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# Knowledge worker creativity and the role of the physical work environment.

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**ABSTRACT**

The present study examines the effect of the physical work environment on the creativity of knowledge workers, compared with the effects of creative personality and the social-organizational work environment. Based on data from 274 knowledge workers in 27 SMEs, we conclude that creative personality, the social-organizational work environment, and the physical work environment independently affect creative performance. The relative contribution of the physical work environment is smaller than that of the social-organizational work environment, and both contributions are smaller than that of creative personality. The results give support for HR practices that focus on the individual, on the social-organizational work environment, and on the physical work environment in order to enhance knowledge worker creativity.

**KEYWORDS**

Human resource management, work environment, creativity, SME, knowledge worker

## 1. Introduction

Knowledge workers or "the creative class" (Florida, 2005) are viewed as core to the competitiveness of a firm in a knowledge-based economy (e.g. Lepak & Snell, 2002). These employees are involved in the creation, distribution, or application of knowledge (Davenport, Thomas, & Cantrell, 2002), and the worker's brains comprise the means of production (Nickols, 2000; Ramírez & Nembhard, 2004). Knowledge workers are the source of original and potentially useful ideas and solutions for a firm's renewal of products, services, and processes (e.g. Amabile, 1988). Human resource management (HRM) plays an important role in strengthening the organization's innovation capacity by enhancing the creativity of knowledge workers (e.g. Gupta & Singhal 1993; Mumford, 2000). Human resource (HR) practices to promote creativity focus on the individual level: recruitment and selection of creative talents, and training and development of employees to become more creative. By recruiting and selecting creative talents, a firm can attract high-potential candidates who have creative personality characteristics (e.g. Gough, 1979; Malakate, Andriopoulos & Gotsi, 2007). By training and developing staff, a company can develop knowledge and skills for creativity, thereby enhancing their creative capabilities (e.g. Puccio, Firestien, Coyle, & Masucci, 2006; Roffe, 1999; Scott, Leritz, & Mumford, 2004).

Because people's creativity not only depends on their personal characteristics, but also on their work environment (Amabile, Conti, Coon, Lazenby & Herron, 1996; Woodman, Sawyer, & Griffin, 1993), HR practices to promote creativity also focus on the social-organizational work environment by providing job design methods. Examples include designing jobs that encourage employees to take risks, that stimulate the exchange and discussion of ideas, and that allow employees to work on new problems (e.g. Amabile et al., 1996; Oldham & Cummings, 1996; Shalley & Gilson, 2004). Other HR practices could support leaders in motivating their subordinates to be more creative (Brockbank, 1999; De Leede & Looise, 2005; Mumford, 2000) such as building or integrating a system that allows creative performance objectives to be defined, or creative efforts to be acknowledged and rewarded (e.g. Amabile et al., 1996; Mumford, Scott, Gaddis & Strange, 2002).

Besides HR practices that focus on selecting and developing creative individuals, and on providing social-organizational work environments that enhance creativity, HRM can also contribute to employee creativity by developing physical work environments that stimulate creativity. Bamberger (2008, p. 840) states that "for those seeking to explain individual performance in organizations, (…) situational factors may include physical workplace conditions". Several scholars suggest that the physical work environment can be supportive for enhancing creativity (e.g. Amabile et al., 1996; George, 2008; Shalley & Gilson, 2004; Woodman et al., 1993). Brockbank (1999) indicates that "office or plant layout" is a strategic HR practice to create a desired organizational culture of creativity and innovation. HR practitioners emphasize the importance of the physical work environment for creativity as well. For example, the HR director of Red Bull, the market leader in the energy drink business observes: "The offices are not play areas but creative spaces - we're a very creative company and we want an environment that stimulates creativity" (May, 2008, p. 54).

Several case studies indicate that HR has been successfully involved in office space changes and restructuring in large North-American and British companies (e.g. Anonymous, 1998; Bencivenga, 1998; Grossman, 2002; Hays, 1998; Khanna & New, 2008; Poe, 2000; Sunoo, 2000; Thomas, 2005). Common changes include introducing open plan offices, cubicles and ergonomic furniture and have led to increased worker performance and satisfaction (Bencivenga, 1998; Brockbank, 1999; Grossman, 2002; Khanna & New, 2008; Kupritz, 2002; May, Oldham, & Rathert, 2005; Vanarsdall, 2005), improved communication and teamwork (Brockbank, 1999; May, 2008), better transfer to the job of learned skills (Kupritz, 2002), and better recruitment and retention of qualified personnel (Earle, 2003; Hays, 1998). HRM involvement in major changes in office spaces in Continental Europe have been reported, for example, in companies in Sweden (Edvinsson, 1997), Denmark (Koch, 2003), and in the Netherlands (Hogenes, Dul & Haan, 2006). Although we can speculate that the above physical workplace interventions could improve employee creativity, such results have not been documented.

Experimental studies show that certain features of the physical workplace can have positive effects on creative task performance and mention features such as the presence of plants (Shibata &

Suzuki, 2002, 2004), a non-crowded work space (Aiello, DeRisi, Epstein & Karlin, 1977) and direct window view (Stone & Irvine, 1994). Other studies examine a combination of various physical features, and find positive effects on creativity. For example, Alencar & Bruno-Faria (1997) report that an agreeable physical environment with adequate light, furniture, space and ventilation can stimulate creativity, whereas an environment with noise, heat, insufficient illumination, and lack of space inhibits creativity. McCoy & Evans (2002) identify physical features in educational environments with low and high creativity potential, and Ceylan, Dul & Aytac (2008) conduct a similar analysis of managers' offices. The physical elements in these studies include windows, light, colors, plants, use of natural materials and furniture. Evidence that the physical work environment substantially contributes to knowledge workers' creativity supports HR practices to strengthen an organization's innovation capacity by influencing decision making of architects and interior designers about the design of physical workplaces (e.g. offices and company buildings). The first contribution of this paper is that we explore this effect of the physical work environment on knowledge workers' creativity.

To what extent can the physical work environment, the social-organizational work environment and individual creative personality contribute to employee creativity, and what is their relative contribution? In a discussion about the possible effects of individual, social-organizational, and physical factors, Hemlin, Allwood & Martin (2008, p. 206) speculate that "the physical environment almost certainly affects the creativity of individuals and groups, but maybe less directly and strongly than some of the other factors". To our knowledge, no empirical studies exist that examine both dimensions of the work environment (i.e. social-organizational and physical) and creative personality to explain employee creativity. The second contribution of this paper is that we address this gap. First, we present a conceptual model and formulate hypotheses on the effects of creative personality, the social-organizational work environment, and the physical work environment on creative performance, and their interactions. Next, we test our hypotheses with a sample of knowledge workers in Dutch SMEs. Finally, we discuss the results in terms of the implications for HR practices and for future research.

## 2. Conceptual model and hypotheses

### 2.1 Conceptual model

Figure 1 shows our conceptual model to explain creative performance. The model's unit of analysis is the individual employee. Creative performance is considered as the production of novel and potentially useful ideas produced by an individual (Amabile, 1988; Madjar, Oldham & Pratt 2002; Shalley, Zhou & Oldham 2004; Zhou & George, 2001), i.e. we consider creativity as an outcome of a creative process.

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The model draws on the interactionist perspective of creativity by Woodman et al. (1993) who propose that creative performance is the result of interactions between the individual and contextual influences from the work environment. Woodman et al. (1993) formulate hypotheses about the direct effects of a number of work environment characteristics on creative performance, such as: "Individual creative performance will be increased by organizational cultures that support risk taking behaviors". Our model includes a variety of specific elements that make up the social-organizational and the physical work environment, and that can be controlled through HR practices. We focus not only on the direct effects of both dimensions of the work environment on creative performance, but also on their role as moderators.

### 2.2 Creative personality

An employee's creative performance depends partly on individual characteristics, such as domain relevant knowledge, cognitive style (e.g. divergent thinking), and personality traits. Numerous studies relate an individual's personality traits such as self-confidence and broad interests to creativity (e.g. Barron & Harrington, 1981; Feist, 1999; Gough, 1979). People that are self-confident and have broad interests may be inclined to look for new experiences that give them novel ideas. While an individual's domain relevant knowledge and cognitive style can be developed, personality traits are considered more stable. Gough (1979) defines the concept of 'creative personality' as the accumulation of separate personality traits that

are related to creativity. Research on the relationship between personality and creativity predominantly focuses on artists, scientists or other professionals with creative abilities. Few empirical studies use the creative personality concept in organizational settings to assess the effect of creative personality on the creative performance of employees (e.g. Madjar et al., 2002; Oldham & Cummings, 1996; Unsworth, Brown, & McGuire, 2000; Zhou, 2003). These studies yield contradictory results. Some find a direct relationship with creativity (e.g. Oldham & Cummings, 1996; Unsworth et al., 2000), whereas others do not (e.g. Madjar et al., 2002; Zhou, 2003). In the light of the arguments above, we propose the following direct relationship between knowledge workers' creative personality and creative performance:

*Hypothesis 1. The higher a knowledge worker's creative personality, the higher his/her creative performance.*

**2.3 Social-organizational work environment**

Recent reviews of empirical research on the effects of the social-organizational work environment on creativity (e.g. Anderson, De Dreu, & Nijstad, 2004; Egan, 2005; George, 2008; Hunter, Bedell, & Mumford, 2007; Rank, Pace, & Frese, 2004; Runco, 2004; Shalley et al., 2004; Shalley & Gilson, 2004; Zhou & Shalley, 2003) suggest that several social-organizational elements of the work environment can motivate people to be more creative. Examples are the presence of teamwork that requires sharing and discussing ideas, and the presence of complex tasks that require creative problem solving. We used empirical studies that were described in these reviews as well as others found by database, reference and citation searches to generate a list of elements of the social-organizational work environment that can enhance creativity (Table 1).

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Amabile et al. (1996) presume that the employee's *perception* of the presence of a specific element of the work environment is important for creativity, rather than the actual presence of that element. For example, being motivated to be creative depends more on the employee's perception that the leader recognizes creative ideas, than the actual recognition provided by the leader. Yet, to a certain extent, there is a relationship between perception and real provision. Although each creativity-supporting element could be considered as a separate contributor to creativity, the goal of the present paper is not to examine the effects of separate elements, nor to understand mechanisms how these elements are related to creativity. Our study focuses on a higher level of aggregation. The separate elements are integral parts of an overall social-organizational work environment that supports creativity. It is a cumulative predictor of creative performance, which is a conglomerate of additive elements. As Meusburger (2009, p. 136) states: "the predictive power of social macro-phenomena … is much greater than that of any discrete variable studied in laboratory experiments". Therefore, we define the degree of support from the overall social-organizational environment as the total perceived presence of creativity-supporting elements in that environment. On the basis of the above arguments, we formulate the following relationship on the effect of the social-organizational work environment on creativity:

*Hypothesis 2. The more a knowledge worker perceives support from his/her social-organizational work environment, the higher his/her creative performance.*

**2.4 Physical work environment**

In the management literature, very little attention is paid to the impact of the physical work environment on creativity. "Since the 1920s, social science has tended to ignore the physical work environment" (Baldy, 1997, p. 365). The majority of physical work environment research reported in the management literature examines the effects of spatial arrangements of offices, in particular the dilemma between social interactions and privacy of open plan offices (e.g. Sundstrom, Burt, & Kamp, 1980; Toker & Gray, 2008;

Zalesny & Farace, 1987), and workers' reactions to spatial density (e.g. May et al., 2005; Oldham, Kulik, & Stepina, 1991). Research on creative work environments rarely includes elements of the physical work environment. For instance, a review study of 45 taxonomies of work environments for creativity and innovation (Hunter et al., 2007) indicates that only one taxonomy (Alencar & Bruno-Faria, 1997) includes physical characteristics. We performed an extensive review of empirical studies to find potential creativity enhancers of the physical work environment. We selected relevant studies on the basis of a broad database search of empirical studies in management, psychology, engineering, ergonomics and human factors, architecture, and indoor design journals, or studies that we found using database, reference and citation searches. Table 2 shows our review results as a list of possible creativity enhancers of the physical work environment. Physical features, such as a window view and plants may provide a source of information for a creative task (e.g. Shibata & Suzuki, 2002; Stone & Irvine, 1994), and features such as colors may have a positive influence on a person's mood (e.g. Küller, Ballal, Laike, Mikellides, & Tonello, 2006). Positive mood is associated with creativity (e.g. Amabile, Barsade, Mueller, & Staw, 2005; Davis, 2009).

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These physical elements can be included in the work environment by interior design and building design. Interior design for creativity refers to the design of physical workplaces (e.g. offices) that provides support for creativity (e.g. indoor plants/flowers, inspiring colors). Building design is related to the design of the building structure elements that provide such support (e.g. window view, daylight, adequate ambient conditions). Following the same approach as we developed for the social-organizational work environment, we define the concept of the physical work environment to support creativity as the total of separate physical elements that are perceived by the employee to be present in the work environment. We, therefore, formulate the following relationship on the effect of the physical work environment on employee creativity:

*Hypothesis 3. The more a knowledge worker perceives support from his/her physical work environment, the higher his/her creative performance.*

**2.5 Interactions**

In their interactionist model, Woodman et al. (1993, p. 295) propose that there are interaction effects of the social-organizational environment and of the physical environment on the relationship between the individual's creative personality and creative performance. Only few empirical studies focus on interactions between creative personality and the social-organizational environment (e.g. George & Zhou, 2001; Madjar, et al., 2002; Oldham & Cummings, 1996; Zhou, 2003). For example, Oldham and Cummings (1996) report that employees with high creative personalities respond more positively to social-organizational environments that support creativity than those with low creative personalities. They argue that the latter may be overstretched or irritated by certain contextual conditions and respond by lowering their creative performance. Following the same argument, high and low creative employees may respond differently to physical work environments that support creativity. However, to our knowledge, no empirical studies are available on the interaction effects between creative personality and physical elements of the work environment. Evans, Johansson, and Carrere (1994, op cit. Leather, Beale, & Sullivan, 2003) analyze the interaction between the physical and the social-organizational environment and suggest that any feature of the physical environment might work both directly on outcomes and/or interactively with psychosocial work elements. Vithayathawornwong, Danko, and Tolbert (2003) suggest that the physical work environment facilitates the social-organizational work environment for creativity, rather than having a direct effect on creativity. As far as we know, no studies are available that empirically examine the interaction between the physical work environment and the social-organizational work environment to predict creativity. We formulate the following hypotheses on interaction effects:

*Hypothesis 4a. The effect of creative personality on creative performance depends on the perceived support from the social-organizational work environment, such that a high creative personality benefits more from a higher level of support from the work environment, than a low creative personality.*

*Hypothesis 4b. The effect of creative personality on creative performance depends on the perceived support from the physical work environment, such that a high creative personality benefits more from a higher level of support from the work environment, than a low creative personality.*

*Hypothesis 4c. The effect of the perceived support from the social-organizational work environment on creative performance depends on the perceived support from the physical work environment, such that the support from the social-organizational work environment has more effect if the support from the physical work environment is higher.*

**2.6 Relative contributions**

Studying the joint effects of creative personality, the social-organizational work environment, and the physical work environment allows us to estimate their relative contributions to creative performance. If we assume that the number of creativity studies that have been published over the years is representative for these relative contributions, individual characteristics ("nature") are undoubtedly more important than the work environment ("nurture"), and the social-organizational work environment is more important than the physical work environment. Ceylan and Dul (2007) questioned 442 HR and ergonomics professionals from three different countries (Brazil, the Netherlands, Turkey) about these relative contributions, and found that these professionals believe that all dimensions are important for enhancing creativity. However, individual characteristics were ranked as more important than the social-organizational work environment, and the physical work environment was considered the least important. On the basis of the above arguments, we formulate the following hypothesis on the relative importance of individual characteristics,

the social-organizational work environment and the physical work environment for the creative performance of knowledge workers:

*Hypothesis 5. The relative contribution of the perceived support from the physical work environment to creativity is smaller than that of the social-organizational work environment, and both contributions are smaller than the contribution of creative personality.*

## 3. Method

### *3.1 Participants and procedure*

This study employs a questionnaire survey method for testing the hypotheses. Data were obtained from 274 Dutch knowledge workers employed in 27 small and medium-sized enterprises. Companies volunteered to take part in a project to enhance innovation in SMEs. The participants were knowledge workers such as consultants, marketers, controllers, designers, and managers, who perform 'brain work' and usually work in an office environment. The mean age of the participants was 37.7, and 78 percent were male. The majority of the respondents (269) had Dutch nationality. Trained research assistants visited each company to identify departments with knowledge workers and to collect the data. Response rates per company varied between eighty percent and hundred percent and a total of 424 questionnaires was returned. We excluded questionnaires with 'don't know' answers or missing data for the main study variables, resulting in 274 questionnaires (65%) that were usable for the final analysis.

### *3.2 Measures*

#### 3.2.1 Independent variables

The Creative Personality Scale (CPS) based on Gough's Adjective Check List (ACL) (Gough, 1979) was used as our creative personality measure. The original list contains 18 adjectives positively related to

creativity and 12 negatively related to creativity. Respondents indicate which of the adjectives best describe them. The total number of selected adjectives that are positively related to creativity minus the total number of selected adjectives that are negatively related to creativity is considered as a measure of an individual's creative personality. Hence, CPS is a formative index. It is considered a reliable and valid measure of creative personality (Batey & Furnham, 2008; Oldham & Cummings, 1996). CPS is a widely used and well-respected creative personality measure and many adaptations have been published in the literature. A common one is to use only a selection of adjectives to simplify data collection (e.g. Madjar et al., 2002, Unsworth et al., 2000; Zhou, 2003). Another, more fundamental adaptation is to change the original formative index into a reflective scale (e.g. Shalley, Gilson, & Blum, 2009). Traditional scale development draws on reflective measurement models where the observed indicators are assumed to be caused by a latent variable, whereas in a formative measurement model (Damantopoulos & Winklhofer, 2001) the opposite direction of causal relationship between the latent variable and the manifest indicators is assumed. We followed the approach of Unsworth et al. (2000) to maintain the formative index and to simplify data collection by selecting 16 positive adjectives as a measure of creative personality (capable, clever, confident, egotistical, humorous, informal, individualistic, insightful, intelligent, wide interests, inventive, original, reflective, resourceful, self-confident, and unconventional). The respondents were asked to mark which of these adjectives best describes them. The total number of selected adjectives is considered as the measure of an individual's creative personality (a maximum of 16). Because the item scores of a formative index do not need to correlate, common test methods for assessing construct reliability do not apply (Rossiter, 2002).

We assessed the work environment by asking respondents to rate nine creativity-supporting elements of the social-organizational work environment (Table 1) and 12 of the physical work environment (Table 2). The respondent rated the extent to which a creativity-supporting element is present (realized) using a 7-point Likert scale (from very little to very much). To increase validity, respondents also had the option of indicating 'don't know' for each element. If this option was chosen, or if data were missing, the respondent was not included in the study, as our overall indices for the social-organizational

and the overall physical work environment need inputs from all single elements. We employed a formative index to obtain the overall measure of the social-organizational and the physical work environment. As the proposed overall measure of the work environment is composed of several different elements, we totaled and averaged the element scores. This resulted in two scores: one for the support from the social-organizational work environment, and one for the support from the physical work environment. The scores of the elements do not need to correlate; hence common test methods for assessing construct reliability do not apply.

### 3.2.2 Dependent variable

We used self-perceived creativity as our dependent variable. This is the extent to which employees perceive that they produce new and potentially useful ideas (Zhou, Shin & Cannella, 2008). Employees themselves are best suited to report creativity because they are aware of the subtle things they do in their jobs that make them creative (Shalley et al., 2009). Other people such as supervisors or colleagues do not have full access to the creative thoughts and activities of an individual, and therefore "the subject, in most cases, knows more about himself than peers, supervisors, teachers, etc." (Hocevar, 1981, p. 459). Yet, to a certain extent self-reported creativity is correlated to supervisor reported creativity (Axtell, Holman & Unsworth, 2000). We used a 3-item reflective self-rating scale to measure employee creativity, which was based on George & Zhou's (2001) 13-item scale for supervisor rating of employee creativity, and Noordam's (2006) modification of this scale for self-rating of employee creativity. Because of the high internal consistency of the original scales (both 0.96), we reduced the number of items in order to simplify data collection. Since we consider creativity (the *generation* of ideas) and innovation (the *implementation* of selected ideas) as related but distinct concepts, we only included items that focus specifically on creativity, i.e. the generation of ideas , and those which had the highest factor loadings in the Noordam study. We modified the items by including a frequency element in the question ("often"), because creativity is not only about "novelty" but also about "fluency" of idea generation. To increase measurement sensitivity, we employed a 7-point Likert scale (1= do not agree… 4= neutral …7= agree)

rather than the original 5-point scales. This resulted in the following three items for measuring employee creativity: *"In my work, I often have new and innovative ideas"*, *"In my work, I often come up with creative solutions to problems"*, and *"In my work, I often suggest new ways of performing work tasks"*.

We performed confirmatory factor analysis for the construct of employee creativity. To achieve an overidentified model, two loadings were specified to be equal. The resulting one-factor model showed acceptable fit ($\chi^2 = 0.25$, $p>0.6$; RMSEA = 0.0; GFI = 1.0; CFI = 1.0). Construct reliability is 0.89, which is well beyond the recommended level of 0.70. The degree of variance extracted is 0.74, which exceeds the recommended 50 percent.

### 3.2.3 Control variables

We included age and gender as control variables in our analysis. Research has shown that there is a non-linear relationship between age and creativity ("age curve"), which has been expressed as a polynomial with a positive coefficient of linear age, and a negative coefficient of quadratic age (Simonton, 1988). Therefore we included linear and quadratic age in our analysis. Several studies show that gender can have an effect on creative performance, although the general picture is contradictory. Baer and Kaufman (2008) state that: "it is unlikely that a meta-analysis would show a significant overall gender difference on these tests, but it should be noted that if there were to be an overall "winner" in the numbers of studies in which one gender outperformed the other, it would be women and girls over men and boys". We included gender as a dummy variable in our analysis. In order to reduce multicollinearity, we mean-centered the scores for age, and for the independent variables.

### 3.2.4 Controlling for common method bias

In our survey study, like in many other studies, the data for the independent and dependent variables come from a single source (the knowledge worker). Therefore, there is a risk for common method bias since respondents may have guessed our hypotheses and may have responded accordingly. We took several measures reported in the literature to control for common method bias. First, in our questionnaire we

separated the independent and dependent variables (Podsakoff, MacKenzie, Lee & Podsakoff, 2003). Second, we explicitly emphasized that there were no right or wrong answers (Mäkelä & Brewster, 2009), and third, we guaranteed anonymity (Podsakoff et al. 2003; Rogelberg, Allen, Shanock, Scott & Shuffler, 2010). After data collection, we performed a statistical single factor test to evaluate whether common method bias was a problem in our dataset. Since there are few techniques to detect common method bias for formative scales (Booth, Park, & Glomb, 2009), we conducted Harman's one-factor test (Scott & Bruce, 1994; Podsakoff & Organ, 1986; Zhou et al., 2008; Patel & Cardon, 2010; Messersmith & Guthrie, 2010), which is commonly used to assess the existence of common method variance at item level. Principle component analysis with the 21 items that make up the independent work environment variables, and the three items from the dependent variable showed that the unrotated principal components solution extracted five components with eigenvalues greater than 1. The first component accounted for only 30% of the variance, indicating that common method variance is not a serious problem in our data set.

**4. Results**

Table 3 presents means, standard deviations, and correlations for the (uncentered) measures used in this study. The main variables - creative personality, the social-organizational work environment, and the physical work environment - are all positively and significantly related to creative performance. The social-organizational work environment and the physical work environment are positively and significantly related to each other.

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The results of a hierarchical regression analysis are presented in Table 4. The control variables were entered first (model 1), followed by the independent variables (creative personality, the social-organizational work environment, the physical work environment; model 2). Next we included the interaction terms (model 3). The explained variance increases significantly from model 1 to model 2, but

not from model 2 to model 3. Because the 274 respondents in our study worked in 27 different companies, we performed a multilevel analysis to evaluate the effect of company on the variance of the dependent variable. This analysis showed that company has only a minor effect (2.4% of the explained variance). Hence, we continued the data analysis with the regression models presented in Table 4.

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The regression analysis of model 2 shows that the regression coefficient for creative personality differs significantly from zero. This means that there is a significant positive effect of creative personality on creative performance (coefficient: 0.20 and $p<0.001$). This result confirms Hypothesis 1: The higher a knowledge worker's creative personality, the higher his/her creative performance. Model 2 also shows that the support from the social-organizational work environment has a significant positive effect on creative performance (coefficient: 0.17 and $p<0.01$). This result confirms Hypothesis 2: The more a knowledge worker perceives support from his/her social-organizational work environment, the higher his/her creative performance. Similarly, the regression coefficient for the support from the physical work environment differs significantly from zero in the expected positive direction (coefficient: 0.12 and $p<0.05$). This result confirms Hypothesis 3: The more a knowledge worker perceives support from his/her physical work environment, the higher his/her creative performance.

Model 3 shows that the interaction terms do not differ significantly from zero. This means that in our dataset, the effect of creative personality on creative performance does not depend on the perceived support from the social-organizational environment or on the perceived support from the physical work environment, and that the effect of the perceived support from the social-organizational work environment on creativity does not depend on the perceived support from the physical work environment, and vice versa. Consequently, Hypotheses 4a, 4b, and 4c are rejected. The standardized regression coefficients indicate that the contribution of creative personality to creative performance (coefficient: 0.20) is larger than the contribution of the social-organizational work environment (coefficient: 0.17), which is higher

than the contribution of the physical environment (coefficient: 0.12), although the differences are small. This result supports Hypothesis 5, showing that creative personality is more important than the social-organizational work environment, which is more important than the physical environment.

## 5. Discussion

The objective of the present study was to examine the effect of the physical work environment on the creativity of knowledge workers, compared with the effects of creative personality and the social-organizational work environment. To our knowledge, this is the first empirical study that considers the physical work environment simultaneously with the social-organizational work environment and creative personality to explain creative performance. This allows for a more comprehensive discussion on the possible roles of HRM to enhance creativity. We found that all three dimensions independently contribute to the creative performance of knowledge workers. This indicates that not only HR practices that focus on recruiting and selecting individuals with creative personality, or on providing a creative social-organizational work environment through job design and leadership support, but also HR practices that focus on providing a creative physical work environment can be effective in enhancing knowledge workers' creativity. This provides empirical evidence for suggestions made by a number of management scholars (e.g. Amabile et al., 1996; Brockbank, 1999; George, 2008; Shalley & Gilson, 2004; Woodman et al., 1993) and HR professionals (cited in e.g. Bencivenga, 1998; May, 2008) that the physical context supports employee creativity.

We did not find significant interaction effects between the social-organizational environment and the physical environment with creative personality. Although *separate* elements of the work environment may interact with creative personality (George & Zhou 2001; Madjar et al., 2002; Oldham & Cummings 1996; Zhou, 2003), at the aggregate level positive and negative interactions may level out. For example Oldham and Cummings (1996) found that high creative personalities benefit more than low creative personalities from the social-organizational work environment elements 'job complexity', 'supportive supervisor' and 'non-controlling supervisor'. Similarly, George and Zhou (2001) report that individuals

who rank high in openness to experience (a personality trait that is considered to be linked to creativity) benefit more from the work environment element 'positive feedback from supervisors' than those who score low in openness to experience. On the other hand, Zhou (2003) found that less creative people benefit more from the element 'presence of creative coworkers' (in absence of close monitoring supervisors), than high creative people, and Madjar et al. (2002) report that individuals with less creative personalities benefit more from the element 'support from family or friends' than individuals with more creative personalities. In other words, some creativity supporting elements are more beneficial for high creative personalities, whereas others are more beneficial for low creative personalities, with possibly no effect on the level of the overall work environment. Nevertheless, the overall work environment does have a direct effect on creativity: it makes all people more creative (both the less and the more creative). More creative people do not benefit more from a supportive work environment than less creative people. However, our regression model 3 shows that the interaction between creative personality and the physical work environment was relatively high (coefficient: 0.09, but not significant) which may suggest that high creative personalities could benefit more from the physical work environment than low creative personalities. Future studies should clarify this. We did not find an interaction between the social-organizational and physical environment either. This contrasts Vithayathawornwong et al.'s (2003) suggestion that the physical work environment facilitates the social-organizational work environment for creativity, rather than having a direct effect on creativity. Our study supports Evans et al's idea (1994, op cit. Leather et al., 2003) that the physical environment directly affects outcomes without interacting with the psychosocial work environment.

We found that the relative contribution of the physical work environment is somewhat smaller than that of the social-organizational work environment, and both contributions are smaller than that of creative personality. This suggests that personality plays a greater role in enhancing creativity than the social-organizational or physical work environment. Creative performance is driven by personal characteristics but can be further enhanced by the work context. The social-organizational work context seems to have a stronger impact on creativity than the physical environment. This finding corresponds to

earlier observations by Ceylan and Dul (2007) who found that human resource and ergonomics professionals considered both the organizational and the physical work environment as important for employee creativity, but ranked the organizational work environment as more important. As expected, we found that age affects creative performance in a non-linear way. Our regression model shows that maximum creative performance can be expected at the age of about 40, which corresponds to peaks found in other studies (Simonton, 1988). We also found that on average, men reported higher levels of creative performance than women. This effect was unexpected, as in most studies no gender differences are found. In cases where differences are found, females usually have higher creative performance than males (Baer & Kaufmann, 2008). Kaufman (2006) suggests that gender differences in self-reported creativity are domain-dependent. Hence, our results may indicate that males tend to rate themselves higher than females in knowledge work. These results suggest that age and gender should be included as control variables in studies on creative work environments.

### 5.1 Limitations and future research

Our study has some limitations. First, there is a possibility for measurement error in the data. We constructed new overall indices for measuring the social-organizational and the physical work environment, which draw upon measures of separate elements of the work environment. As a first approximation, we presumed that the effects of single elements on creativity can be added linearly to obtain the overall measure. Further studies to explore different ways of aggregating (e.g. using weighting factors or non-linear summation) are desirable. Second, we measured creativity by using respondents' self-reports. Although self- perceived creativity may be a more valid measure of an individual's creative performance than a measure of individual's creative performance that is perceived by other individuals, such as supervisors or colleagues (Hocevar, 1981; Shalley et al., 2009; Zhou et al., 2008), such measurement is less objective than counts of creative output. Further studies should include other measures of creative performance besides self-reports. Third, for practical reasons, in many field studies, data for the independent and the dependent variables have to come from a single source - the employees

themselves, and have to be collected at the same time (Zhou et al., 2008). Although we have attempted to prevent common method bias during data collection, and Harman's one-factor test indicated that common method bias was not a major problem in our dataset, further studies should preferably include measures of independent and dependent variables collected from different sources.

One distinctive feature of our study is that our respondents were knowledge workers in SMEs. SMEs are considered most important for regional and national innovation (Asheim & Isaksen, 2003), and knowledge workers' creativity in these enterprises is an essential resource. Most empirical studies on creativity and innovation use respondents from larger companies, possibly for reasons of efficient data collection. Our data collection in SMEs was rather labor intensive as many companies had to be visited by different assistants using a standardized protocol. However, executive directors of SMEs were motivated to participate in the study because we offered them advice after the analysis of the work environment (Dul & Ceylan, 2011). All data was gathered from knowledge workers who were employed in Dutch SMEs. In order to generalize our results to knowledge workers in other (larger) companies and other cultures, replication studies are needed, which include these. Our results cannot be generalized to creativity in other domains, for example, entrepreneurial creativity or artistic creativity, because we focus on employee creativity in a business setting.

### 5.2 Implications for managerial practice

Our finding that the physical work environment can contribute to creative performance of knowledge workers supports the view and practice that HR has a strategic role in physical workplace design in today's knowledge-intensive and innovation driven economy. HR professionals can play a vital role in contributing to designing creative workplaces by cooperating with architects, interior designers, facility managers, ergonomists, purchasing managers, etc. Because we found no interaction effects, such HR practices could be performed independently from other HR practices to enhance creativity (recruitment and selection, job design, leadership support). Physical workplace design just adds to the effects of other practices. One advantage of focusing on designing physical work environments is that many creativity

stimulating features such as plants or inspiring colors are relatively cost effective and can be easily implemented without much resistance against change, in contrast to social-organizational measures such as restructuring jobs or changing leadership styles. Another advantage is that changes in physical work environments are immediately visible to employees. In a knowledge-based economy, where the creativity of knowledge workers is central, HR practices to promote physical work environments that enhance creativity is strategically important because they contribute to the company's innovation capacity.

Our findings about the relative contributions of creative personality, the social-organizational and physical work environment indicate that HR practices that focus on selecting creative personalities may be more effective than those focusing on the work environment. Egan (2005) warns that using Gough's (1979) Creative Personality Scale for selection purposes may not be effective because applicants may intentionally give skewed answers. Instead he suggests that HR practices should focus on managerial behavior and workplace environments. On the other hand, Kobe and Goller (2009) claim that CPS can be a valid method for assessing creative personality, if assessments are done carefully by experts,

On the basis of our findings, we recommend that companies implement three types of HR practices to enhance employee creativity simultaneously:

- Recruitment and selection of employees on the basis of personality traits that are related to creativity (by using CPS or another creative personality test);
- Job design and leadership practices that provide social-organizational work environments that support creativity (see Table 1);
- Interior and building design practices that provide physical work environments that support creativity (see Table 2).

These HR practices can together create a company profile that is difficult to imitate for competitors (Henard & McFadyen, 2008), and hence can contribute to a sustainable competitive advantage.

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**FIGURES**

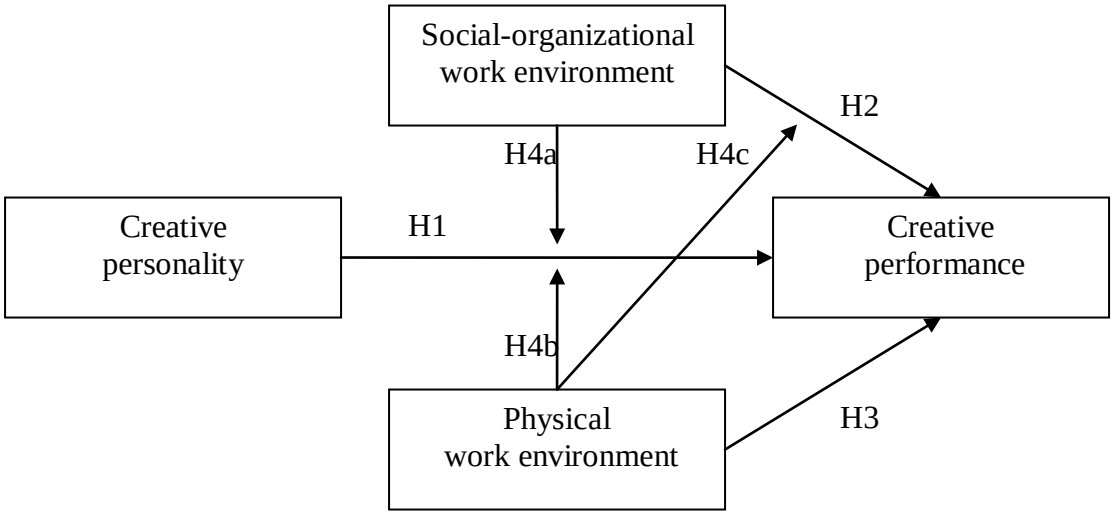


Figure 1. A conceptual model of the relationships between creative personality, work environment and creative performance.

## TABLES

**Table 1. Elements of the social-organizational work environment that are possibly related to creativity**

| Number | Element | Description | Examples of empirical studies that relate the element to creativity |
|---|---|---|---|
| 1 | Challenging job | The complexity of the job, and how demanding the job is. | Amabile & Gryskiewicz (1989)<br>Hatcher et al. (1989)<br>Oldham & Cummings (1996) |
| 2 | Teamwork | Working in a group of people towards a common goal, by having interactions with each other. | Amabile et al. (1996)<br>Leenders et al. (2003)<br>Monge et al. (1992) |
| 3 | Task rotation | A schedule with a set of different tasks to be performed simultaneously. | Madjar & Oldham (2006) |
| 4 | Autonomy in job | Decision latitude in the job, for example with respect to deciding about the order of work tasks. | Greenberg (1992, 1994)<br>De Jong & Kemp (2003)<br>Ohly et al. (2006)<br>Zhou (1998) |
| 5 | Coaching supervisor | A supervisor who supports and encourages employees, builds mutual trust and commitment, and provides positive feedback. | Amabile et al. (2004)<br>George & Zhou (2001)<br>Oldham & Cummings (1996)<br>Zhou (1998) |
| 6 | Time for thinking | The availability of time for idea generation without the time pressure in everyday work. | Andrews & Smith (1996) |
| 7 | Creative goals | The situation that the employee must produce new ideas according to goals, and with the expectation of evaluation. | Carson & Carson (1993)<br>Madjar & Shalley (2008)<br>Shalley (1991, 1995)<br>Shalley & Perry-Smith (2001) |
| 8 | Recognition of creative ideas | The recognition (e.g. praise, awards) of new ideas. | Amabile et al. (1996)<br>Baer et al. (2003)<br>Eisenberger & Shanock (2003)<br>Paolillo & Brown (1978) |
| 9 | Incentives for creative results | Possibility of rewards (e.g. pay raises, profit sharing, bonuses, promotions) after reaching creative results. | Amabile et al. (1996)<br>Baer et al. (2003)<br>Paolillo & Brown (1978)<br>Eisenberger & Shanock (2003)<br>Friedman (2009) |

**Table 2. Elements of the physical work environment that are possibly related to creativity**

| Number | Element | Description | Examples of empirical studies that relate the element to creativity |
|---|---|---|---|
| 10 | Furniture | Furniture (e.g. chairs, tables, cupboards) that are placed in the workplace. | Ridoutt et al. (2002) |
| 11 | Indoor plants/flowers | Natural plants or flowers that are placed in the workplace. | Ceylan et al. (2008)<br>Shibata & Suzuki (2002, 2004) |
| 12 | Calming colors | Colors that provide a relaxing experience (e.g. green, blue, or blue violet). | Ceylan et al. (2008) |
| 13 | Inspiring colors | Colors that provide a stimulating experience (e.g. yellow, orange, pink, red, or red violet). | McCoy & Evans (2002)<br>Stone (2003) |
| 14 | Privacy | The possibility of being secluded from the presence or view of others. | Aiello et al. (1977)<br>Stokols et al. (2002) |
| 15 | Window view to nature | Having visual access from the work environment to the outer natural environment (e.g. trees, plants). | McCoy & Evans (2002) |
| 16 | Any window view | Having visual access from work environment to any outer environment. | Stone & Irvine (1994) |
| 17 | Quantity of light | The amount of light in the work environment. | Knez (1995) |
| 18 | Daylight | The light coming from the sun into the work environment. | Ceylan et al. (2008) |
| 19 | Indoor (physical) climate | The temperature, velocity, humidity and composition of the air in the work environment. | Hygge & Knez (2001) |
| 20 | Sound (positive sound) | Positive sounds (e.g. music, silence, absence of noise). | Alencar & Bruno-Faria (1997)<br>Stokols et al. (2002) |
| 21 | Smell (positive smell) | Positive odors (e.g. fresh air, absence of bad smell). | Knasko (1992) |

**Table 3. Means, standard deviations, and correlations of the study measures[a]**

| Variable | M | S.D. | 1. | 2. | 3. | 4. | 5. |
|---|---|---|---|---|---|---|---|
| 1. Creative performance | 5.08 | 1.05 | | | | | |
| 2. Age | 37.7 | 10.6 | 0.10 | | | | |
| 3. Gender (1=female; 2=male) | 1.78 | 0.42 | 0.15* | 0.15* | | | |
| 4. Creative personality | 6.11 | 2.72 | 0.22*** | 0.12* | 0.10 | | |
| 5. Social-organizational work environment | 4.65 | 0.93 | 0.21*** | -0.05 | 0.07 | 0.02 | |
| 6. Physical work environment | 4.16 | 1.24 | 0.17** | -0.04 | -0.06 | 0.05 | 0.39*** |

*p<0.05, **p<0.01, **p<0.001 (two-tailed)
[a] N = 274

**Table 4. Results of regression analyses predicting creative performance** [a,b]

| | Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| Age | 0.09 | 0.09 | 0.09 |
| $Age^2$ | -0.16** | -0.20*** | -0.19*** |
| Gender | 0.15* | 0.13* | 0.13* |
| Creative personality | | 0.20*** | 0.20*** |
| Social-organizational work environment | | 0.17** | 0.16** |
| Physical work environment | | 0.12* | 0.10 |
| Creative personality x Social-organizational work environment | | | 0.01 |
| Creative personality x Physical work environment | | | 0.09 |
| Social-organizational x Physical work environment | | | -0.02 |
| $\Delta R^2$ | | 9.8% | 1.0% |
| Partial F | 5.28** | 10.29*** | 0.97 |
| $R^2$ | 5.5% | 15.3% | 16.3% |
| Adjusted $R^2$ | 4.5% | 13.4% | 13.4% |
| Model F | 5.28** | 8.06*** | 5.69*** |

* p<0.05, ** p<0.01, *** p<0.001
[a] N=274
[b] Standardized regression coefficients are reported for a one-sided test.