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Time pressure and team member creativity within R&D projects: The role of learning orientation and knowledge sourcing

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Abstract

This paper examines team member creativity within R&D projects and the influence of perceived time pressure on the creative process. A model based on the componential and knowledge sourcing perspectives is proposed to examine the effects of learning orientation, knowledge sourcing and perceived time pressure on team member creativity. The model is validated using a sample of 341 R&D project teams from 53 companies. Perceived time pressure has two effects on team member creativity: (1) a positive effect mediated by learning orientation and knowledge sourcing, where *moderate levels of time pressure* act as *a trigger* of the motivational and cognitive processes (*i.e.*, *challenging effect*); and (2) a negative effect moderating the relationship between team member knowledge sourcing and creativity, where *high levels of time pressure* act as *a constraint* of cognitive processes (*i.e.*, *constraining effect*). Findings show that learning orientation and knowledge sourcing behaviors play a central role in reducing team members' experience of time pressure and in fostering their creativity. There are important theoretical and practical implications relating to how team leaders may manage knowledge sourcing and time pressure within R&D projects to enhance team member creativity.

Keywords: Learning orientation; Knowledge sourcing; Creativity; Time pressure; R&D project

1. Introduction

R&D project teams are widely recognized as the building blocks of modern-day organizations (Alder et al., 2016; Chen et al., 2016; Tang and Ye, 2015). R&D refers to team members' ability to conduct research activities within a project and use shared knowledge for generating, developing and implementing creative solutions (Tang and Ye, 2015: 123). Indeed, R&D project teams are meant to stimulate the creativity of their members in order to develop innovations (Tang and Ye, 2015). Nevertheless, R&D project team members are usually under time pressure (Kach et al., 2012; Nordqvist et al., 2004). Some scholars suggest that high levels of time pressure limit creativity by preventing team members from engaging in knowledge sourcing activities and by tempting them to fall back on familiar routines and algorithms rather than looking for and applying new knowledge (Andrews and Smith, 1996). Other scholars suggest that low levels of time pressure tempt team members into inactivity, thereby reducing their creativity (Freedman and Edwards, 1988).

Empirically, prior research on time pressure and creativity shows somewhat contradictory results and a full range of possible time pressure effects, including negative (Andrews and Smith, 1996; Antes and Mumford, 2009), positive (Andrews and Farris, 1972; Ekvall and Ryhammar, 1999; Ohly and Fritz, 2010), nonlinear (Baer and Oldham, 2006; Ohly et al., 2006), and non-significant effects (Amabile et al., 1996). Amabile et

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al. (2002) are the first who proposed a conceptual model based on the componential theory to overcome this inconsistency in the literature. According to Amabile et al. (2002), inconsistent results can be explained by the fact that studies have mostly focused on the direct effect of time pressure on creative outcomes, neglecting the motivational and cognitive processes to which time pressure is linked and that underlie workplace creativity. Indeed, the componential theory suggests that creativity is influenced by two core processes (Amabile, 1983): a *motivational process*, through which individuals are most creative when they feel motivated primarily by the interest and challenge of the task itself; and a *cognitive process*, through which individuals are most creative when they are able to gain, evaluate and then apply the required knowledge.

Given the importance of team member creativity within R&D projects and the above mentioned issues related to inconsistencies regarding the effect of perceived time pressure on creativity, in the present study, we combine Amabile's (1983) componential theory with a knowledge sourcing perspective (Gray and Meister, 2004) to answer the flowing research question: *How can R&D project team members enhance their creativity under perceived time pressure*? Departing from these frameworks, on the one hand, we posit that moderate levels of time pressure enhance team member creativity by sequentially triggering team members' learning orientation (*motivational process*) and knowledge sourcing initiatives (*cognitive process*) (Amabile et al., 2002; Baer and Oldham, 2006). On the other hand, we contend that high levels of time pressure slow down team member creativity by limiting the time needed to source knowledge (Kelly and Loving, 2004).

Our model is tested using a sample of 341 R&D project teams from 53 French companies and partial least squares (PLS). Our results show that perceived time pressure has two effects on team member creativity: (1) a positive effect mediated by learning orientation and knowledge sourcing, where *moderate levels of time pressure* act as *a trigger* of the motivational and cognitive processes (*i.e.*, *challenging effect*); and (2) a negative effect moderating the relationship between team member knowledge sourcing and creativity, where *high levels of time pressure* act as *a constraint* of cognitive processes (*i.e.*, *constraining effect*). Findings show that learning orientation and knowledge sourcing behaviors play a central role in reducing team members' experience of time pressure and in fostering their creativity.

Our research has important implications for theory and practice. First, our study provides a more nuanced understanding of the effects of time pressure on team member creativity than previous studies and addresses inconsistent results in previous research. Second, our study provides researchers a better understanding of the role that learning orientation and knowledge sourcing behaviors can play in reducing team members' experience of time pressure and in enhancing their creativity. Third, our study proposes for the first time an integrative model to clarify how learning orientation, knowledge sourcing, and time pressure influence team member creativity.

2. Theoretical background and hypotheses

2.1. Team member creativity and time pressure effects

Team member creativity involves the generation of ideas about products, services, practices, processes, or procedures that are novel and useful to an R&D project (Tang and Ye, 2015). Team member creativity is an inherently social process that builds on and incorporates individual knowledge and skills at the project level (Kratzer et al., 2010).

Although the terms creativity and innovation are sometimes used as synonyms in the management literature, they name fundamentally different aspects of R&D (Gilson and Shalley, 2004). Indeed, creativity is focused on the generation of novel ideas (Amabile, 1988), whereas innovation represents the successful implementation of creative ideas within R&D team projects (West, 2002).

Sternberg (1999) expanded the concept of creativity by taking into account that novelty also arises if an existing idea is placed in a new context. Sternberg identified eight different types of creative contributions for problem solving that can be divided into three categories (Khedhaouria and Jamal, 2015): (1) the creation of completely original solutions leading to radical innovations, *i.e.*, *knowledge creation*; (2) the duplication and application of existing solutions to new problems and in new contexts, *i.e.*, *knowledge replication*; and (3) the adaptation of existing solutions to new problems and in new contexts, *i.e.*, *knowledge adaptation*. This typology emphasizes that creativity is not limited to the generation of completely new ideas but captures the replication and adaptation of existing ideas to new contexts (Majchrzak et al., 2004).

From a componential perspective (Amabile, 1983), team member creativity is the result of the interplay between the creative capabilities of team members and their work environment. There has been increasing interest in identifying the characteristics of the work environment that influence creativity (*e.g.*, Amabile et al., 1996). One condition frequently mentioned in the literature is the time pressure team members experience at work (Amabile et al., 2002; Kach et al., 2012; Nordqvist et al., 2004). According to Baer and Oldham (2006: 963), time pressure is the extent to which team members perceive they lack the needed time to develop creative ideas within the project. Research on time pressure and creativity has produced contradictory results, with some studies reporting positive effects (Andrews and Farris, 1972; Ekvall and Ryhammar, 1999; Hsu and Fan, 2008; Ohly and Fritz, 2010); some revealing negative effects (Andrews and Smith, 1996; Kelly and McGrath, 1985); and others suggesting nonlinear, *i.e.*, highest levels of creativity at moderate levels of time pressure (Baer and Oldham, 2006; Janssen, 2001; Ohly et al., 2006), or non-significant effects (Amabile et al., 1996). To date, Binnewies and Wörnlein's (2011) study represents that most comprehensive attempt to clarify the time pressure-creativity relationship. The authors indeed suggested that such a relationship is not only curvilinear, but also dependent on work design characteristics. Their results specifically showed that job control moderated the inverted

U-shaped relationship between daily time pressure and daily creativity and such a relationship was stronger when job control is high.

Taken together, previous findings, though contradictory, suggest that time pressure can represent both a challenge and a hindrance to creativity. This is indeed consistent with prior research on time pressure, which reveals that the quantitative job demand can be appraised as both demanding and challenging (Schmitt et al., 2015). For example, some scholars indicated that time pressure had negative consequences on employee outcomes (Andrews and Smith, 1996; Teuchmann et al., 1999). Yet, other research revealed that time pressure, as a challenge, had positive effects on employee motivation and well-being (Fay and Sonnentag, 2002; Widmer et al., 2012). Overall, these premises thus point to the fact that, in order to address prior inconsistent findings, it is meaningful to investigate *when* and *how* time pressure acts as a challenge or an obstacle to creativity. However, to date, research could not empirically address this relevant issue, since most studies have focused primarily on the direct effects of time pressure on creativity, neglecting the cognitive and motivational processes with which time pressure may interact to affect creative outcomes (Amabile et al., 2002).

In this regard, the componential theory (Amabile, 1983) offers important insights that can help disentangle the way in which time pressure could interact with such cognitive and motivational processes to influence creativity. This theoretical framework contends that creativity is influenced by two processes: a *motivational process*, whereby individuals are most creative when they feel intrinsically motivated; and a *cognitive process*, whereby individuals are most creative when they are able to gain the needed knowledge in pursuit of a solution. Additionally, and importantly, the componential theory suggests that such processes are likely to be affected by the perceived characteristics of the work environment (Amabile, 1996). Amabile and Pratt (2016) recently updated the original componential model of creativity by adding some dynamic elements that are expected to affect the creative process in organizations. However, this model retains the core componential structure of the original framework (*i.e.*, motivational and cognitive processes, and environmental influences), suggesting that these elements are highly influential to creativity. Taken together, these assumptions are relevant to the time pressure-creativity relationship because they suggest that the effects of time pressure on team member creativity may be more thoroughly captured by taking into account the intervening roles of motivational and cognitive processes.

Building upon a componential perspective, we suggest two ways in which time pressure may have an effect on team member creativity (Amabile et al., 2002): (1) a positive effect mediated by learning orientation and knowledge sourcing, where moderate levels of time pressure act as a trigger of the motivational and cognitive processes (*i.e.*, *challenging effect*); and (2) a negative effect moderating the relationship between team member knowledge sourcing and creativity, where high levels of time pressure act as a constraint of cognitive processes (*i.e.*, *constraining effect*). In subsequent sections, we propose a conceptual framework that explains the interplay of time pressure with learning orientation and knowledge sourcing in predicting team member creativity.

2.2. Team member creativity: challenges from time pressure

We hypothesize that time pressure exerts a positive effect on team member creativity because it activates motivational and cognitive processes that are highly beneficial to the generation of novel and useful solutions. More specifically, time pressure can positively affect team member creativity through learning orientation where moderate levels act as a trigger of the motivational process (Baer and Oldham, 2006). Team members' learning orientation refers to the group members' propensity to focus on learning, acquiring new skills, mastering new situations and developing competencies (Bunderson and Sutcliffe, 2003; VandeWalle, 1997). First, time pressure has been positively associated with learning orientation through intrinsic motivation (Baer and Oldham, 2006). Amabile et al. (2002) explained that team members may often see the need to get something done quickly or to get many things done simultaneously. Thus, moderate levels of time pressure would be endogenous to team members' project, which lead them to feel positively challenged and to be more involved to learn within the project. Second, learning orientation has been associated with creativity through intrinsic motivation as one of the factors that trigger creativity (Amabile, 1997; Gong et al., 2009). Indeed, learning orientation plays the role of a motivational process through which intrinsically motivated team members may be engaged in learning activities, which result in creative outcomes (Dweck, 1986). The effect of time pressure on creativity is thus supposed to be positively mediated by learning orientation. Therefore, the following hypotheses are tested:

Hypothesis 1a. *Perceived time pressure will be positively related to team members' learning orientation.*

Hypothesis 1b. *Team members' learning orientation will be positively related to team member creativity*.

Hypothesis 1c. *The relationship between perceived time pressure and team member creativity will be positively mediated by team members' learning orientation*.

Furthermore, time pressure may have a positive effect on team member creativity through knowledge sourcing, where time pressure acts as a trigger of the creative cognitive process (Amabile et al., 2002). Knowledge sourcing refers to team members' willingness to actively engage in the process of searching for, accessing, transferring, and applying both internal and external knowledge (Chen et al., 2016; Khedhaouria and Jamal, 2015). In a practical sense, knowledge can be obtained from three core sources (Gray and Meister, 2004, 2006): organizational repositories, whereby knowledge sourcing involves learning about new problems, often encountered inside the organization (*e.g.*, published documents posted on the company's intranet and access to knowledge-based systems); internet sources, whereby knowledge sourcing involves drawing on new knowledge using expert advice and technical or business development expertise that is not available within the organization (*e.g.,* access to community network sites and virtual communities); and project teams, whereby knowledge sourcing may use team member experiences and expertise to facilitate innovations (*e.g.*, direct contact, conversations and exchanges among group members).

Relying on such a knowledge sourcing perspective, we contend that the learning-oriented processes activated by time pressure would in turn trigger knowledge sourcing initiatives, which will ultimately result in higher creativity among team members. Previous studies consider learning orientation a trigger of the knowledge sourcing process (Gray and Meister, 2004). Involving team member motivation and dedication to learn within the project, learning orientation is related to both skill acquisition and intrinsic motivation (Shalley et al., 2009). Learning orientation increases team members' willingness to solicit and use feedback to improve their knowledge and creativity (Kostopoulos and Bozionelos, 2011). Indeed, team members with a strong learning orientation are intrinsically motivated to learn about problems leading them to source the relevant knowledge (Shalley et al., 2009).

This line of reasoning suggests that knowledge sourcing is the result of an adaptive learning process (Cohen and Levinthal, 1990), characterized by a heightened motivation to identify, assimilate, and apply relevant knowledge (Gray and Meister, 2004). When individuals are motivated to learn, even under time pressure, they expend more challenging effort on understanding a problem and searching for solutions using a wide variety of knowledge from multiple sources, resulting in increased knowledge sourcing activities (Gray and Durcikova, 2005; Gray and Meister, 2004). Therefore, we hypothesize the following:

Hypothesis 2a. *Team members' learning orientation will be positively related to team members' knowledge sourcing.*

Hypothesis 2b. *The relationship between perceived time pressure and team members' knowledge sourcing will be positively mediated by team members' learning orientation.*

Team members' knowledge sourcing in turn acts as a creative cognitive process that is essential to trigger effective creative solutions for problems (Amabile, 1983) by favoring the identification, preparation, and response generation for solving the problem (Gray and Meister, 2006). Indeed, team members' knowledge sourcing enables team members accessing to required knowledge in order to understand a given problem. Team members can then create new knowledge combining sourced supplied knowledge with their already stored knowledge (Staats et al., 2014). Thus, integration of knowledge at the project level is necessary for developing new ideas.

More specifically, team members' knowledge sourcing can improve team member creativity in several ways (Gray and Meister, 2006). Through *knowledge creation*, team members can integrate their understanding of a problem and invent new knowledge that favors radically novel solutions (Farr et al., 2003). Next, through *knowledge replication*, team members can productively exploit existing resources to generate greater value (Kostopoulos and Bozionelos, 2011; Zhang and Li, 2016). Although replicated knowledge is only relatively novel, it can be creatively used in new contexts with notably better fit to the given problem or cheaper costs than the original knowledge (Sternberg et al., 2003). Finally, through *knowledge adaptation*, sourced knowledge provides an 'alternative lens' through which prior knowledge and existing problems can be appraised so that project team members can adapt their knowledge to generate entirely new knowledge (Khedhaouria and Jamal, 2015). Creation, replication, and adaptation of knowledge in teams represent both outcomes of knowledge sourcing and creative problem-solving activities (Kirton, 1980). Accordingly, the intensified knowledge sourcing activities that learning-oriented team members undertake is likely to result in increased creativity. We therefore hypothesize the following:

Hypothesis 3a. *Team members' knowledge sourcing will be positively related to team member creativity.*

Hypothesis 3b. *The relationship between team members' learning orientation and team member creativity will be positively mediated by team members' knowledge sourcing.*

Taken together, hypotheses H1a through H3b suggest that time pressure indirectly enhances team member creativity through the chain of the mediating role of team members' learning orientation and knowledge sourcing (Fig. 1). Consistent with both a componential and knowledge sourcing perspective, time pressure indeed acts as a productive source that brings about a higher learning orientation among team members. Such a learning-oriented mind-set in turn leads to intensified involvement in collective knowledge sourcing activities, which ultimately result in increased team member creativity.

2.3. Team member creativity: constraints from time pressure

Time pressure may also act as a boundary condition that attenuates the positive relationship between knowledge sourcing and team member creativity (Kelly and Loving, 2004). There is some evidence that successful creative outcomes depend on the availability of time (Amabile et al., 2002). Creative problem solving is similar to navigating a maze, and creative solutions depend on the exploration of the maze for available cognitive pathways (Newell et al., 1962). If such cognitive exploration of the maze is important to creativity, there must be sufficient time for the cognitive processing involved in intellectually playing with ideas and possible solution paths. Accordingly, the more time that is made available for creative cognitive processing, the more ideas can be generated and evaluated. Conversely, a high levels of time pressure would constrain team members' ability to explore different solutions, thereby limiting their creative expression (Baer and Oldham, 2006). Therefore, the following hypothesis will be tested:

Hypothesis 4a. *Time pressure will moderate the relationship between team members' knowledge sourcing and team member creativity, such that the relationship is less positive with high levels of time pressure.*

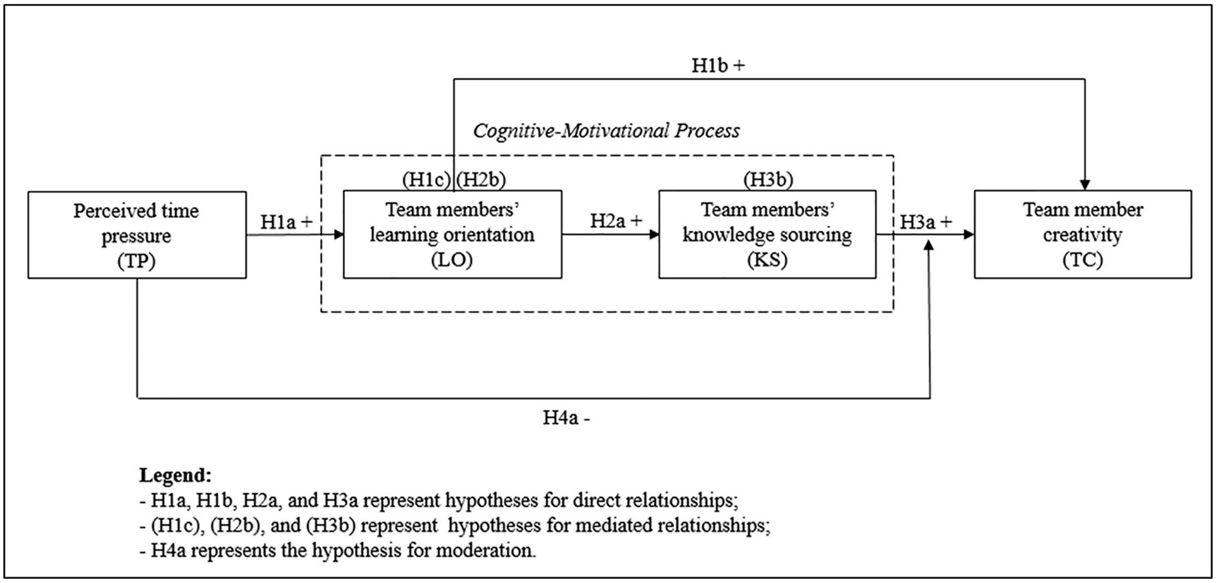

Fig. 1. Conceptual model.

Our research model and hypotheses are displayed in Fig. 1.

3. Methodology

The present study is a quantitative research because it uses an empirical approach to test a conceptual model and its associated hypotheses.

3.1. Data collection

Data were collected using the key informants approach (Egan, 2005). Key informants usually act as team leaders and are very experienced and well informed about team members (Sethi et al., 2001). Their experiences are instrumental in that they serve to understand how team members produce creative outcomes under perceived time pressure (Egan, 2005).

An email invitation was sent to 3000 former graduate alumni who occupied technological management positions within companies and often faced to substantial time pressure (Andrews and Farris, 1972). They were selected based on two main criteria:

1. serve as a team leader in at least one R&D project in the previous year;
2. report the shared perceptions of their team members about R&D projects.

R&D projects are classified according to a recent R&D project classification adapted by Kuchta and Skowron (2016) from Turner and Cochrane (1993). This classification is based on the achievement of two main criteria: the awareness of project goals and methods used to achieve such goals (Table 1).

- R&D projects (A): with well-defined goals but insufficiently defined methods to achieve such goals (*e.g.*, in the case of product and service development, tasks and methods to achieve given products are mostly not sufficiently defined).
- R&D projects (B): with insufficiently defined goals and well-defined methods (*e.g.*, in the case of applications software development, deliverables constituting project's major product are mostly not sufficiently defined).
- R&D projects (C): with insufficiently defined goals and insufficiently defined methods (*e.g.*, in the case of research and development change, deliverables constituting project's major product as well as tasks and methods to achieve given products are mostly not sufficiently defined).

The three types of R&D projects are mostly related to technology applications research and have at least one insufficiently defined criterion, which needs a substantial time pressure to be achieved (Kuchta and Skowron, 2016).

A pilot study was conducted with ten graduate alumni that we targeted because of their frequent involvement in managing

Table 1
R&D project classification (Kuchta and Skowron, 2016: 835).

Type of R&D projects	R&D projects (A)	R&D projects (B)	R&D projects (C)
	Product and service development (*e.g.*, new information technology hardware)	Applications software development (*e.g.*, implementation of new software, network communication system improvements)	Research and development change (*e.g.*, management process improvements and organization restructuring, improvement of economic and social well-being of users)
Well-defined goal	Yes	No	No
Well-defined method	No	Yes	No

R&D teams in their organizations. The alumni completed the initial questionnaire and provided comments during a 30-minute telephone conversation. According to their feedback, the questionnaire was restructured and reworded to improve its clarity and the logical succession of questions. The improved questionnaire was structured in six sections. The first section dealt with R&D project membership (two questions were asked). The second section dealt with team member creativity construct (five questions were asked). The third section dealt with knowledge sourcing subdimensions (ten questions were asked). The fourth section dealt with learning orientation construct (three main questions were asked). The fifth section dealt with perceived time pressure within an R&D project (one question was asked). Finally, the sixth section dealt with team member's characteristics such as gender, age, education level, work experience, and work section. All questions related to our conceptual model are listed in the Appendix. The questionnaire was then posted on a website, and an invitation to participate in the study was sent to all former graduate alumni. Those interested in participating as key informants were able to click on a link embedded in the email invitation to be automatically directed to the survey website.

A total of 417 responses were received from alumni working for 53 large and medium-sized French companies in various economic sectors (industry, commerce and services). In total, 341 responses were from team leaders,[1] 207 of which held middle management positions and 134 of which held senior management positions in their respective organizations. The respondents' key roles in R&D projects consisted of defining team goals and organizing team members. As shown in Table 2, the respondents were between the ages of 24 and 66 years, with an average age of 34.87 years. The sample group comprised 45.45% men and 54.54% women. The majority of the respondents hold a master degree (87.39%). Their work experience varied from <10 years to more than 25 years (with an average of 10.02 years of work experience).

Table 2
Sample characteristics.

Characteristics	N = 341
Gender	
Male	186
Female	155
Age (years)	
18–24	18
25–45	277
46–65	45
>66	1
Education level	
Post-secondary	1
Bachelor or equivalent	9
Master or equivalent	298
Doctoral or equivalent	31
Other (early, primary, secondary, …)	2
Work experience (years)	
1–10	210
11–15	57
16–25	44
>25	30
Work sectors	
Industry	85
Commerce	80
Services	176

3.2. Measures

The model presented in Fig. 1 includes four variables measured using a seven-point Likert-type scale that was validated in the existing management literature. The respondents indicated their agreement with a set of statements ranged from (1) "strongly disagree" to (7) "strongly agree". All measures displayed a satisfactory level of reliability ($\alpha > 0.70$). The full list of items of all retained measures is shown in the Appendix.

Team member creativity (TC) is measured as a reflective construct using five items related to innovation, replication and adaptation ($\alpha = 0.85$). Three items are used to measure innovative contributions (Denison et al., 1996), and two items are used to measure replication and adaptation contributions (Kirton, 1989; Majchrzak et al., 2004). Taken together, the five items assess team members' capacity to generate novel ideas that are useful to an R&D project, which is in line with the way this construct has been operationalized in the literature (Tang and Ye, 2015). Sample items are: "In my project group we frequently experiment with proven solutions to resolve problems", and "In my project group we are highly imaginative in adapting existing solutions for resolving a new problem".

Team members' knowledge sourcing (KS) is measured as a formative construct using ten items related to group sourcing (KSG) ($\alpha = 0.81$), to repositories (KSR) ($\alpha = 0.87$), and to the Internet (KSI) ($\alpha = 0.73$); this construct was adapted from Gray and Meister (2004, 2006). These items capture the overall process of searching for, accessing, transferring, and applying knowledge, which has been identified in the literature (Chen et al., 2016). Sample items include: "In my project group we often consult documents posted on the company's intranet", and "In my project group we often consult knowledge-based systems to find solutions for similar encountered problems".

Team members' learning orientation (LO) is measured as a reflective construct using three items ($\alpha = 0.83$) adapted from Gray and Meister (2004) and Gong et al. (2009). This measure examines the group members' tendency to learn, acquire new abilities, master new situations and improve their competences, which is consistent with the construct operationalization provided by the literature (Bunderson and Sutcliffe, 2003). Sample items are: "In my project group we prefer tasks that really challenge as so we can learn new things", and "In my project group we often look for opportunities to develop new skills and knowledge".

Finally, time pressure (TP) is measured with the following item derived from the work of Baer and Oldham (2006): "In my project group we have not much time to develop creative

[1] In practice most researchers would recommend using minimum sample sizes of 10 observations by measurement items (see for an overview Kline, 2011, p. 11–12). A sample size of 341 observations would be enough for a model involving 4 latent variables and 19 measurement items.

ideas at work". This item assesses the extent to which team members feel they have insufficient time to perform a creative work, which corresponds to the conceptualization of time pressure documented in the literature (Baer and Oldham, 2006).

4. Data analysis and results

Data were analyzed using PLS path modeling, following the general procedures suggested by Chin (1998). Compared with the structural equation modeling approach using Lisrel, PLS is appropriate for our study because it can address both reflective and formative constructs in the same model (Fornell and Bookstein, 1982; Ringle et al., 2012). It is not just appropriate but presumably safer to use in our setting. See Fornell and Bookstein (1982) who even stated that the use of SEM-Lisrel may lead to misidentification issues, inadmissible solutions, and factor indeterminacy.

4.1. Testing the measurement model

We first assessed the psychometric properties of the measurement scales for the first-order constructs in terms of convergent validity, discriminant validity, and reliability. Our procedure is consistent with Anderson and Gerbing's (1988) recommendation of a two-step structural equation modeling procedure. According to this approach, a measurement model is tested prior to examining the hypotheses, in order to establish the validity and reliability of the study variables (step 1). Next, the structural model is estimated to assess the fit of the hypothesized conceptual model to the data (step 2).

Measurement scales have good convergent validity if the factor loading of items on their corresponding constructs exceed the 0.60 threshold (Hair et al., 2010). Our results show that all measurement scales have an adequate convergent validity (Table 3).

Table 4 provides evidence of sufficient discriminant validity as the square root of the average variance extracted (AVE) for every construct is greater than the inter-correlation estimates (Chin, 1998). The composite reliability scores for the measurement scales range from 0.88 to 0.91 (see Table 4), exceeding the recommended 0.70 threshold (Hair et al., 2010), which indicates a good level of reliability.

Finally, to test for common method variance (CMV) issues, we used Harman's (1976) one factor test in an attempt to isolate the covariance due to artifactual causes (Podsakoff and Organ, 1986). Our results show an explained variance of 30.08%, which is under the threshold level of 50%, indicating the absence of CMV issues.

4.2. Testing the structural model

Team members' knowledge sourcing (KS) was conceptualized as a multidimensional construct including four dimensions: KSG (from group), KSR (from repositories), and KSI (from the Internet). An important concern with formatively measured constructs is the level of multicollinearity across dimensions (Diamantopoulos et al., 2008). We tested the formative construct for multicollinearity by calculating the variance inflation factor (VIF) values. The results show that the VIF values (VIF_{KSG} = 1.17; VIF_{KSR} = 1.35; VIF_{KSI} = 1.20) are below the tolerated threshold of 3.30 (Diamantopoulos and Siguaw, 2006), which indicates that there are no serious multicollinearity issues.

Another concern with a formatively measured construct is the weight significance of its dimensions (Diamantopoulos and Siguaw, 2006). The weight is similar to the path coefficient and explains the effect of each dimension on the formative construct (Hair et al., 2010). The elimination of non-significant dimension weights is problematic and should be theoretically justified rather than merely based on empirical results (Diamantopoulos et al., 2008).

The results show that all dimensions have significant weights (W_{KSG} = 0.69, $p < 0.001$; W_{KSR} = 0.30, $p < 0.05$; W_{KSI} = 0.69, $p < .01$), establishing their validity (Diamantopoulos et al., 2008).

Table 3
Psychometric properties of the measurement scales.

Contact	Scale item	Item mean	Item standard deviation	Item loading	Item standard error	*t*-statistic
Team member creativity	TC1	5.48	1.14	0.69	0.03	5.76
	TC2	5.44	1.18	0.70	0.03	6.95
	TC3	4.93	1.37	0.81	0.02	10.88
	TC4	5.32	1.21	0.88	0.02	13.79
	TC5	4.90	1.48	0.85	0.03	11.76
Knowledge sourcing from the group	KSG1	5.76	1.24	0.88	0.04	12.02
	KSG2	5.66	1.24	0.83	0.03	11.69
	KSG3	5.93	1.30	0.84	0.03	14.64
Knowledge sourcing from repositories	KSR1	4.62	1.52	0.71	0.02	7.28
	KSR2	4.28	1.56	0.79	0.02	13.99
	KSR3	4.72	1.45	0.90	0.03	18.06
	KSR4	4.76	1.44	0.89	0.02	16.23
	KSR5	4.92	1.65	0.78	0.02	12.34
Knowledge sourcing from the internet	KSI1	4.69	1.49	0.86	0.05	13.95
	KSI2	3.85	1.69	0.92	0.05	10.49
Learning orientation	LO1	5.15	1.33	0.84	0.02	18.23
	LO2	5.10	1.24	0.85	0.02	17.11
	LO3	5.10	1.31	0.90	0.02	23.96
Time pressure	TP	5.47	1.33	1.00	0.00	16,484

See Appendix for the specific questions of the above list of items.

Table 4
Discriminant validity.

Variables	Composite reliability	Correlation of constructs[(a)]					
		TP	LO	KSI	KSR	KSG	TC
TP	1	n/a					
LO	0.90	0.20	0.86				
KSI	0.88	0.04	0.25	0.89			
KSR	0.91	0.09	0.35	0.40	0.82		
KSG	0.89	0.18	0.41	0.17	0.38	0.85	
TC	0.89	0.21	0.38	0.21	0.20	0.26	0.80

Legend: (a) Diagonal elements are the square root of the AVE; TC = Team member creativity; KSG = Knowledge sourcing from the group; KSR = Knowledge sourcing from repositories; KSI = Knowledge sourcing from the Internet; LO = Learning orientation; TP = Time pressure.

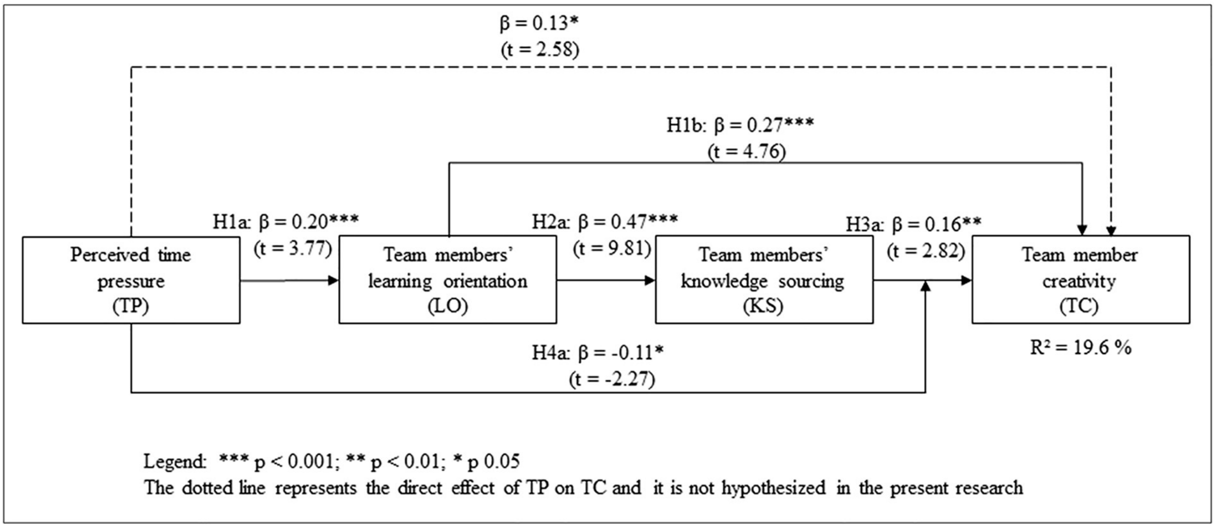

Fig. 2. PLS results.

These results highlight that groups (KSG), repositories (KSR) and the Internet (KSI) are all sources of knowledge used by team members.

Once all dimensions were validated, we tested the moderating effect of time pressure (TP) on the relationship between team members' knowledge sourcing (KS) and team member creativity (TC), as hypothesized in our research model. To account for measurement errors, we used the "*product-indicators*" approach recommended by Chin (1998) for formative constructs. To avoid the multicollinearity issues related to this approach, it is recommended to standardize and centralize the measurement of indicators (Aiken and West, 1991). For computing the moderating effect, we used the standardized and centered latent variable scores produced by PLS (Chin, 1998).

The research hypotheses were tested by examining the significance of the path coefficient (β) and the percentage of the explained variance (R^2) of TC. All hypotheses about direct relationships (H1a, H1b, H2a, and H3a) are accepted (Fig. 2). We should note that the direct relationship between TP and TC (dotted line in Fig. 2) is positive and significant (β = 0.13, $p < 0.05$). This relationship is not hypothesized in our research due to the inconsistencies in the literature about the direct effect of TP on TC.

The model explains 19.6% of the variance of TC. The goodness of fit of the model (GoF) is 0.28, which exceeds the cut-off value of 0.25 of R^2 for medium effect sizes as suggested by Tenenhaus et al. (2005).

We tested the mediation roles of team members' learning orientation (H1c and H2b) and knowledge sourcing (H3b) using the bootstrapping approach (Preacher and Hayes, 2004). We examined whether it is possible, with 95% confidence (bootstrap/resampling = 100), that the true indirect effects would be zero (which would imply that there is no mediation effect).

As shown in Table 5, the mediation analysis confirmed the mediating roles of LO between TP and TC (β = 0.07, LB = 0.02 and UB = 0.12), LO between TP and KS (β = 0.10, LB = 0.03 and UB = 0.17), and KS between LO and TC (β = 0.08, LB = 0.01 and UB = 0.13) as 0 is outside the 95% confidence interval. In addition, results indicate that direct effects of TP on TC (β = 0.13, $p < 0.05$) and LO on TC (β = 0.27, $p < 0.001$) remain significant when controlling for LO and KS, respectively, supporting partial mediations for hypotheses H1c and H3b and a total mediation for hypothesis H2b as there is no hypothesized direct effect of TP on TC.

Finally, to better understand the moderating effects of time pressure on the creative cognitive process (*i.e.*, relationship between KS and TC),[2] we separated respondents into groups with low, average, and high levels of perceived time pressure (Aiken and West, 1991) and used SPSS to compute the effect of knowledge sourcing on creativity for each group (Table 6).

Table 6 shows that for low perceived time pressure, team members' knowledge sourcing has a high and significant effect on team member creativity (β = 0.44, $p < 0.001$); for moderate perceived time pressure, team members' knowledge sourcing has a low but significant effect on team member creativity (β = 0.23, $p = 0.02$); and finally, for high perceived time pressure, team members' knowledge sourcing has a non-significant effect on team member creativity (β = 0.17, $p = 0.07$). In short, as hypothesized (H4a) the effect of team members' knowledge sourcing on team member creativity is less positive if time pressure becomes high.

Overall, each antecedent in our model is important for team member creativity, albeit *via* different processes. Team members' learning orientation is positively related to team member creativity (H1b) *via* team members' knowledge sourcing (H3b). The relationship between Team members' learning orientation and knowledge sourcing is positive and significant (H2a). Team members' knowledge sourcing also positively related to team member creativity (H3a). Also as expected, perceived time pressure is positively related to team member creativity *via* the

[2] We tested the curvilinear effect of time pressure on the relationship between team members' learning orientation and knowledge sourcing (Baer and Oldham, 2006) and results show no significant effect.

Table 5
Mediation effect illustrated by bootstrapping analysis.

Bootstrap results for indirect effect	Indirect effect (β) (difference between total effect and direct effect)	Standard error	LB (95%)	UB (95%)
H1c: TP ➔ (LO) ➔ TC	0.07	0.03	0.02	0.12
H2b: TP ➔ (LO) ➔ KS	0.10	0.03	0.03	0.17
H3b: LO ➔ (KS) ➔ TC	0.08	0.03	0.01	0.13

Legend: TP ➔ (LO) ➔ TC, from TP to TC mediated by LO; TP ➔ (LO) ➔ KS, from TP to KS LO orientation; LO ➔ (KS) ➔ TC, from LO to TC mediated by KS; LB = lower bound of the 95% confidence interval at; UB = upper bound of the 95% confidence interval.

cognitive-motivational process: perceived time pressure positively affected team member creativity *via* both role of learning orientation (H1c) and indirectly knowledge sourcing (H2b). With high levels of time pressure, the effect of knowledge sourcing on team member creativity is reduced (H4a).

5. Discussion

From a theoretical perspective, our research makes important contributions. First, our results provide evidence concerning the role of learning behaviors in improving team members' knowledge sourcing and creativity within R&D projects. Although previous findings in the literature suggest that learning orientation is a key factor for team members to foster their creativity (Edmondson, 1999; Khedhaouria and Jamal, 2015), little is known about the mechanisms by which learning orientation influences team member creativity (Lee and Yang, 2015). Our results suggest that learning orientation has two main effects on team member creativity: a direct and positive effect supporting the role of intrinsic motivation in fostering creativity (Amabile, 1983, 1997); and a positive effect mediated by the knowledge sourcing process, through which motivated team members use multiple sources of knowledge (*i.e.*, groups, repositories and the Internet) to find new and useful ideas (Zhang and Bartol, 2010). Our results may be an answer to Cooper (2000) about reasons teams fail to develop creative outcomes within R&D projects. Our results suggest that this failure may be due to a low learning orientation of team members.

Second, we contribute to the creativity literature by demonstrating the importance of knowledge sourcing in explaining team members' creative outcomes. Current literature has mostly focused on the effect of knowledge management tools on creativity with an emphasis on the importance of available knowledge for team member creativity (Khedhaouria and Jamal, 2015). However, knowledge availability is not a sufficient condition for individuals' ability to use available knowledge (Gray and Meister, 2004). The current study builds on the knowledge sourcing perspective to overcome this shortfall and better explain the mechanisms by which team members source required knowledge to transform it into creative outcomes. Accordingly, the current study advances the creativity literature by identifying knowledge sourcing as a part of the creative cognitive process by which cognitive pathways are explored based on knowledge from groups, repositories and the Internet (Tang and Ye, 2015). Moreover, we show the important mediating role of knowledge sourcing for team member creativity with respect to their learning orientation. Our results suggest that motivated team members are engaged in knowledge sourcing activities to learn about problems and explore new knowledge, which results in creative outcomes.

Third, our study provides a more nuanced understanding of the effects of time pressure on team member creativity than previous studies. Most of the existing studies have focused on the direct effect of time pressure on creative outcomes, neglecting the role of motivational and cognitive processes (Amabile et al., 2002; Baer and Oldham, 2006). Our study suggests that time pressure has a positive effect on creativity, mediated by learning orientation and knowledge sourcing, and a negative effect moderating the relationship between team member knowledge sourcing and creativity. First, time pressure has a positive effect of creativity, mediated by learning orientation and knowledge sourcing, where moderate levels act as a trigger of the motivational and cognitive processes. Indeed, when team members are intrinsically motivated to learn, they are less likely to perceive time pressure as an obstacle and more likely to perceive it as a challenge (Roskes, 2015). Hence, challenging time pressure encourages team members to source the required knowledge, and thereby stimulating their creativity. Second, time pressure has a negative moderating effect on the relationship between team members' knowledge sourcing and creativity, where high levels of time pressure act as a constraint of cognitive processes. In this situation, team members are less likely to perceive time pressure as a challenge and more likely to perceive it as a constraint (Roskes, 2015). Indeed, when time pressure reaches high levels it limits the availability of cognitive resources and undermines the creative cognitive processes (Kelly and Loving, 2004).

Finally, although not specifically hypothesized (due to inconsistencies about its effects on creativity in previous research), perceived time pressure seems to have a direct and positive effect on team member creativity in R&D activities. This finding suggests that time pressure may act as a trigger of individual cognitive structures in particular when it is perceived as arising from the intellectually challenging nature of the problem itself (Andrews and Farris, 1972). This interpretation is consistent with

Table 6
Moderation effects illustrated by subgroup analyses.

Time pressure subgroups	N	KS ➔ TC		
		β (t-test)	p-value	R^2 (%)
Low time pressure	114	0.44 (5.133)	<0.001	19
Moderate time pressure	113	0.23 (2.430)	0.02	5.1
High time pressure	114	0.17 (1.863)	0.07	3.0

Legend: β = standardized values; TP = time pressure; KS = team members' knowledge sourcing; TC = team member creativity.

the challenge-hindrance framework (LePine et al., 2005), which suggests that people exposed to job demands that promote mastery, achievements, or personal growth (*i.e.*, challenge demands) perceive a positive relationship between their efforts to cope with these demands and the likelihood of achieving desired outcomes, thus displaying high creative performance. Conversely, exposure to job demands that are appraised as potentially thwarting one's progress toward work-related accomplishments (*i.e.*, hindrance demands) is likely to decrease creative performance because people do not recognize a positive relationship between their coping efforts and the possibility of ultimately gaining valued outcomes. According to the challenge-hindrance stressor, time pressure represents a typical challenge demand because people exposed to this demand would recognize that if they invest more effort at work they are more likely to successfully fulfill their tasks in a shorter period of time (LePine et al., 2005; Ohly and Fritz, 2010). Time pressure is thus likely to enhance team member engagement, resulting in high creative outcomes (Baer and Oldham, 2006).

From a practical perspective, knowing the critical role of team member creativity in the successful development of innovative R&D projects (Tang and Ye, 2015), our findings can be applied to foster team member creativity within R&D projects. Importantly, such results have direct implications for project management activities in the R&D sector. Indeed, project management research has emphasized the relevance of the creative and explorative phases in the management of innovative projects (Kock et al., 2016; Lundin et al., 2015; Midler et al., 2016). Moreover, prior studies in this area have indicated that the same learning and knowledge sourcing processes that underlie effective creative performance also exert a significant influence on the transition between the different steps of a project and, consequently, can shape its successful implementation (Midler, 1995; Todorović et al., 2015).

In line with this stream of literature, our findings provide important new information that allows R&D teams to successfully undertake project management activities of creative projects. Specifically, our study highlights the role of learning orientation and knowledge sourcing in reducing team members' experience of time pressure and in fostering their creativity. Although high levels of time pressure can hamper creative processes, moderate levels can stimulate team member creativity through motivational and cognitive processes. Hence, understanding how team members can be motivated and how knowledge can be sourced may help identify ways to reduce team members' experience of time pressure and enhance their creativity. First, our study emphasizes the critical role that learning orientation plays in the motivational process to improve team member creativity. For team leaders, being aware that some team members possess a strong learning orientation (*e.g.*, assessed through learning style tests or by previous observations) is a necessary condition for ensuring knowledge sharing and effectiveness (Farr et al., 2003). Second, our study highlights the critical role that knowledge sourcing plays in the cognitive process to improve team member creativity. For team leaders, promoting knowledge sharing through cooperation within teams is necessary to reduce team members' experience of time pressure. Cooperation has been found to reduce team members' experience of time pressure by promoting supportive behavior within a team (Nordqvist et al., 2004). Overall, team leaders should give team members a sense of being "on a mission", doing something intellectually challenging, in order to trigger their motivational and cognitive processes (Shalley et al., 2009).

6. Limitations and future avenues for research

Along with these potential contributions, our study has some limitations. Some obvious antecedents of knowledge sourcing are not included in the present study. First, group characteristics such as the intellectual demands, project complexity (Gray and Meister, 2004), and risk aversion (Gray and Durcikova, 2005) have been shown to influence knowledge sourcing and creativity behaviors. Further studies are needed to replicate our model and introduce other group characteristics to improve the explanatory power of team member creativity. Furthermore, the large sample population that participated in the study suggests that several unmeasured individual and organizational characteristics may have affected the study results. For example, the diverse educational and professional backgrounds of team members may affect their capacity to collectively source knowledge and effectively integrate it to develop novel solutions (Huang et al., 2014; Mitchell and Boyle, 2015). Likewise, certain organizational policies and working conditions that differentiate the various organizations, namely human resource management practices (*e.g.*, training and rewards systems) and organizational climate (*e.g.*, climate for creativity and innovation), are likely to impact the learning and knowledge-based processes that are related to team member creativity (Scott and Bruce, 1994; Sung and Choi, 2014). Accordingly, future research is needed to control for the effect of such individual and organizational factors on team member creativity and its underlying processes in order to provide further empirical evidence for the hypothesized relationships among the study variables.

Second, the data collection is based on self-reported measures, which may lead to biases, in particular when data are collected at the same point in time. To address this issue, future longitudinal research is needed to make use of separate primary and secondary observations (Podsakoff and Organ, 1986). Likewise, the cross-sectional design of our study prevents significant causal inference concerning the relationship among the study variables. In order to address this issue, the present model should be tested in an experimental setting, which may help expanding the level of confidence on the internal validity of our results (Aguinis and Bradley, 2014). Accordingly, randomized experiments with the use of control groups would be required in future studies in addition to the current survey data, to ensure both internal and external validity. Sacramento et al. (2013) conducted two studies in which they adopted such a combined methodology to assess the influence of job demands on team member creativity. Specifically, in the first study, the authors experimentally manipulated job demands and showed that they had a positive impact on team member creativity for those teams that were oriented toward achieving gains. In the second study, they replicated these findings through an empirical field survey. Thus, in addition to examining survey data, an experimental methodology can be applied in future research to manipulate time pressure and verify its causal effects on team member creativity.

Third, time pressure was measured using a single item measure. Although PLS is suitable to measure a construct with single-item indicator (Ringle et al., 2012), future research is needed to measure time pressure as a multi-item construct (Baer and Oldham, 2006). Furthermore, time pressure is one stressor but other stressors such as role ambiguity and role conflict should be examined in future research to explain their effects on team member creativity (LePine et al., 2005).

Finally, in the present study, team member creativity was measured based on individual perceptions. Future comparative intergroup analysis (Adarves-Yorno et al., 2007) would be useful for understanding how team members source knowledge and how the sourced knowledge can influence their team creativity.

Despite the mentioned limitations, our findings reveal new interesting patterns, suggesting that the complex time–pressure creativity relationship can be better understood by taking into account the interplay between time pressure, motivational and cognitive processes underlying team member creativity. Our results show that beyond exerting positive direct effects, time pressure can also indirectly improve team member creativity by activating a motivational process (through learning orientation) and a cognitive process (through knowledge sourcing), while high perceived time pressure impairs it by limiting knowledge sourcing.

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Appendix A. List of constructs and items

Items
Team member creativity (TC) (reflective construct)
TC1. In my project group we frequently experiment with proven solutions to resolve problems.
TC2. In my project group we are highly imaginative in adapting existing solutions for resolving a new problem.
TC3. In my project group we frequently experiments with new alternatives.
TC4. In my project group we are highly imaginative in thinking about new or better solutions to resolve problems.
TC5. In my project group we often invent new ideas to resolve non-routine situations.
Knowledge sourcing (KS) (formative construct)
Knowledge sourcing from the group (*KSG*) (*reflective sub-dimension*)
KSG1. In my project group we frequently discuss difficulties when we need to improve knowledge on issues related to the project.

Appendix A (*continued*)

Items
KSG2. We frequently consult with my project group to improve knowledge on a topic or issue
KSG3. We rarely use conversations in my project group to acquire required knowledge [r].
Knowledge sourcing from repositories (*KSR*) (*reflective sub-dimension*)
KSR1. In my project group we often refer to available documents to learn more about a problem.
KSR2. In my project group we often consult documents posted on the company's intranet.
KSR3. In my project group we often consult knowledge-based systems to improve our knowledge on a topic or issue.
KSR4. In my project group we often consult knowledge-based systems to find solutions for similar encountered problems.
KSR4. In my project group we rarely consult knowledge-based systems [r].
Knowledge sourcing from internet (*KSI*) (*reflective sub-dimension*)
KSI1. In my project group we often consult documents available on the Internet.
KSI2. In my project group we often consult community network sites on the Internet to find useful knowledge on a topic or issue.
Learning orientation (LO) (reflective construct)
LO1. In my project group we prefer tasks that really challenge as so we can learn new things.
LO2. In my project group we often look for opportunities to develop new skills and knowledge.
LO3. In my project group we enjoy challenging work where we will learn new knowledge.
Time pressure (TP)
TP. In my project group we have not much time to develop creative ideas at work [r].

Legend: [r] = Reverse-coded item.

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