relationship between creative cognitive processing and creative outcomes as assessed by peers (the link at the top of Figure 1), and then to examine the hypothesized relationships between time pressure and creative cognitive processing.

In summary, as illustrated in Figure 1 (shaded portions), the present study investigated four parts of the componential theory of creativity: time pressure, as one aspect of the work environment (the extra-individual component); intrinsic motivation (an intra-individual component); creative cognitive processes; and creative outcomes. In addition to the links between these elements already explicitly predicted by the theory, we suggest and test a new link that is only implied by the theory – a direct connection between time pressure and creative cognitive processes. Moreover, this study attempted to demonstrate a direct connection between creative cognitive processes and creative outcomes – a link that, although assumed in the componential theory and in many other theories of creativity, has not been empirically tested.

Methods

Overview

The present study investigated time pressure and creative cognitive processes in organizations by analyzing daily reports of creative cognitive processing events, perceived time pressure, and intrinsic motivation, from individuals in several different companies. Creative cognitive processing was operationally defined as reports, in daily diary narratives submitted by participants, of specific instances of brainstorming, insight, discovery, idea generation, and other thought processes specified by the componential theory of creativity. A detailed coding scheme was created to transform these qualitative data into quantitative measures. Time pressure and intrinsic motivation were operationally defined as responses to numerical scales assessing these items on daily diary questionnaires submitted by participants. Additional measures of time pressure were obtained from two administrations of a validated work environment instrument.

Peer assessments of participants' overall creativity were obtained from monthly numerical-scale questionnaires.

Participants

The present study included 177 employees who were members of 22 project teams from 7 companies within 3 industries (chemicals, high tech, and consumer products). Team size ranged from 3 to 18 members, with an average of 8 members. Because the study focused on daily creative processing in organizations, teams were selected only if creativity was a possible and desirable outcome of their target project, and all or most members were available for study daily during the entire project or a discrete project phase. Because the projects we studied varied in length, individual participation ranged from 5 to 30 weeks, with a mean of 14 weeks. The mean participant age was 37 years (range = 22-68), and 79% of the participants were men. Our sample was highly educated; 86% were college graduates or had engaged in some post-graduate work.

Procedure

*Daily Questionnaire***.** In order to obtain daily, real-time, unobtrusive measures closely tracking creative cognitive process events and other experiences in the work lives of study participants, we employed the Electronic Event Sampling methodology (Amabile, Whitney, Weinstock, Miller & Fallang, 1997); this is an adaptation of the Experience Sampling Methodology developed by Csikszentmihalyi and his colleagues (Csikszentmihalyi & Larson, 1987). The Electronic Event Sampling method consists of electronic administration (via email) of a brief Daily Questionnaire every day, Monday through Friday, through the entire course of the participant's target project or project phase. Participants were asked to complete their Daily Questionnaires independently of each other, toward the end of their workday. Of the 190 participants initially in the sample, the mean response rate on the Daily Questionnaire, after taking into account holidays, vacations, and sick days, was 75% (with a minimum of 16% and a maximum of 100%). Thirteen participants were dropped due to response rates below 20%, yielding the sample of 177 used in analyses. Participants dropped due to low response rates did not differ significantly from participants kept in the study on sex, age, education level, length of employment, time pressure, intrinsic motivation, or creative cognitive processes. Dropped participants had a lower average of daily hours worked on the project (6.5) than retained participants (7.8, $p < .05$). Participants completed an average of 52 Daily Questionnaires (range = 12-119), yielding a total sample of 9,134 Daily Questionnaires.

The Daily Questionnaire included both scale-rated and free-response items. The present study utilized a subset of the items on the Daily Questionnaire. Each of the Daily Questionnaire scale-rated items had a 7-point response scale (1 = not at all, 7 = extremely). There were two free-response items of central interest to the present study. The first called for participants to "Briefly describe one event from today that stands out in your mind as relevant to the target project, your feelings about the project, your work on the project, your team's feelings about the project, or your team's work on the project," and the second invited participants to "Add anything else you would like to report today." (We use the generic term "event description" to refer to each day's combined narratives from a given participant.) Participants' event descriptions ranged from 1 to 857 words, with a mean of 55 words per day.

Coding of free-response narratives from the Daily Questionnaire. The Detailed Event Narrative Analysis (DENA) coding scheme was developed for categorizing information in the daily narratives, thus allowing transformation of qualitative data into quantitative (Amabile, Mueller & Archambault, 2000). In this study, DENA was used to identify creative cognitive processing events and events having to do with high time pressure or high workload. Each event description narrative in our data set was segmented prior to coding, according to guidelines specifying that each discrete event, perception, reaction, or comment should be a separate one- or two-word segment. On average, the event descriptions in the present sample had 5.36 segments (range = 1-70). As an illustration, there are three segments in the event description, "I will (1) present the (2) ideas I came up with today, in tomorrow's (3) meeting with the CTO." The three segments describe three discrete events, each representing a different "Event Type" in the DENA scheme: a presentation, a set of ideas that were generated (a creative cognitive processing event), and a meeting. The coding task involved both identifying segments and coding those segments into a particular Event Type category.

The DENA coding for this study was carried out by five individual coders who participated in a rigorous two-month training program until all coders reached an acceptable level of inter-judge reliability. Cohen's kappa (Cohen, 1960) for identification of the Event Type of each segment was .72, and percent agreement was 73%.

Other instruments. Participants also completed a monthly Individual Assessment Form, providing scale ratings of all team members' work over the previous month; the response rate was 68%. In addition, they completed the scale-rated KEYS work environment assessment instrument (Amabile et al., 1996) at the beginning, mid-point, and end of the study; the response rate was 76%. Finally, they completed a demographic questionnaire at the beginning of the study.

Measures

Time pressure. Two quantitative measures of perceived time pressure, one daily and one periodic, were used in the study. The first was an item on the Daily Questionnaire that asked participants to rate the extent to which "time pressure in the work" described the work environment of their target project as they perceived it that day. Participants reported a high level of average time pressure (4.9 on a 1-7 scale, where 5 = "quite a bit"). As an example of what participants were experiencing on highly time-pressured days, the following narrative is taken from a Daily Questionnaire where this particular item was rated 7 on the 7-point scale:
"At 7:30 this morning, my team leader asked me what my game-plan was for the day, and could I be available for a roll-out meeting. I wrote out on a flip-chart what I thought needed to be done today, looked at the list, and told her it was 2 or 3 days of work."

Time pressure was also measured at the beginning, middle, and end of the project, using the 5-item Workload Pressure scale of the KEYS work environment instrument (Amabile et al., 1996). KEYS is a validated instrument that uses a four point response scale (1 = never or almost never true, 4 = always or almost always true) to assess various aspects of the perceived work environment. The Workload Pressure scale has items concerning both time pressure (e.g., "I feel a sense of time pressure in my work") and workload (e.g., "I have too much work to do in too little time"); the two types of items are strongly inter-correlated. The scale has good internal consistency ($\alpha = .77$) and test-retest stability (rho = .71). In our sample, average workload pressure was 2.67 (range = 1.4 to 4.0).

The single-item time pressure measure on the Daily Questionnaire correlated significantly with the validated KEYS Workload Pressure scale ($r = .46$, $p < .001$). This provides important cross-validation evidence supporting the use of the Daily Questionnaire measure.

Measures related to time pressure. In addition to the two measures of time pressure used to test our hypotheses (from the DQ and KEYS instruments), we also investigated other variables related to time pressure in the interest of understanding this construct more fully: hours worked and time pressure event descriptions. Because previous research has found that people work harder under perceptions of time pressure, we obtained a measure of the number of hours participants worked each day; these data were then used as a check on our interpretation of the Daily Questionnaire time pressure item. The hours-worked data were also used as a means to investigate the possibility that people might do less creative cognitive processing on time-pressured days simply because they do less of everything; this would be the case, for example, if perceived time pressure resulted from participants shrinking their work day. Participants' reports of the number of hours they had spent working on the target project each day ranged from 0 to 24, with a mean of 7.8.

As another check on our interpretation of the daily time pressure scale rating, we set out to examine the relationship between that rating and events that would be expected to cause it. For this purpose, we used DENA coding of the event descriptions to capture specific incidents where time pressure or high workload was mentioned. Two Event Type categories were used to signify such events: Time Pressure (events describing high or increasing time pressure, or being particularly busy, e.g., "The time pressure was pretty extreme today,") and Workload (events describing high or increasing workload, e.g., "I had way too many things to do today."). The coding resulted in a dichotomous variable; on any day in which a participant's narrative included a segment of this type, the time pressure/workload variable was set to one; otherwise, it was zero. Our sample yielded 208 event descriptions that reported an incident of high or increasing time pressure/workload (2.3% of all event descriptions).

Intrinsic motivation. Five Daily Questionnaire scale-rated items made up the intrinsic motivation index ($\alpha = .90$). Four were from a section headed "Today, in my work on the target project, I felt…." These items included: "involved in my work," "I enjoyed my work," "motivated by interest in my work," and "challenged by my work." One additional item asked participants to rate the extent to which "positive challenge in the work" described the work environment of their target project as they perceived it that day. Average intrinsic motivation was relatively high (4.6 on a 1-7 scale).

Creative cognitive processing. In order to test our hypotheses, we required measures of the frequency and timing of participants' creative cognitive processing incidents (e.g., generating ideas) as reported in the narrative sections of the Daily Questionnaire. To this end, we used the DENA Event Type category Positive Cognitive Event. The Positive Cognitive Event category was chosen when the segment being coded described any type of positive cognitive activity (in contrast to a negative cognitive activity like confusion). This category was defined as "insight, idea, creativity, realization, discovery, awareness, flexible thinking, clarification, remembering, brainstorming, focused concentration, or learning" (Amabile et al., 2000, p. 5). These events covered all of the elements of creative cognitive processing described in the componential theory of creativity, as illustrated by the following examples from participants' actual event descriptions: (a) problem or task identification ("I found out that some code I thought was working really isn't."); (b) preparation ("I talked with a professor from the university concerning photolytic metallization technology. … I'm beginning to get some general sense of where I can take this concept and broaden it."); (c) response generation ("Working with two team-mates, I came up with an idea to eliminate the mismatch between [two elements of the hardware]."); and (d) response validation and communication ("I tried out my pattern adhesive […] in the lab. [It] didn't really work well, but I made some interesting observations that help me understand the problem a little better.").

Each segment coded in the Positive Cognitive Event category was used in this study as a measure of creative cognitive processing if the participant reported actually having the cognitive event himself/herself, on the day in question. Thus, our measure of creative cognitive processing is a dichotomous variable, indicating the presence in an individual's daily event description of such an event. On any day in which a participant's narrative included a segment of this type, the creative cognitive processing variable was set to one; otherwise it was zero. Our sample yielded 457 event descriptions that reported a creative cognitive processing incident (5.0% of all event descriptions).

Creative outcomes. Peer ratings of creative outcomes were obtained from monthly Individual Assessment Forms on which participants were asked to rate each teammate's "creative contribution to the project" over the prior month on a 7-point scale (1 = very low/ very poor; 7 = very high/ very good). Our monthly peer-rated creativity score was a mean of all teammate ratings of that individual; the average rating was 4.67. To assess the degree to which teammates tended to agree when rating their peers, we calculated intraclass correlation coefficients for the peer ratings, and then calculated an effective scale reliability by applying the Spearman-Brown formula (Gulliksen, 1987). The resulting reliability coefficient was .81.

Controls. We controlled for team in all analyses (which automatically controlled for company as well, because teams were nested within companies). Moreover, because there were some small but significant variations in time pressure from Monday through Friday, we controlled for day of the week in all analyses of daily data. Finally, in all analyses where the DENA Event Type codes constituted the dependent variable, we controlled for the number of segments in the event description; this was done to adjust for the greater probability that a respondent would report any particular type of event when he or she wrote more. Additional controls were used for specific analyses, as described below.

Data Analysis

The Daily Questionnaire data form a panel data set (i.e., time series cross sectional data), with data on 177 respondents by days, yielding a total of 9,134 respondent/day observations.

Variables based on Daily Questionnaire scales were treated as continuous, and ordinary least squares (OLS) regressions were used for analyses predicting these variables. For analyses where creative cognitive processing (a dichotomous variable) was the outcome, logistic regressions were used. Mediation analysis was conducted using the procedures outlined by Baron and Kenny (1986). All statistical analyses were done using Stata (Statacorp, 2001).

For a panel data set, it is likely that observations will be correlated across days within respondents. This correlation will cause the ordinary standard errors to be biased. To correct for this, all analyses used heteroscedasticity-consistent standard errors (White, 1980), further corrected for clustering of observations within respondents (Rogers, 1993). This effectively treats the respondent as the unit of analysis for calculating the standard errors, while allowing both between- and within-respondent variation to be used in the calculation of regression coefficients. For *t*-statistics, degrees of freedom are based on the number of respondents, not the total number of observations.

For analyses where daily measures of creative cognitive processing events predicted monthly peer-ratings, the number of creative cognitive processing segments each day was divided by the total number of DENA-coded segments for the day, and this figure was averaged over the month. The resulting data set contained one observation per respondent per month. The same cluster-corrected standard error calculations were used for the monthly data as for the daily data.

For analyses where KEYS Workload Pressure predicted creative cognitive processing, the number of creative cognitive processing segments each day was averaged across all or half of the project (as appropriate for the analysis being done), and the average number of DENA-coded segments was used as a control variable.

The monthly averages and project averages of creative cognitive processing were highly skewed, with a few large outliers. For this reason, robust regression techniques, which downweight observations with outlying residuals, were used for analyses with this variable.

Results

Table 1 presents descriptive statistics and Pearson correlation coefficients for all analysis variables.

Relationship among Time Pressure Measures

We checked the daily scale-rated measure of time pressure against reported incidents that would be expected to affect it, by regressing it on the time pressure/workload incidents derived from the DENA codes. As expected, perceived time pressure was significantly related to time pressure/workload events on the same day (Beta = .45, $t(176) = 3.99$, $p < .001$) as well as the previous day (Beta = .49, $t(176) = 4.27$, $p < .001$). This finding indicates that perceived time pressure tended to be higher on days when events occurred that involved high or increasing time pressure, high or increasing workload, or being particularly busy; the effect persisted through the next day, as well.

Moreover, because time pressure has been found to increase productivity (Kelly & Karau, 1993, 1999), we expected to find that people worked more hours on time-pressured days. This is indeed what we found. The hours worked measure increases with perceived time pressure (Beta = .38, $t(176) = 5.95$, $p < .001$) and increases at an even faster rate at high time pressure (Beta coefficient on time pressure squared = .06, $t(176) = 2.01$, $p < .05$). This result also makes it clear that people were not experiencing time pressure simply because they were trying to cram their work into fewer hours. Finally, as reported earlier, the two measures of time pressure, the Daily Questionnaire measure and the periodic KEYS measure, were significantly inter-correlated ($r = .46$, $p < .001$). Taken together, these analyses support the use of the time pressure measures in this study.

Creative Cognitive Processes and Creative Outcomes

If the creative cognitive processes variable is indeed a measure of the processes described in the componential theory of creativity, it should positively predict creative outcomes (see Figure 1) as assessed according to the standard measure, observer ratings. As expected, average creative cognitive processing for the prior 30 days is a significant predictor of monthly peer ratings of creativity (Beta = 3.89, $t(176) = 2.58$, $p < .05$).

Time Pressure and Creative Cognitive Processes

We hypothesized (H1) that the more time pressure people are under, the less likely they will be to engage in creative cognitive processing. This hypothesis was supported through logistic regressions demonstrating that perceived time pressure on a given day negatively predicted creative cognitive processing on the same day. (See Table 2, Model 1.) Moreover, this effect is not due to a simple decrease in the overall available work time that participants had on time-pressured days. As noted earlier, they actually spent more time working as time pressure increased. As a result, the strength of the negative relationship between time pressure and creative cognitive processing is increased when we control for hours worked (Beta = -0.12, $z = 3.31$, $p < .001$). Thus, it is not simply that people were working less overall on time-pressured days. Rather, it seems that they were specifically doing less creative cognitive processing.

To test for a possible lingering impact of time pressure on creative cognitive processing, we ran logistic regressions on perceived time pressure lagged by one day and by two days. As shown in Table 2 (Models 2 and 3), both one-day and two-day lags showed a significant result. To explore our main finding more fully, we also conducted curvilinear analyses. Although there was no significant quadratic relationship (Model 4), there was a significant nonlinear relationship with time pressure; the highest level of time pressure (7 on the 7-point scale) had significantly lower creative cognitive processing than the other levels, even after adjusting for the linear relationship with time pressure (Model 5).

Further evidence of the strength of the time pressure effect results from examining the size of the decrease in creative cognitive processing that can be expected. The effect does appear to be substantial. For example, in the single-day lagged model, a single standard deviation increase in time pressure results in a 19% decrease in the probability of a creative cognitive processing event the next day. Moreover, the negative effect of time pressure is particularly strong at the highest level of time pressure (7 on our 1-7 scale). Creative cognitive processing drops by 45% at the highest level of time pressure, relative to lower levels.

We investigated the possibility that the negative relationship between time pressure and creative cognitive processing was simply due to a general increase in time pressure over time and a general decrease in creative cognitive processing over time, as participants' projects moved from early idea-creation stages to later implementation stages. We did find such a time pressure trend; project stage correlated significantly with time pressure ($r = .07$, $p < .05$). However, we found no corresponding creative cognitive processing trend. Moreover, project stage did not moderate the effect of time pressure on creative cognitive processing. (See Table 2, Model 6).

In addition, we considered possible sources of bias in the creative cognitive processing measure that might account for the negative relationship with time pressure. First, it is possible that people reported fewer creative cognitive processing incidents on time-pressured days and the following days because they were simply too busy to write very much in their event descriptions, and thus wrote fewer events of all types. However, this appears not to be the case. As described previously, the number of segments was used as a control variable for analyses based on event descriptions, and in fact, the number of segments written had a low correlation with time pressure ratings ($r = .03$, *n.s.*). As a robustness check, we also generated a daily continuous measure of creative cognitive processing by dividing the number of creative cognitive processing events by the number of segments. Time pressure was a significant predictor of this variable (Beta = -.016, $t(176) = 2.90$, $p < .01$). In addition, we considered the possibility that people wrote less about creative cognitive processing on time-pressured days because they were writing instead about the time pressure. Again, this does not appear to be the case. When days containing segments coded as Workload or Time Pressure were dropped from the analysis, the daily rating of time pressure remained a significant predictor of creative cognitive processing (Table 2, Model 7).

A negative relationship between time pressure and creative cognitive processing was also found using our second measure of time pressure, the KEYS Workload Pressure scale. In results that demonstrate the possible directionality of the relationship, and suggest that effects on cognitive behavior may accumulate over time, Workload Pressure measured at the beginning of each half of the project negatively predicts average creative cognitive processing for the following half of the project (Beta = -0.010, $t(167) = 2.27$, $p < .05$). In addition, we found a non-significant trend indicating that average KEYS Workload Pressure across the entire project negatively predicts average creative cognitive processing across the entire project (Beta = -0.013, $t(148) = 1.71$, $p < .10$).

Time Pressure, Creative Cognitive Processing, and Intrinsic Motivation

We hypothesized (H2) that the negative relationship between time pressure and creative cognitive processing would be partially mediated by intrinsic motivation. However, contrary to prediction, we found a strong positive relationship between time pressure and intrinsic motivation. (See Table 3, Model 2.) Moreover, we found no significant relationship between intrinsic motivation and creative cognitive processing. Thus, there is no evidence that intrinsic motivation partially mediated the negative relationship between time pressure and creative cognitive processing.

Discussion

This study strongly suggests that time pressure undermines the thought processes that contribute to creative output in organizations. Despite previous research revealing that time-pressured people may work faster, get more done, and do better work on straightforward tasks, our findings suggest that they will be less likely to think creatively on the job. Even though our participants were working more on time pressured days, they gave evidence of less creative cognitive processing. Moreover, the KEYS Workload Pressure results suggest possible cumulative effects over time. Over the course of a project, chronically high levels of time pressure may be associated with chronically lower engagement in creative thinking. Thus, although time pressure may lead people to work harder, it appears to also make them less likely to allocate their cognitive resources to creative thinking.

Our basic finding is consistent with three prior studies on time pressure and creative outcomes (Amabile et al., 1996; Andrews & Smith, 1996; Kelly & McGrath, 1985). However, it goes beyond those studies by presenting the first empirical demonstration of a negative relationship between time pressure and the creative cognitive processing that is assumed to underlie creative outcomes. The use of daily experience sampling in this study allowed a microscopic examination of day-by-day creative cognitive processes that has not been possible in previous time pressure research or previous organizational creativity research. Although our non-experimental design cannot confirm causality, the results of one-day and two-day lagged analyses, as well as the KEYS results, do point toward a direction in the basic finding. Moreover, the results appear robust, replicated across two different measures of perceived time pressure and with several statistical controls.

Theoretical Contribution

This study contributes to creativity theory in three ways. First, it examined the black box of cognitive processes that have been postulated by many theorists as an essential element of human creativity. Although prior research on creativity in organizations has essentially ignored these cognitive processes, this study captured them on a daily basis. Second, it demonstrates a long-assumed but previously untested link in the componential theory of creativity (Amabile, 1983, 1988, 1996) between those creative cognitive processes and creative work outcomes as assessed by peers (the standard measure of creative outcomes). Third, it has discovered an apparently direct relationship between time pressure – one aspect of the work environment – and creative cognitive processes. The componential theory does predict an overall negative effect of time pressure on creative cognitive processing, which we found here. However, it proposes an indirect effect of the work environment on creativity through an effect on intrinsic motivation; this indirect effect has been assumed to hold for all aspects of the work environment, including time pressure. We found no evidence of such a mediated effect.

There are several reasons to suspect that time pressure may have a direct negative effect on creativity. Creativity theorists, from Wallas (1926) through Campbell (1960) and Simonton (1999), have long proposed the importance of "incubation time" in the creative process. This is the time necessary for relevant mental elements to rearrange themselves into new patterns, and for the mind to sub-consciously choose the most likely possibilities among them. Although processing time is not explicitly discussed in the componential theory of creativity (Amabile, 1996), sufficient time must be necessary for effective operation of each of the creative cognitive processes that together lead to creative outcomes (problem or task identification, preparation, response generation, and response validation). (See Figure 1). For example, people need time to generate a variety of responses or, in the terminology of the componential theory, to explore the cognitive maze and recover from the possibly unfruitful pathways that are always a risk in such exploration. The more responses generated, the more likely it is that one will be truly creative. Moreover, to produce truly creative – novel *and* useful – outcomes, people need time to cycle through the various creative cognitive processes repeatedly.

A direct effect of time pressure, particularly on exploratory response-generation processes, is suggested by some previous empirical research on creativity tasks and other related activities. In addition to evidence cited earlier on the role of exploratory or playful behaviors in producing creative work (Ruscio et al., 1998; Whitney et al., 1995), there is evidence that measures of adults' intellectual playfulness correlate with measures of their creativity (Glynn & Webster, 1992). Moreover, cognitive studies have found that time pressure leads people to narrow the range of information they process (Ben Zur & Breznitz, 1981), to take less risk (Ben Zur & Breznitz, 1981), and to use simpler cognitive strategies (Zakay, 1993). Each of these effects is directly antithetical to the processes specified in the componential theory.

A direct effect is also suggested by some event descriptions that our participants wrote on days of extremely high time pressure. For example, one participant reported, after being handed a responsibility that was previously a consultant's, "I am concerned that two weeks to transition before the consultant departs is premature. Without adequate in-depth knowledge of the design, I can not make critical decisions about the tests required for design verification." Another reported, "I told my supervisor that the hours I am working are completely unacceptable, and that I planned to leave the company if this continued to be the norm on projects here. The look on her face was a bit aghast. Was she really shocked? Could this possibly be a surprise? […] I feel physically exhausted again right now… lack of mental clarity, lack of motivation about the project." These statements suggest a perception that it is difficult, on time-pressured days, to focus one's mental energies on the sort of learning and thinking that the componential theory describes as necessary for solving a problem creatively. It is instructive to also examine the opposite scenario – low time pressure days. Event descriptions on these days suggest that people may allocate more time to thinking creatively: "[Today] I decided to do a little [fiber modification] experiment on my own. Technicians don't usually have time for this, but I haven't seen another team member today and have nothing to do and time was passing slowly."

Finally, we know that people in our study were not simply retreating from work on time-pressured days; they did not write any less in their event descriptions on those days, and they actually worked more hours. This finding, which is consistent with previous research showing higher productivity under time pressure, suggests that people's minds may have been preoccupied by things other than deep exploration of cognitive pathways for solving important problems. We cannot say, from the data collected here, what those other things might be. Perhaps, as would be suggested by threat-rigidity theory (Staw, Sandelands, & Dutton, 1981), people perceive time pressure as a threat and become more rigid in their thinking when they are preoccupied by such a threat. Perhaps, given that people tend to make more performance errors on complex tasks under time pressure (Zakay, 1993), there was considerable re-work on time-pressured days. Perhaps such days were simply busier or more fragmented, with more superfluous meetings or distractions by activities that were not directly relevant to project tasks. Perhaps there was a greater volume of logistical task details that required attention. Future research should attempt to pinpoint the primary culprits more specifically. What we can say at this point is that, although people may have been working harder on time-pressured days, they were not working smarter by engaging their creative cognitive processes. Moreover, it appears that this failure to allocate cognitive resources to creativity on time-pressured days may carry over to subsequent days when the time pressure had eased, and may actually become habitual over the course of a project.

The lack of support for an indirect effect of time pressure on creative processing arose from a particularly surprising finding. Daily perceived time pressure was positively related to daily reported intrinsic motivation, a finding opposite to that predicted by the componential theory. Moreover, this finding is inconsistent with the finding in one previous experimental study that experimenter-imposed deadlines led to lower intrinsic motivation (Amabile et al., 1976). The type and meaning of time pressure in a particular situation might account for these apparent contradictions. Cognitive evaluation theory (Deci & Ryan, 1985) and the overjustification hypothesis (Lepper, Greene, & Nisbett, 1973) suggest that people will be less intrinsically motivated when they feel less autonomous – that is, when they perceive their behavior to be controlled by others in a salient way. On the other hand, their intrinsic motivation will be supported by environmental factors that lead them to become more deeply involved in the activity itself. In the experimental study on deadlines, the experimenter-induced deadline was completely arbitrary; it was not in any way an endogenous part of the task itself. Thus, its controlling aspect was likely highly salient. By contrast, in most complex organizations such as those we studied, it is likely that deadlines and other time constraints are not perceived as purely arbitrary. Rather, individuals may often see the real need to get something done quickly or to get many things done simultaneously; thus, the time pressure would be endogenous to the work. This should lessen the controlling aspect of the time pressure and, as a result, may serve primarily to get participants more deeply involved with their work on a given day by heightening their sense of positive challenge in it. There is some prior evidence for this “motivational synergy” phenomenon, by which constraints in the work environment may synergistically add to – rather than detract from – intrinsic motivation in some contexts (see Amabile, 1993). Nonetheless, it is certainly possible that, in some organizations, time pressure will be perceived as completely arbitrary and intended primarily to control behavior. Under such circumstances, a negative effect on intrinsic motivation would be expected.

We have focused thus far on two possible theoretical explanations for a negative effect of time pressure on creative cognitive processing: a direct effect (which is supported by our data) and an indirect effect through the intrinsic motivation component (which is not supported by our data). However, there is a third possibility. There may be an indirect effect through some other mechanism that we did not explore, such as one of the other two components or another factor that does not currently appear in the componential theory. For example, the literature on stress and decision-making suggests that psychological and biological changes in individuals under time pressure may mediate the effect on cognitive processing (Zakay, 1993); some event descriptions written on days of high time pressure do suggest increased levels of stress. Moreover, it is possible that individual differences in tolerance for stress or individual differences in preferred levels of time pressure act as moderators of time pressure’s effect on creative processes. One previous study found a curvilinear relationship between scientists’ reported “overload” (the difference between their current level of perceived time pressure and their own optimal level of time pressure) and the rated innovativeness of their work (Andrews & Farris, 1972); innovativeness was highest when time pressure was neither above nor below the preferred level. However, because our study did not assess stress levels or individual preferences for time pressure, these issues await further research.

Thus, although this study supports the componential theory’s basic prediction of a negative effect of time pressure, as well as the theory’s proposition that creative cognitive processing is essential for creative outcomes, it suggests one modification and one addition to the theory. First, if our intrinsic motivation result is borne out by future research, there should be a modification of the proposition that time pressure is an extrinsic constraint that will have consistently negative effects on intrinsic motivation. Rather, there should be propositions of both negative and positive effects of time pressure on intrinsic motivation, depending on whether the controlling or involving aspects of the time pressure are more salient. Second, the theory should add a direct link between time pressure – and, perhaps, other aspects of the work environment – and creative cognitive processes. (See Figure 1.) Another such aspect may be the availability of necessary resources, without which certain elements of creative processing (such as gathering information and testing ideas) cannot be accomplished – regardless of motivational state. A finer-grained analysis of mechanisms of environmental impact in the componential theory might lead to a systematic distinction between the aspects of the work environment that are likely to work through motivational mechanisms and others, such as time and resources, that are likely to operate through more direct means. Future research, including experimental research, will be required to enable this analysis. In addition, future research may support the inclusion of stress-related changes and other mediators, or individual tolerance for stress and other moderators, to theoretical conceptualizations of organizational creativity.

Methodological Considerations

In addition to its theoretical contributions, this study makes a methodological contribution to organizational research. The relatively unobtrusive Electronic Event Sampling technique allowed us to collect daily, free-response, real-time reports of creative cognitive processes in the naturalistic work context. Using the DENA coding scheme, these qualitative reports were then converted into reliable quantitative measures of specific instances of each individual participant's creative cognitive processes each day. Importantly, those measures predicted observer ratings of creativity, the standard creativity measure in the literature – even though a great many other factors undoubtedly contribute to organizational peer ratings of an individual's creativity. These results allow us to have considerable confidence in the validity of our time pressure findings.

The combination qualitative/quantitative methodology developed here for studying daily events in organizations not only allows observation of creative cognitive processes that have been previously unexamined; it may also prove useful in future work on many other micro-level processes. Ideally, continuing use of rich, longitudinal, real-time measures such as this will bring increased clarity to the sometimes muddy picture presented by organizational studies that rely solely on retrospective one-time scale ratings to examine experiences and performance. More broadly, the Electronic Event Sampling and DENA coding methods bear considerable promise for revealing what really goes on inside organizations.

Several methodological issues in the present study place limits on the conclusions that can be drawn and the confidence of those conclusions. First, as noted earlier, even with the directionality suggested by the lagged analysis, the non-experimental design does not allow conclusions about causality. Second, the narrative event descriptions presented only small samples of everything going on in the participants' work and work environment, samples that they chose to share with us. We assume that those event descriptions yielded good, representative, accurate samples of what was actually going on in the project, the team, the company, and the individual participants' own thoughts and own work. If such "thin slices" of the events unfolding in the participants' work lives yielded the significant results obtained in this study, it is likely that our findings are robust. However, although we were able to control for certain forms of bias (such as day of the week and length of event descriptions), it is still possible that our participants' reports were biased in some other way. For example, it may be that participants were having no fewer creative cognitive processing events on highly time-pressured days but, for some reason, tended to report other events instead on those days. We did control for the tendency to report time pressure/workload events, but we did not check for all possible types of events.

Third, the professional nature of our sample and their work context may limit the generalizability of these findings to less well-educated people or to people not working in team settings. Finally, we studied perceived time pressure, with no objective measure of the deadlines or assignments that were being given to these participants. Although their reports of time pressure events and workload events did correlate with their perceptions, although this study's hypotheses made it appropriate to focus on perceptions as the most likely influences on creative behavior, and although previous research found a relationship between perceived time pressure and experimentally-imposed deadlines (Kelly & Karau, 1993, 1999), future organizational research should attempt to collect both objective and subjective measures of time pressure.

Conclusion

We have focused on the largely negative effects of time pressure in this paper. However, it is important to keep in mind that we examined only creative cognitive processes, and only projects that were explicitly identified as those for which creativity was both possible and desirable. We did not study non-creative processes, or projects that might be more like the algorithmic, rate-dependent tasks on which previous researchers have discovered positive effects. And, even for creative cognitive processes, some degree of time pressure may be helpful. One prior study, conducted with scientists in a 1960's research laboratory, found a positive relationship between perceived time pressure and the rated innovativeness of the scientists' work (Andrews & Farris, 1972). However, perhaps because of the historical time and the non-corporate atmosphere in which these scientists were working, their average levels of perceived time pressure were quite low; 60% of participants in that study reported time pressure below the mid-point of the time pressure scale. By contrast, the participants in our study, all corporate employees in the fast-paced late 1990's, experienced considerably higher levels of time pressure; their mean was well above the mid-point of our time pressure scale. It is entirely likely that creative ideas will <u>not</u> often be produced in the complete absence of any time pressure whatsoever, either self-imposed or externally-imposed; under such conditions, given other demands on individuals' time, the work may simply receive insufficient attention. In other words, the true relationship between time pressure and creativity, across the entire possible range of time pressure, may well be curvilinear.

Unlike many other factors that can influence creativity, such as individual personality or organizational politics, time pressure is something over which managers should have more immediate control. This study suggests that managers take steps to protect time for employees to engage in creative cognitive processing, particularly those employees whose work calls for a high degree of creativity. Moreover, given the accelerating pace of activity in contemporary organizations, accompanied by an increasing emphasis on producing rather than reflecting, such measures will likely have to be strongly proactive. Managers who believe that frenetic activity is the hallmark of innovation may be making a serious mistake. Not only may it lead to burn-out and hampered progress in the long run, but it may also kill creativity in the short run. Although time pressure likely has negative effects on creative processing even at moderate levels, this study suggests that its effects may be disproportionately worse at extreme levels. Quite simply, extremely high time pressure may engender cognitive strategies that allow no time to think creatively. Rather than jolting people into producing a creative insight, it may instead make that insight all the more elusive.

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TABLE 1

Descriptive Statistics and Correlations[a]

Variable[b]	Mean	s.d.	TP-DQ	TP-KEYS	TPE	HRS	CCP	MPC	IM
Time Pressure from Daily Questionnaire (TP-DQ)	4.87	1.58	--	--	--	--	--	--	--
Time Pressure from KEYS Workload Pressure Scale (TP-KEYS)	2.67	0.52	.46***	--	--	--	--	--	--
Time Pressure Events from DENA Coding (TPE)[c]	0.02	0.15	.05***	.18**	--	--	--	--	--
Hours Worked (HRS)	7.79	2.78	.26***	.33***	.06***	--	--	--	--
Creative Cognitive Processing from DENA Coding (CCP)[c]	0.05	0.22	-.04**	-.07	.02	-.01	--	--	--
Monthly Peer-rated Creativity (MPC)	4.67	1.00	-.02	-.06	.01	.06	.13***[d]	--	--
Intrinsic Motivation (IM)	4.60	1.10	.29***	.03	-.01	.20***	.02	.06	--
Number of DENA-Coded Segments	5.36	4.09	.03	.24*	.09***	.08*	.07***	-.02	-.06

[a] All p-values were corrected for non-independence of observations within participants. These correlations do not control for day of the week or team membership.
[b] All measures, except the Workload Pressure and monthly creativity ratings, were obtained from the Daily Questionnaire. The Workload Pressure ratings were obtained from the KEYS instrument, and monthly creativity ratings were obtained from the Individual Assessment Forms. For daily measures, N varies from 8,630 to 9,134, depending on missing values. For TP_KEYS, N=424, and for MPC, N=579.
[c] For summary statistics and for correlations with daily variables, the DENA measures are dichotomous variables. For correlations with monthly variables and with each other, the DENA measures are scaled by dividing by the average number of DENA-coded segments.
[d] The reported value is a standardized coefficient from robust regression, to account for non-normality of variables.
* p <.05, ** p <.01, *** p <.001

TABLE 2

Time Pressure (as Assessed by the Daily Questionnaire) Predicting Creative Cognitive Processing[a]

	Model 1[b]	Model 2[c]	Model 3[d]	Model 4[e]	Model 5[e]	Model 6[e]	Model 7[e,f]
Time Pressure from Daily Questionnaire (TP-DQ)	-0.10** (.04)	-0.14*** (.03)	-0.07* (.03)	-0.13** (.04)	-0.12** (.04)	-0.10** (.04)	-0.11** (.04)
TP-DQ squared				-0.03 (.02)			
Time Pressure=7					-0.40* (.20)		
Proportion of project completed (PROJPCT)						0.11 (.20)	
(PROJPCT) x (TP-DQ)						0.16 (.12)	
Pseudo R^2	0.04	0.04	0.04	0.04	0.04	0.04	0.04
N [g]	8910	8594	8403	8910	8910	8910	8705

[a] Logistic regressions with daily creative cognitive processing as the dependent variable. Unstandardized regression coefficients are reported, with cluster-corrected robust standard errors in parentheses. All models include, as control variables, team, day of the week, and the number of DENA-coded segments.
[b] Same-day Daily Questionnaire time pressure predicts creative cognitive processing
[c] Previous-day Daily Questionnaire time pressure predicts creative cognitive processing.
[d] Two days previous Daily Questionnaire time pressure predicts creative cognitive processing.
[e] This model uses same-day Daily Questionnaire time pressure.
[f] This analysis excludes days with workload/time pressure events.
[g] The full data set includes 9,134 observations. There were 224 missing values for DQ-TP, leaving 8,910 for analyses, with fewer observations for lagged analyses.
* p <.05, ** p <.01, *** p <.001

TABLE 3

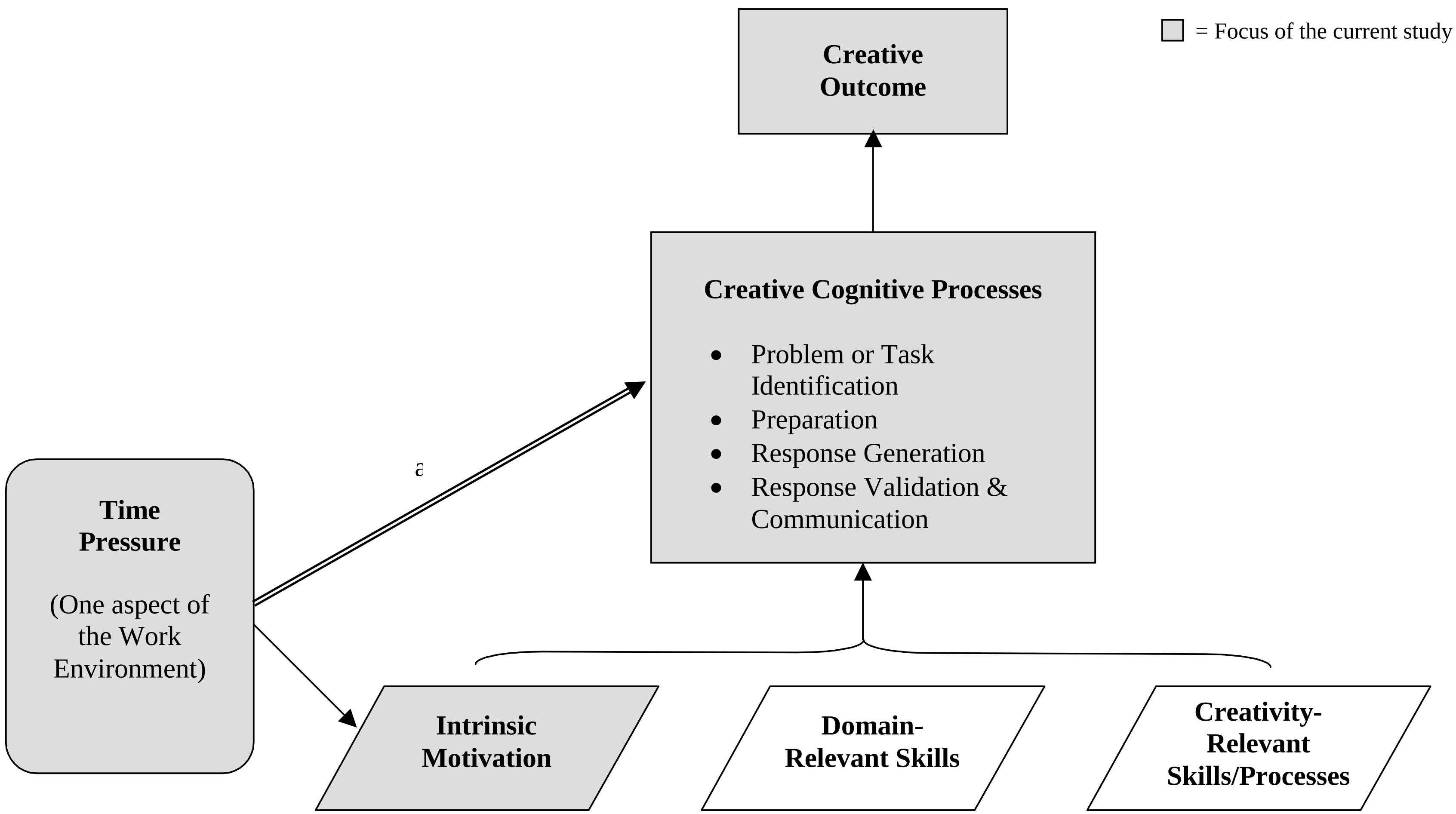
Test for Intrinsic Motivation Mediating the Relationship between Time Pressure and Creative Cognitive Processing[a]

	Model 1[b]	Model 2	Model 3
Dependent variable	Creative Cognitive Processing	Intrinsic Motivation	Creative Cognitive Processing
Time Pressure from Daily Questionnaire (TP-DQ)	-0.10** (.04)	0.20*** (.03)	-0.12*** (.04)
Intrinsic Motivation			0.09 (.06)
R^2 or Pseudo R^2	0.04	0.16	0.04
N[c]	8910	8893	8893

[a] Logistic regressions were used for analyses where daily creative cognitive processing was the dependent variable. OLS regression was used when intrinsic motivation was the dependent variable. Unstandardized regression coefficients are reported, with cluster-corrected robust standard errors in parentheses. All models include, as control variables, team and day of the week. In addition, models with creative cognitive processing control for the number of DENA-coded segments.
[b] This is the same as Model 1 in Table 2.
[c] Models including intrinsic motivation have 17 fewer observations due to missing values.
** $p < .01$, *** $p < .001$

FIGURE 1

Modified View of the Componential Theory of Creativity (Amabile, 1996, p. 113)



[a]New addition to the theory suggested by the current study