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

K. Rosing

M. Frese
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A DYNAMIC PERSPECTIVE ON AFFECT AND CREATIVITY

RONALD BLEDOW
Ghent University

KATHRIN ROSING
Leuphana University of Lueneburg

MICHAEL FRESE
National University of Singapore
Leuphana University of Lueneburg

We argue that creativity is influenced by the dynamic interplay of positive and negative affect: High creativity results if a person experiences an episode of negative affect that is followed by a decrease in negative affect and an increase in positive affect, a process referred to as an "affective shift." An experience-sampling study with 102 full-time employees provided support for the hypotheses. An experimental study with 80 students underlined the proposed causal effect of an affective shift on creativity. We discuss practical implications for facilitating creativity in organizations.

Creativity—the development of new and useful ideas—is critical for human adaptation in complex and dynamic environments (Amabile, 1996). Given the complexity and dynamics of today's organizations, knowledge of how creativity can be stimulated is critical for an effective managerial practice. Among the determinants of creativity, affective states stand out as factors that can be influenced and that have been consistently linked to creativity (Baas, De Dreu, & Nijstad, 2008). More specifically, a vast body of research has confirmed that positive affect, which encompasses feelings such as happiness and enthusiasm, leads to high creativity (Isen, 1999). This evidence provides a solid basis for recommending that creativity in organizations can be stimulated by cultivating feelings of happiness and enthusiasm (Amabile, 2000). However, it is questionable whether positive affect alone suffices for creativity. As one of the most complex mental functions, creativity may draw from the whole spectrum of affective experiences—and the cognitive processes they elicit—including negative feelings such as anxiety, frustration, and distress (George & Zhou, 2007; Kaufmann & Vosburg, 1997). If this is the case, a one-sided focus on positive affect may fall short of explaining creativity and of unleashing people's creative potentials.

The present article attempts to move toward a balanced and dynamic account of affect that acknowledges the significance of positive as well as negative affect for creativity. Our core proposition is illustrated by the analogy of the phoenix: The phoenix is a mythological bird that burns to ashes and subsequently resurrects from its own ashes to become a colorful bird once more. It repeats this cycle over and over again. The figure of the phoenix appears in numerous cultures and has found its way to modern language in the proverb "like a phoenix rising from the ashes" (Van den Broek, 1972). With some equivalence to a phoenix's renewal—which depends on a preceding phase of decline—the emergence of new ideas is often preceded by and depends on a phase of negative affect. We argue that new ideas result as a consequence of a dynamic process in which a person experiences a phase of negative affect and subsequently leaves negative affect behind and enters a state of high positive affect.

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In terms of the phoenix analogy, past research on the affect-creativity link has primarily focused on the rise of the phoenix and has found a close link between positive affect and creativity. It has paid less attention to the phoenix's preceding decline, that is, to the role negative affect plays in the creative process, and the available evidence regarding this role is inconsistent (Baas et al., 2008). Moreover, research has often neglected the dynamic nature of affect. A person's affective experience changes continuously; emotions rise and fall in response to external events, and moods are subject to ongoing, gradual change (Weiss & Cropanzano, 1996). Theories of self-regulation emphasize that change in affect and the interplay of positive and negative affect have critical functions (Carver & Scheier, 1990; Kuhl, 2000; McClelland, 1987). However, neglecting this theoretical notion, empirical research has mostly considered isolated affective states rather than the dynamic interplay of positive and negative affect to be a determinant of creativity. In this article, we address this limitation. We aim to advance the understanding of the affect-creativity link by specifying the dynamic interplay between positive and negative affect that leads to creativity.

CONCEPTUAL FRAMEWORK

Adaptive human functioning depends on the regulating influence of positive and negative affect on perception and cognition (e.g., Rothermund, Voss, & Wentura, 2008). Positive and negative affect fluctuate over time, and fluctuations in affect are associated with changes in a person's attentional focus and mode of thinking (Friedman & Förster, 2010). Positive and negative affect fluctuate on two distinct dimensions that exhibit a negative correlation (Watson, 1988). That is, positive and negative affect can both be present within a time interval; however, as they are mutually inhibitory, the simultaneous presence of high positive and high negative affect at any moment is rare (Fong, 2006; Schmukle, Egloff, & Burns, 2002).

A conceptual framework that integrates research on how positive and negative affect regulate psychological functioning is personality systems interaction (PSI) theory (for a detailed discussion, see Kuhl [2000, 2001]). The distinctive characteristic of this theory is its focus on change in affect. It can therefore serve as a guiding framework for developing a theoretical rationale about the dynamics of affect underlying creativity. According to the theory, positive affect regulates whether cognition proceeds in a controlled, slow, and sequential mode (low positive affect) or in an automatic, fast, and parallel mode (high positive affect). If positive affect is low, people can objectively analyze a situation and deliberate on potential courses of action (Carver & White, 1994; Kazén & Kuhl, 2005; Schwarz & Bless, 1991). An increase in positive affect leads to behavioral activation, so that previously developed intentions can be implemented (Kuhl & Kazén, 1999). After an increase in positive affect, behavioral control proceeds in an intuitive and effortless manner, and cognitive processing broadens and includes exploratory thoughts and actions (Fredrickson, 2005).

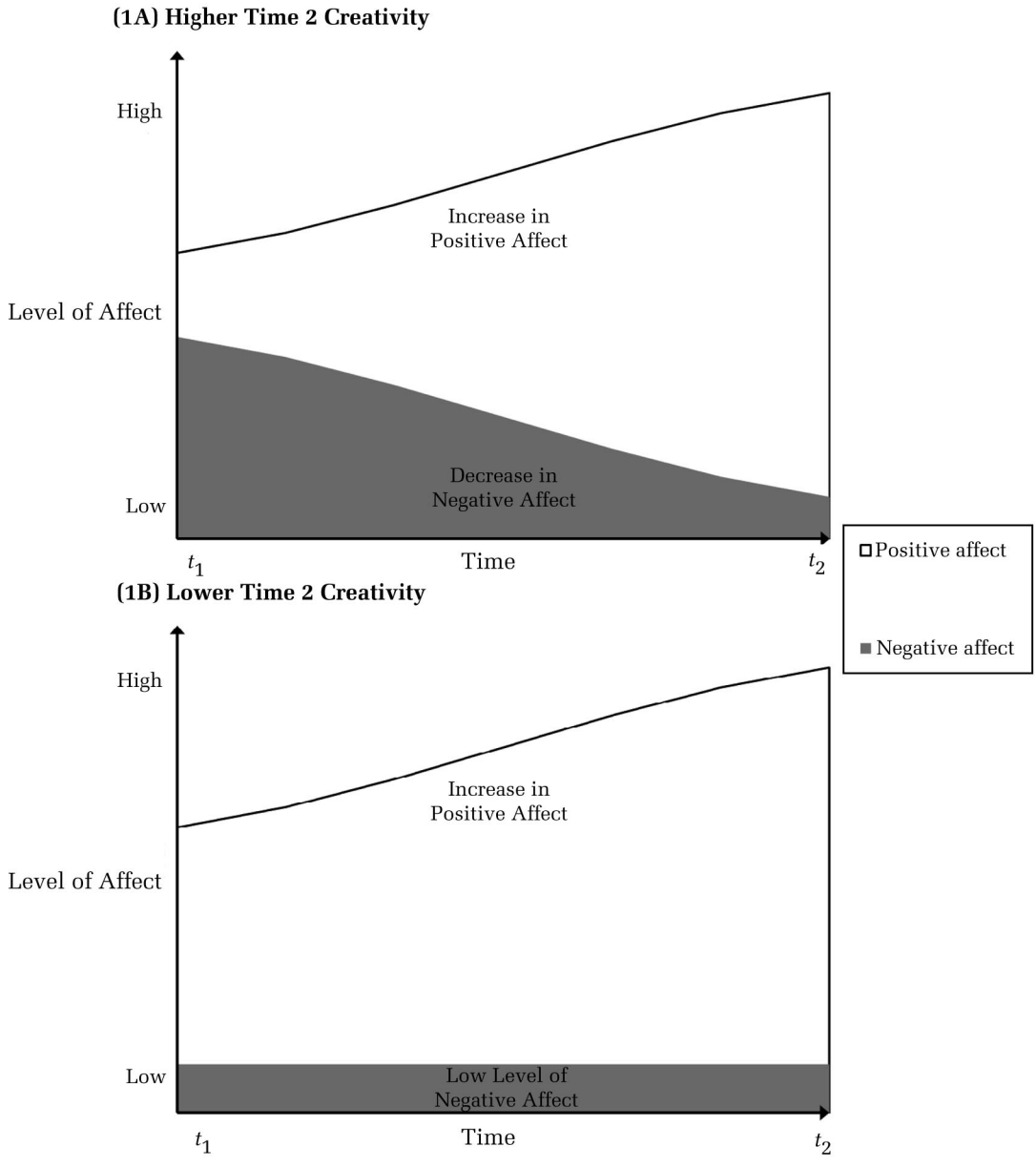
Negative affect regulates whether attention is narrow and focused on isolated elements (high negative affect) or broad and inclusive of the context (low negative affect) (Baumann & Kuhl, 2002). If negative affect is high, situations or events that threaten a person's goals are examined in detail, and incongruent information is processed in a sequential-analytic manner (Bless, Clore, Schwarz, Golisano, Rabe, & Wölk, 1996). If negative affect decreases, information processing moves away from isolated elements and becomes more inclusive of the larger context (Förster & Higgins, 2005). Associative networks of memory are activated, which form the basis of a person's integrated representation of the self and the environment (Koole & Jostmann, 2004). These networks provide the person with an overview of internal states, autobiographical experiences, and action opportunities and form the basis for complex cognitive operations such as creativity (Bolte, Goschke, & Kuhl, 2003). When negative affect decreases, information that was processed during the preceding episode of negative affect can be integrated into the person's associative memory networks.

Two general implications for creativity follow from this theory. First, both positive and negative affect play important roles, as they are associated with distinct cognitive functions that can contribute to creativity. This proposition converges with George and Zhou's (2002, 2007) dual-tuning model and De Dreu, Baas, and Nijstad's (2008) dual pathway to creativity model. Both models suggest that positive and negative affect can lead to creativity. More specifically, George and Zhou's (2007) dual-tuning model also suggests that both positive and negative affect are to some extent necessary for creativity due to their distinct "tuning" effects on

cognition. The limitation of the dual-tuning model is, however, that it does not explicitly address the dynamics of positive and negative affect.

The necessity of taking the dynamics of affect into account is the second implication that follows from PSI theory for creativity. According to the theory, the dynamics of affect enable the integration of cognitive functions that are necessary for creativity. This is a novel idea that has not yet been systematically developed and tested. In the following, we develop this idea in two steps. We first posit that the sequence of negative affect followed by positive affect is linked to creativity. Second, we argue that this sequence is achieved through a change process that involves both dimensions of affect and that change in affect plays a distinct role in the creative process. Figure 1 illustrates the core idea of this article. The dynamic trajectories of positive affect and negative affect displayed in Figure 1A should lead to higher creativity as compared to the situation displayed in Figure 1B, in which negative affect is at a constant, low level.

FIGURE 1
Consequence of Variation in Affective Processes for Creativitiy



Affect and Creativity

An extensive body of research has shown that the presence of positive affect increases the likelihood that new and useful ideas will be developed (Baas et al., 2008; Binnewies & Wörnlein, 2011). Positive affect leads to higher creativity because it activates cognition and increases cognitive flexibility (De Dreu et al., 2008; Fredrickson, 2001). Amabile, Barsade, Mueller, and Staw's (2005) in-depth field study, for example, examined the creative performances of members of project teams on a daily basis over the course of several months. The authors found support for a linear relation between positive affect and creativity: The more positive events participants experienced and the higher their level of positive affect, the better was their creative performance.

On the basis of PSI theory, we argue that the positive relation between positive affect and creativity is stronger when positive affect is preceded by an episode of negative affect. Negative affect can lay the foundation for creativity so that negative affect at time 1 (t_1) moderates the relation between positive affect and creativity at time 2 (t_2). Empirical evidence from different sources supports the assumption that negative affect can contribute to creativity. In experimental studies, De Dreu et al. (2008) found that the induction of negative affect increased the number of new ideas participants generated, because participants showed higher persistence at the task. Indirect evidence that negative affect may play an important role in creativity is provided by studies on characteristics of highly creative people. Bipolar disorder and depression appear to occur more frequently among highly creative people and their relatives as compared to the general population (Feist, 1999; Jamison, 1995; Ludwig, 1992). George and Zhou (2007) provided evidence that negative affect can contribute to creativity in work settings. They found that the level of negative affect employees experienced was positively related to supervisor ratings of creativity if the level of positive affect was also high and if the context was supportive.

Despite these findings, most studies report either a negative or no relation between negative affect and creativity (Baas et al., 2008). We argue that time needs to be taken into account to resolve inconsistent findings. At any given moment, the narrow attentional focus associated with negative affect hinders rather than facilitates creativity (Baumann & Kuhl, 2002); however, negative affect contributes to creativity through a lagged process that depends on the subsequent presence of positive affect. Negative affect draws attention to problems and signals that effort needs to be invested to solve a problematic situation (Foo, Uy & Baron, 2009; George & Zhou, 2002; Martin, Ward, Achee, & Wyer, 1993). According to PSI theory, an episode of negative affect is associated with a bottom-up mode of cognitive processing that focuses on incongruent and unexpected information (Kuhl, 2000); thereby, a detailed and objective understanding of a situation can be developed (Bless et al., 1996; Gasper, 2003; Spering, Wagener, & Funke, 2005). The detection of problems during a phase of negative affect can also elicit incubation processes that result in new ideas at a later point in time (Sio & Ormerod, 2009). During a subsequent episode of positive affect, cognitive flexibility and activation increase, and knowledge is processed in a top-down manner (Baumann & Kuhl, 2005; Derryberry & Tucker, 1994). The presence of positive affect enables creativity, and new ideas likely emerge during an episode of positive affect. Yet, without a preceding phase of negative affect to lay the foundation for new ideas, positive affect should be less strongly related to creativity. Thus, we propose:

Hypothesis 1. Negative affect at time 1 moderates the relation between positive affect at time 2 and creativity such that the relation is more positive if negative affect at time 2 is high.

Affective Shift and Creativity

We next posit that a dynamic process that involves change in affect between t_1 and t_2 underlies the outlined sequence of affective states and is linked to the emergence of new ideas. We refer to this process as an affective shift. An affective shift involves an increase in positive affect and a decrease in negative affect from t_1 to t_2 (see Figure 1A). An increase in positive affect from t_1 to t_2 is an important component of an affective shift, because positive affect at t_1 will often not be at a high level due to the presence of negative affect (Schmukle et al., 2002). By means of an increase in positive affect after an episode of negative affect, a person reaches a state of high positive affect that enables the flexible mode of thinking that can lead to creativity. Note, however, that this does not imply that positive affect needs to be low at t_1. In fact, creativity should be facilitated if positive affect already cooccurs with negative affect at t_1 and then further

increases. The creativity enhancing effect of positive affect unfolds over time and is more pronounced for longer-lasting than for short-lived episodes of positive affect (Amabile et al., 2005).

An increase in positive affect should be more strongly related to creativity if it is accompanied by a decrease in negative affect. Although negative affect can lay the foundation for creativity at a later point in time, at any given moment, the presence of negative affect impedes rather than enables creativity (Baumann & Kuhl, 2002). Negative affect leads to a tightening of cognitive processes on isolated details and to a slow and sequential mode of cognitive processing (Derryberry & Tucker, 1994). The emergence of new associations among remotely connected concepts is therefore unlikely as long as negative affect is high. According to PSI theory, negative affect impedes accessibility of associative networks of memory, which provide the foundation for complex intuitive operations. For instance, Baumann and Kuhl (2002) presented participants with coherent word triplets of the remote association test (e.g., "green," "pass," and "goat"). These word triplets are connected by a common concept (i.e., "mountain"). In the absence of negative affect, participants implicitly realized that there was a connection between such coherent word triplets as compared to random word triplets, even if they could not name the common concept. In the presence of negative affective stimuli, participants were not able to see the connection. Negative affect thus initially inhibits remote associations, which are an important component of creativity (Mednick, 1962).

If negative affect decreases, the focus of cognitive processing expands, which enables associations among remotely connected concepts (Baumann & Kuhl, 2002). PSI theory suggests that the process of a decrease in negative affect has a critical function for creativity. Activation of a person's associative networks of memory is strongest after a decrease in negative affect; that is, activation is stronger if negative affect is first experienced and then downregulated, as compared to a situation in which no negative affect was present (Kuhl, 2001). Due to the activation of associative networks of memory, a decrease in negative affect should broadly facilitate new associations, so that new ideas can be developed that are not constrained by the cognitive content a person has focused on before the decrease in negative affect. The adaptive value of new associations should be, however, particularly pronounced if they relate to the incongruent information that was previously processed. By means of an affective shift, new associations can be formed that integrate incongruent information that was processed during a phase of negative affect with available knowledge that is represented in extended memory networks. For example, a person who fails on an important task will experience negative affect and reflect on the event such that an objective and detailed understanding is developed. After a decrease in negative affect, the ability to form new associations is broadly augmented. If the cognitive representation of the preceding failure experience is still accessible, new associations may be formed that relate to and integrate the failure experience. For instance, knowledge regarding how success was achieved on other tasks may be associated with the failure experience, and the person can generate a new strategy for handling the task.

High creativity should thus result if an increase in positive affect is accompanied by a decrease in negative affect. An increase of positive affect leads to higher cognitive activation and flexible top-down processing of existing knowledge (Baumann & Kuhl, 2005; Derryberry & Tucker, 1994). A decrease of negative affect activates associative networks of memory and enables the integration of information that was processed in a bottom-up manner during an episode of negative affect (Baumann & Kuhl, 2002). Change in negative affect should therefore moderate the relation between change in positive affect and creativity. Thus, we propose:

Hypothesis 2. Change in negative affect from time 1 to time 2 moderates the relation between change in positive affect from time 1 to time 2 and creativity, such that an increase in positive affect is more strongly related to creativity if there is a decrease in negative affect.

We conducted two studies on the dynamic interplay of positive with negative affect and its relation with creativity. In Study 1, we used experience-sampling methodology and tested the hypotheses in a field study. The relations between affect and changes in affect within the time frame of one workday were related to creativity during the day. In Study 2, we applied an experimental design and examined the causal effect of a short-term affective shift on creativity.

STUDY 1

Methods

Participants and procedure. We recruited a heterogeneous sample of full-time employees in pro-

fessional jobs to allow for generalization across jobs and industries. One of the primary concerns of experience-sampling studies is that participants commit themselves to answer surveys repeatedly. To obtain a heterogeneous sample and to ensure participants' commitment, we used personal contacts and directly contacted potential participants to volunteer for the study. Working with a group of students, we developed a list of people who held professional jobs that demanded creativity. We contacted each potential participant individually and inquired about her or his willingness to support a scientific study on work behavior. As an incentive, participants were offered feedback on the results of the study. In the course of describing the research design, we asked participants whether their jobs called for the development of new and useful ideas. All participants indicated that this was the case.

We contacted 140 people in this way; 116 agreed to participate in the study. As our main focus was on within-person variability in creativity, it was important that participants had completed the daily questionnaire for at least three out of five days. One hundred two participants met this criterion and were included in the final sample (final response rate: 73%). The 14 participants whom we dropped from the final sample because they had not provided answers for at least three days did not differ significantly in demographic characteristics or on the variables used in the study. Participants' ages ranged from 20 to 57, with an average age of 34 years. Forty-two percent were women. Seventy-five percent of the participants held a university degree. The most frequent professional backgrounds were business (34%), psychology (18%), engineering (15%), IT-engineering (8%), and teaching (6%). Participants worked for private as well as public organizations. Twenty-seven percent worked in small companies with fewer than 50 employees, 24 percent in companies with fewer than 500 employees, and 44 percent in organizations with more than 500 employees. Their average tenure was 6.3 years.

Data collection was divided into two parts: First, participants filled out a questionnaire to measure personal characteristics and demographic control variables. Second, in the following week, participants filled out a short online survey each morning and at the end of each workday to measure positive and negative affect and creativity. Each morning, participants received an e-mail link to the online questionnaire and were asked to respond to the questionnaire after arriving at their office and before they started work. One hour before the scheduled end of their workday, which participants had communicated to us before, they received a second e-mail link. Participants were asked to respond to the questionnaire after finishing work and before leaving the office. On average, participants completed both the morning and evening questionnaires on 4.6 days, leading to a total sample of 475 pairs of morning and evening observations for 102 participants.

Control variables. We included age, gender, tenure, highest educational level, and organizational size as demographic control variables. To examine validity of the daily measure of creativity, we included a ten-item measure of the Big Five Inventory of personality (BFI-10) (Rammstedt & John, 2007). This inventory measures each personality dimension with two items, and has been found to be both reliable and valid. Rammstedt and John (2007) reported the following average coefficients for the five scales: part-whole correlation, .83; test-retest reliability, .75; self-peer convergent validity correlation, .44.

Creativity. At the end of each workday, participants reported the level of creativity for that day. We used five items by Tierney, Farmer, and Graen (1999); these were adapted to the level of the workday by Ohly and Fritz (2010). Example items are "Today, I generated novel, but operable work-related ideas" and "Today, I served as a good role model for creativity." Cronbach's alpha for the five-item creativity scale for the 475 days for which participants provided creativity ratings was .84.

Positive and negative affect. Positive and negative affect were measured as psychological states with the PANAS inventory each morning and at the end of each workday (Watson, Clark, & Tellegen, 1988). We refer to the morning measurement of affect as t_1 and to the measurement of affect at the end of the workday as t_2. We measured positive affect by six items: excited, interested, strong, active, inspired, and alert. We measured negative affect by seven items: scared, guilty, distressed, afraid, nervous, hostile, upset, and angry. In the morning survey, the instructions were "Please indicate how you feel this morning," and participants were asked to report their affective state for each adjective on a five-point scale (1 = "not at all," 5 = "extremely"). Cronbach's alphas were calculated across the 475 morning observations; values were .87 for the positive affect scale and .83 for the negative affect scale. At the end of the workday,

participants reported their affective state using the same positive and negative affect adjectives (Cronbach's alphas of .86 and .82, respectively). Participants were instructed to indicate how they felt, on average, during that workday, and to refer to the time period since they had responded to the morning survey.

Analyses. For all analyses, we used random coefficient modeling to predict creativity by the day-specific variables. Repeated measures data from the daily surveys were nested within persons. This nesting led to a two-level model, with positive and negative affect at t_1 (morning measurement) and t_2 (end of workday measurement) as predictors on the day level (n = 475 observations) and personality as well as demographic controls as predictors on the person level (n = 102 participants). Predictors on the day level were centered around the mean of each person. This method of centering ensured that relations on the day level were unconfounded by person-level variance (Hofmann & Gavin, 1998).

Results

Table 1 presents means, standard deviations, variance proportions, and intercorrelations of the main variables. Correlations above the diagonal are day-level correlations. Correlations below the diagonal are person-level correlations. Variance proportions indicate the proportion of day-level and person-level variance in the daily measures. For the dependent variable creativity, 55 percent of the variance was on the level of days and 45 percent was on the level of persons. If creativity was regressed on the person-level variables (i.e., age, gender, tenure, highest educational level, organizational size, five factors of personality), only extraversion (γ = .17, p = .02) and openness to experience (γ = .15, p = .04) significantly predicted between-person variance in creativity. These relations are in line with past research on creativity and personality and provide support for the construct validity of the daily measure of creativity (Feist, 1999). As person-level variables do not provide potential alternative explanations for the hypothesized relationships, we did not include them in the hierarchical linear models presented in Table 2 (Becker, 2005). Person-level variables can only account for between-person variance in creativity, whereas the hypothesized relationships refer to within-person variance in creativity, that is, fluctuations in creativity between days independent of between-person differences. Between-person variance in the independent variables was removed through person-mean centering (Enders & Tofighi, 2007). Inclusion of person-level control variables should therefore leave results unaffected. To test this assumption, all analyses that are presented below were rerun with control variables. As expected, inclusion of person-level control variables did not change results.

Test of hypotheses. Results are displayed in Table 2. Hypothesis 1 proposed that negative affect at t_1 moderates the relation between positive affect at t_2 and creativity. In support of the hypothesis, the interaction term between negative affect (t_1) and positive affect (t_2) in model 2 was significant and explained variance in addition to the positive main effect of positive affect (γ = .44, p = .02, ΔR^2 = 1%). The moderating effect of negative affect is displayed in Figure 2a. The relation between positive affect (t_2) and creativity was more positive if negative affect (t_1) was high rather than low. Thus, in line with expectations, the sequence of negative affect in the morning of a workday followed by positive affect during the day was related to creativity.

We performed additional analyses to rule out the alternative explanation that the findings for Hypothesis 1 reflect a mere contrast effect on perception. That is, there may be a bias to perceive a workday in a more positive light if negative affect was high in the morning (t_1) and positive affect was high during the day (t_2). In the case of a contrast effect, participants would not be more creative but would only perceive themselves as more creative. Such a contrast effect should not be creativity-specific but also influence evaluations of other aspects of a workday. To rule out this possibility, we included a four-item measure on perceived strain in the survey at the end of each day as a nonequivalent dependent variable (Cohen & Williamson, 1988). Positive affect at t_2 was negatively related to perceived strain. However, negative affect at t_1 did not moderate the relationship between positive affect at t_2 and perceived strain. This result speaks against a contrast effect as the moderating effect of negative affect at t_1 was creativity-specific.

Hypothesis 2 addressed the relation between change in affect from t_1 to t_2 with creativity. To examine the relation between change in affect during a day and creativity, three different methods were used: raw score change, residual change, and higher-order interactions. By using multiple methods to examine change, limitations of each method can be addressed and the robustness of results can

TABLE 1
Means, Standard Deviations, Variance Proportions, and Correlations[a]

Variable[b]	Mean	s.d.	Total Variance on the Day Level	Total Variance on the Person Level	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Day-level variables																		
1. Creativity	2.26	0.84	55	45		.11*	−.02	.17**	−.04									
2. Positive affect at t_1	3.11	0.71	62	38	.33**		−.15**	.32**	−.05									
3. Negative affect at t_1	1.26	0.42	67	33	.00	−.14		−.10*	.23**									
4. Positive affect at t_2	3.19	0.68	61	39	.30**	.74**	−.15		−.26**									
5. Negative affect at t_2	1.38	0.48	70	30	.11	−.05	.69**	−.17										
Person-level variables																		
6. Age	34	9.52	—	—	.18	.10	−.11	.19	−.16									
7. Gender[b]	1.60	0.50	—	—	.16	.06	−.02	.06	−.13	.32**								
8. Tenure (years)	6.32	7.39	—	—	.06	−.08	−.03	−.09	−.11	.67**	.24*							
9. Educational level[b]	4.65	0.75	—	—	.10	.04	−.10	.05	.05	−.04	−.13	−.26**						
10. Organizational size[b]	2.19	0.35	—	—	.02	−.01	.29**	−.03	.25*	.01	.01	−.11	.14					
11. Conscientiousness	3.58	0.62	—	—	.16	.26**	−.17	.33	−.06	.13	−.13	.15	.00	−.06				
12. Extraversion	3.41	0.86	—	—	.26**	.12	.06	.12	.18	−.16	−.03	−.21*	.03	.15	.11			
13. Openness	3.48	0.85	—	—	.26**	.13	.06	.10	.05	.07	.07	−.05	−.11	−.06	.05	.20		
14. Neuroticism	2.62	0.70	—	—	−.01	−.27**	.27**	−.20*	.31**	−.04	−.13	.04	.15	.12	−.15	−.11	−.13	
15. Agreeableness	3.41	0.57	—	—	.16	.09	.10	.12	.06	.09	−.16	−.16	.20*	.12	−.04	.05	.10	.06

[a] Correlations below the diagonal represent the person level ($n = 102$). In order to calculate person-level correlations for variables that were measured on the day level, values were aggregated across days. Correlations above the diagonal represent the day level ($n = 475$). In order to obtain standardized estimates for day-level correlations, we standardized all variables prior to calculating the coefficients with HLM. We show the total variance of each variable that resides on the day level and on the person level, respectively; both are proportions expressed as percentages.

[b] Coding of control variables: gender was coded as 1 for female and 2 for male participants; educational level was coded from 1 for no degree to 6 for Ph.D. degree; organizational size was coded 1 for less than 50 employees, 2 for 50–500 employees, and 3 for more than 500 employees.

* $p \leq .05$

** $p \leq .01$

Two-tailed test.

TABLE 2
Hierarchical Linear Models with Creativity as the Dependent Variable[a]

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Intercept	2.26** (0.06)	2.27** (0.06)	2.25 (0.06)	2.26** (0.06)	2.25 (0.06)
Positive affect at t_1				0.11† (0.06)	0.11† (0.06)
Negative affect at t_1	−0.01 (0.09)	0.03 (0.09)		0.01 (0.09)	0.08 (0.09)
Positive affect at t_2	0.29** (0.06)	0.29** (0.06)		0.26** (0.06)	0.25** (0.06)
Negative affect at t_2				0.00 (0.08)	−0.09 (0.09)
Negative affect at t_1 × positive affect at t_2		0.44* (0.18)			0.39* (0.18)
Positive affect × negative affect (residual change)					−0.36* (0.16)
Positive affect ($t_2 - t_1$)			0.07 (0.05)		
Negative affect ($t_2 - t_1$)			−0.07 (0.07)		
Positive affect ($t_2 - t_1$) × negative affect ($t_2 - t_1$)			−0.30** (0.09)		
Pseudo-R^2	.06	.07	.03	.06	.08

[a] Creativity is the dependent variable. The values are unstandardized parameter estimates for regression weights (γ). Standard errors are indicated in parentheses. $n = 475$ observations nested within 102 individuals. R^2 is the within-person variance explained in creativity by the variables in the model.

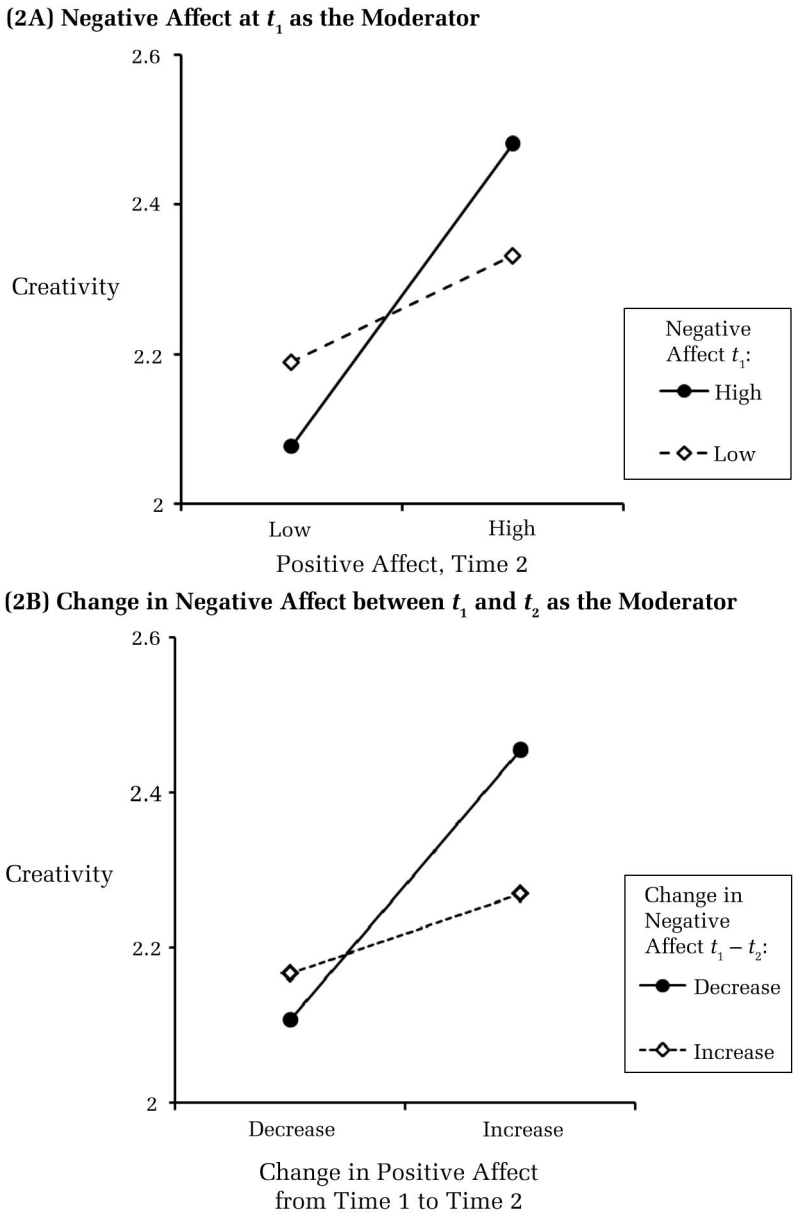
† $p < .10$
* $p < .05$
** $p < .01$
Two-tailed test.

be examined (Campbell & Kenny, 1999). The measure of raw score change in negative affect was obtained by subtracting t_1 negative affect from t_2 negative affect. The measure thus reflects how many scale points negative affect had increased or decreased between t_1 and t_2 on the five-point Likert scale. To compute the raw score change in positive affect, t_1 positive affect was subtracted from t_2 positive affect. To test Hypothesis 2, the interaction between the two change scores was computed and entered in a regression with creativity as the dependent variable. In support of the hypothesis, change in negative affect moderated the relation between change in positive affect and creativity (model 3: $\gamma = -.30$, $p < .01$, $\Delta R^2 = 3\%$). An increase in positive affect was positively related to creativity if there was a decrease in negative affect. Note that the main effect of change in positive affect was not significant; the underlying reason is that raw score change confounds the starting values at t_1 and degree of change. Given equal variances at the two measurement points, change scores are necessarily negatively correlated with starting values (Campbell & Kenny, 1999). In this study, the correlation (r) between positive affect at t_1 and change in positive affect was $-.61$ ($p < .01$); the correlation between negative affect at t_1 and change in negative affect was $-.55$ ($p < .01$). According to raw score change, a strong increase in positive affect between t_1 and t_2 thus implies low positive affect at t_1. Hypothesis 2, however, does not suggest that low positive affect at t_1 should be beneficial for creativity. The residual change method addresses this limitation of raw score change by essentially simulating that all t_1 values were the same (Rogosa, Brandt, & Zimowski, 1982).[1]

Results in models 4 and 5 reflect residual change in affect from t_1 to t_2 because positive and negative affect at t_1 are controlled for. Residual change refers to the deviation of actual t_2 values from those that would be expected based on t_1 values. The coefficients for t_2 positive and negative affect estimate the relation between residual changes in affect from t_1 to t_2 with creativity. In model 4, change in positive affect was positively related to creativity; change in negative affect was unrelated to creativity. The interaction between residual change in positive and negative affect was used to test Hy-

[1] As a consequence of statistically equating t_1 values, residual change departs from raw score and common sense conceptualizations of change. Due to regression toward the mean, the predicted values at t_2 are always less extreme than those at t_1. As a consequence, a situation in which raw score values are identical at t_1 and t_2 qualifies as change. For instance, for a person who scores 1 s.d. above the mean on positive affect at t_1 and t_2, there will be an increase in positive affect because the t_2 value is higher than what would be expected based on the t_1 value. For a detailed discussion, please refer to Campbell and Kenny (1999).

FIGURE 2
Negative Affect as a Moderator of the Relation between Positive Affect and Creativity



pothesis 2.[2] In support of Hypothesis 2, the interaction term in model 5 was significant ($\gamma = -.36$, $p = .03$, $\Delta R^2 = 1\%$). As displayed in Figure 2b, the relation between residual change in positive affect and creativity was more positive if there was a decrease rather than an increase in negative affect from t_1 to t_2. In contrast to raw score change, for residual change, an increase in positive affect from t_1 to t_2 does not imply low positive affect at t_1. In fact, t_1 positive affect was (marginally) significantly related to creativity even after controlling for t_2 positive affect. Days with high levels of creativity

[2] To obtain the interaction term, residual values were first computed separately for positive affect and negative affect and then multiplied. Residual values were obtained by regressing t_2 positive affect on t_1 positive affect and t_2 negative affect on t_1 negative affect in two separate regressions and by saving the residual values as variables.

were thus characterized by high rather than low positive affect in the morning and a further increase in positive affect during the day.

The third method for examining change in affect and creativity involved higher order interactions. This is the methodologically optimal approach and allows for a simultaneous test of Hypotheses 1 and 2 (cf. Edwards & Parry, 1993).[3] As this method leads to equivalent results, and as a detailed illustration introduces additional complexity, we only briefly summarize the method and its results. We regressed creativity on positive and negative affect at t_1 and t_2. In addition, we entered the six possible two-way interaction terms, the four possible three-way interaction terms, and the one possible four-way interaction term. The four-way interaction was significant ($p = .03$). Graphical inspection of the four-way interaction showed that the relation between positive affect at t_2 and creativity was more positive if negative affect at t_1 was high rather than low. Second, the relation between positive affect at t_2 and creativity was more positive if negative affect at t_2 was low. Third, results showed that there was a higher level of creativity if positive affect at t_1 was high rather than low. All three methods to examine change in affect thus supported Hypothesis 2.

Discussion

Study 1 provided evidence that a dynamic interplay of positive and negative affect was related to creativity: Workdays on which participants showed their highest levels of creativity were characterized by the presence of positive and negative affect in the morning and a subsequent increase in positive affect and a decrease in negative affect. Two main limitations of Study 1 need to be pointed out. First, plausible alternative causal explanations cannot be ruled out. As positive affect at t_2 and creativity were concurrently measured, an increase in positive affect and a decrease in negative affect may have been the consequence rather than the cause of creativity (Klimoski & Mohammed, 1994). Second, only overall change in affect during a workday and the relation with overall creativity were studied. During a day, however, there are many short-term changes in affect and varying levels of creativity. Whether or not short-term changes in affect are linked to the emergence of specific ideas could not be examined in Study 1.

STUDY 2

In order to address the limitations of Study 1, we conducted an experimental study in a controlled laboratory setting. We induced an affective shift and examined its impact on creativity compared to a condition in which only positive affect was induced. An affective shift concerned short-term change in affect in the time frame of several minutes. The experiment tested the assumption that an affective shift leads to higher creativity because of its content-independent effect on cognitive functioning. According to PSI theory, down-regulation of negative affect activates associative networks of memory that form the basis for new associations (Kuhl, 2001). Due to this activation, participants should show higher creativity on a task even if they have not processed information relevant to that task during a preceding phase of negative affect.

Methods

Design and participants. Eighty master's students of psychology (75% women) participated in the experiment for a compensation of 5€ each. Participants were randomly assigned to one of two conditions. In the control condition, participants worked on an affectively neutral task followed by the induction of positive affect. In the affective shift condition, negative affect was induced first and positive affect subsequently. Participants' creativity was then assessed via a brainstorming task.

Procedure and manipulation. We adapted an experimental paradigm and procedures to manipulate affect and to measure creativity from DeDreu et al. (2008). The experiment was administered in group sessions with ten participants. In each group, individual participants were randomly assigned to the experimental or the control condition. Participants were asked to participate in three independent, eight-minute, paper-and-pencil tasks. They were told that the first two tasks concerned autobiographical memory and that the third task concerned brainstorming. The experimenter controlled the timing and told participants when to proceed to the next task. In the affective shift condition, participants were first asked to write a short essay (one page maximum) about a situation that made them feel afraid, distressed, or nervous. They were asked to remember the situation as vividly and in as

[3] We would like to thank an anonymous reviewer for pointing this out.

much detail as possible and to underline the parts of their text that described what caused their feelings. In the control condition, participants were asked to write down in detail all activities they had carried out the previous day. This task is used to induce a neutral affective state that can be compared to an experimentally manipulated affective state (Fong, 2006). Once they had finished the first task, participants rated how negative and how positive they felt on two five-point rating scales. These ratings were used as manipulation checks. The next task was the same for both experimental conditions: All participants were asked to write a short essay (one page maximum) about a situation that made them feel happy, inspired, or enthusiastic. Again, they were asked to remember the situation as vividly and in as much detail as possible and to underline the parts of their text that described what caused their feelings. After completion of the second task, participants again rated how negative and how positive they felt on two five-point rating scales.

Participants were then asked to proceed to a brainstorming task. They were informed that their university needs to constantly improve its quality of teaching and that the departmental teaching staff was interested in their ideas about ways in which teaching could be improved. Participants were asked to brainstorm and write down in bullet points as many ideas, solutions, or suggestions they could think of on how teaching could be improved. After eight minutes, participants were requested to stop writing down new ideas and to answer a short questionnaire. Afterward, participants were debriefed regarding the purpose of the study.

Dependent variables. Based on Guilford (1967), three facets of creativity were derived as dependent variables from participants' performance on the brainstorming task: originality, creative fluency, and cognitive flexibility. Two independent raters, who were blind to experimental conditions and study hypotheses, rated participants' responses regarding the three facets of creativity. To examine interrater reliability, Pearson's correlations and intraclass correlation coefficients (ICC[*C,k*]) were calculated. ICC[*C,k*] values indicate the reliability of the average between two raters (McGraw & Wong, 1996). We report this coefficient, as the average values between raters on the three facets of creativity were used to test hypotheses. For originality, the two raters assessed the originality of each participant's ideas on a scale from 1 ("not original at all") to 7 ("very original"). Interrater reliability was acceptable (r = .52, ICC[*C,k*] = .68). For creative fluency, the two raters counted the number of unique ideas each participant had generated (r = .99, ICC[*C,k*] = .99). Third, cognitive flexibility was measured by the number of content categories participants had used when generating ideas (r = .61, ICC[*C,k*] = .76). The raters assigned each unique idea to one of seven categories identified by DeDreu et al. (2008): university environment, student facilities, student quality, teaching materials, teachers, policy, and other issues. A higher number of categories used by a participant reflects greater cognitive flexibility. Participants were also asked to self-assess their creativity on the brainstorming task to examine convergence of rater evaluations and self-report. We adapted two items from the experience-sampling study to the present task ("I showed originality in my answers" and "I served as a good role model for creativity"). The multiple correlation (R) between participants' self-reported creativity and rater evaluations of the three aspects of creativity was .43 ($p < .01$).

Results

Manipulation check. We used a two (group: experimental, control) by two (time: time 1, time 2) mixed analysis of variance with time as a within-subjects factor to examine whether the experimental manipulation was successful. The dependent variables were positive and negative affect, which we measured at t_1 (after the first manipulation) and at t_2 (after the second manipulation). For the dependent variable negative affect, the group factor (F[1, 78] = 10.38, $p < .01$), the time factor (F[1, 78] = 33.94, $p < .01$), and their interaction were significant (F[1, 78] = 8,42 $p < .01$). Examination of simple main effects with adjustment for multiple comparisons showed that negative affect was significantly higher in the experimental group compared to the control group at t_1 after the negative affect manipulation (mean = 2.74 vs. mean = 2.00, s.e. = .19, $p < .01$). The induction of negative affect had thus been successful. After the induction of positive affect (t_2), there was no significant difference in negative affect between the experimental and control groups (mean = 1.95 vs. mean = 1.74, s.e. = .15, p = .16). Moreover, change in negative affect from t_1 to t_2 was significant only for the experimental group (mean = 2.74 vs. mean = 1.95, s.e. = .12, $p < .01$). The affect inductions thus produced the intended decrease in negative affect only for the experimental condition. For the depen-

dent variable positive affect, the group factor was nonsignificant ($F[1, 78] = 1.7$, $p < .19$), whereas the time factor ($F[1, 78] = 42.96$, $p < .01$) and the time by group factor ($F[1, 78] = 10.08$, $p < .01$) were significant. At t_1, positive affect was significantly lower in the experimental group compared to the control group (mean = 2.98 vs. mean = 3.47, s.e. = .20, $p = .02$). At t_2, there was no significant difference in positive affect between the experimental and control groups (mean = 3.81 vs. mean = 3.76, s.e. = .19, $p = .80$). For both groups, the increase in positive affect from t_1 to t_2 was significant. In sum, these results confirm that the manipulations had their intended effects. Only the experimental group reported an affective shift, that is, an episode of negative affect followed by a decrease in negative affect and an increase in positive affect. The control group showed only an increase in positive affect and no change in negative affect.

Group comparison. Table 3 shows the differences between the control group and the experimental group on the three dependent variables that reflect different aspects of creativity. For originality and cognitive flexibility, there was a significant difference between groups ($p = .02$). Participants in the affective shift condition showed higher originality and higher cognitive flexibility as compared to the positive affect condition. For creative fluency (that is, the number of ideas participants generated) there were no significant differences.

Discussion

Study 2 showed that an experimentally induced affective shift from negative to positive affect during a time interval of several minutes led to higher creativity than did a mere increase in positive affect. Interestingly, participants in the affective shift condition showed higher originality and higher flexibility, which are two aspects of idea quality. No differences were found for fluency of ideas, which refers to idea quantity. Although this finding was not expected, it is compatible with the outlined theoretical perspective. A decrease in negative affect should primarily activate remote associations and thereby increase originality and flexibility rather than idea quantity (Baumann & Kuhl, 2002).

In contrast to Study 1, the experimental design of Study 2 provided support for the causal claim that an affective shift leads to creativity. This finding does not, however, rule out the plausible proposition that a reverse causal effect also exists and that creativity has an influence on subsequent affect (Amabile et al., 2005). It is further noteworthy that the induction of negative affect at t_1 led not only to higher negative affect but also to lower positive affect, demonstrating that negative affect inhibits positive affect. A limitation of Study 2 is that time frames and other possible sequences of affective states were not systematically manipulated. Future research on the dynamics of affect may, for instance, examine the consequences for creativity if positive affect is followed by negative affect, or if positive affect or negative affect are sustained over a longer period.

GENERAL DISCUSSION

The goal of this article was to move toward a balanced and dynamic account of the roles that positive and negative affect play in the creative process. In contrast to past models of creativity, we proposed that a dynamic interplay of positive and negative affect leads to creativity. We tested this proposition in two studies. In Study 1, high creativity resulted if negative affect in the morning was followed by a decrease in negative affect and an increase in positive affect during the day. In Study 2, a short-term affective shift was experimentally induced. Participants in the affective shift condition showed higher originality and higher cognitive flexibility on a subsequent brainstorming task as compared to a positive affect condition. Positive consequences for creativity were thus observed for

TABLE 3
Between-Group Differences on Three Dimensions of Creativity

	Control Group		Affective Shift Condition		Group Comparison	
Creativity Dimension	**Mean**	**s.d.**	**Mean**	**s.d.**	***F*(1,78)**	***p***
Originality	3.53	0.98	4.12	1.13	6.22	.02
Cognitive flexibility	2.87	1.07	3.48	1.27	5.28	.02
Creative fluency	8.79	3.43	9.19	3.70	0.25	.62

an affective shift during the time frame of several minutes and during the time frame of one workday.

The functions of negative affect for creativity may have been previously overlooked because of the close link between positive affect and creativity, and because negative affect is often conceptualized as the opposite of positive affect (Amabile et al., 2005). The present studies shed light on how negative affect—in concert with positive affect—contributes to creativity. An episode of negative affect can lay the foundation for high creativity at a later point in time, and a decrease in negative affect serves a distinctive function. A dynamic perspective on the affect-creativity link thus suggests that the regulation of negative affect plays a key role for achieving high levels of creativity. On the one hand, people need to be capable of tolerating episodes of negative affect; on the other hand, the ability to down-regulate negative affect is critical (cf. Koole, Kuhl, Jostmann, & Vohs, 2005).

Limitations

A limitation of the two studies is that we did not measure the cognitive processes that link changes in affect to creativity. More specifically, we did not disentangle to what extent the information people processed during an episode of negative affect influenced subsequent creativity. We argued that negative affect can contribute to creativity because it focuses cognitive processing on discrepant information, so that a person develops a detailed and objective understanding of a situation. We further proposed that an affective shift activates associative networks of memory, so that new associations can be formed. In Study 1, creativity can have been affected by the information people processed during a phase of negative affect and by the activating effect of an affective shift on associative knowledge networks. The finding that negative affect at t_1 and a decrease in negative affect from t_1 to t_2 explained incremental variance in creativity supports the assumption that creativity was affected by both mediating processes. However, as we did not measure the information people processed and the content of creativity, the relative contribution of these mediating processes and their interplay could not be examined. Study 2 tested the hypothesis that an affective shift has an effect on creativity that is independent of the cognitive content people process during a preceding episode of negative affect. As participants were unaware of the content of the brainstorming task until after the affective shift, only the content-independent effect of an affective shift on cognitive functioning can have influenced creativity. We thus did not examine what role the task-related information people process during an episode of negative affect plays in the affective shift process and for subsequent creativity.

The interface between affect and cognition in the creative process therefore requires future research attention. In particular, research can examine how the overall influence of change in affect on cognitive functioning affects the processing of specific cognitive content, such as the identification and elaboration of work-related problems and the generation of creative solutions. For instance, change in affect may be involved if an incubation period enhances creativity. Unconscious cognitive processes may be elicited while negative affect is present and a person becomes aware of a problem. Unconscious processes during a subsequent phase of incubation, in which the focus of attention is distracted from the problem, can influence creativity (Dijksterhuis & Meurs, 2006; Zhong, Dijksterhuis, & Galinsky, 2008). Evidence regarding whether an incubation period actually contributes to creativity is, however, mixed (Sio & Ormerod, 2009). A critical contingency may be whether or not an incubation period is accompanied by a shift from negative to positive affect.

A potential methodological limitation concerns the use of self-report measures of affect and creativity in Study 1. Regarding creativity, we argue that self-report may be the most valid means of measurement for a person's creativity on a particular workday (cf. Kahneman, Krueger, Schkade, Schwarz, & Stone, 2004; Shalley, Gilson, & Blum, 2009). The development of new and useful ideas within the time frame of one day does not imply that people talk about these ideas or implement ideas right away. Creativity on any particular day is therefore not necessarily observed by others or reflected in objective outcomes. Moreover, evidence for the validity of the self-report measure was provided by the finding in Study 2 that self-reported creativity was correlated with the scores of two raters. A limitation of the self-report measurement of affect in Study 1 is that we examined only consciously accessible positive and negative affect. Affective processes that regulate cognitive functioning are, however, only partially consciously accessible (Barsade, Ramarajan, & Westen, 2009; Quirin, Kazén, & Kuhl, 2009), which suggests that we have captured only a fragment of the actual

affective processes, and that the overall influence of affect on creativity may be more pronounced.

Implications for Research and Practice

In line with George (2011), this article recommends a focus on the joint and interactive effects of positive and negative affect in future research on affect in organizations. Conceptualizing and measuring positive and negative affect as two poles of one dimension, by contrast, hinders an understanding of their distinct functions. Moreover, a focus on the dynamics of affect and the mechanism responsible for these dynamics may lead to new insights and to reinterpretations of findings in creativity research and other domains (e.g., Filipowicz, Barsade, & Melwani, 2011). For instance, in experimental studies that found increased creativity after inducing negative affect, causality was usually attributed to the affective state of a person (e.g., De Dreu et al., 2008). A dynamic perspective offers a different interpretation: It may not be negative affect per se that leads to increased creativity, but rather the self-regulatory mechanisms used to overcome negative affect, which are activated as a consequence of negative affect.

We would like to highlight avenues for future research that may further our understanding of the process that we call the affective shift. First, an affective shift can have consequences for variables other than creativity. For instance, Bledow, Schmitt, Frese, and Kuehnel (2011) found that software engineers showed high levels of work engagement if they experienced the sequence of negative events such as failures followed by positive mood. Future research may want to determine the common denominator of the consequence of an affective shift. A related research question concerns the extent to which variability in affect is adaptive. Our theoretical propositions imply that a certain amount of variability across the spectrum of affective experiences is adaptive in addition to a high baseline level of positive affect (Diener & Diener, 1996). However, there is a fine line between adaptive variability in affect and nonadaptive emotional instability (Kuppens, Van Mechelen, Nezlek, Dossche, & Timmermans, 2007).

A further research question concerns the time frames in which an affective shift occurs and whether it has similar consequences across different time frames. Our theoretical rationale suggests that an affective shift may have similar consequences across different time frames if the underlying psychological processes are the same. Potential time frames can span from milliseconds to years, and affective shifts in different time frames are interwoven. An artist, for instance, may reach a period of peak creativity after emerging from a long-lasting crisis (Jamison, 1995). During the period of peak creativity, there may be short-term affective shifts that influence creative performance on specific pieces of art.

The present research points to the importance of affect regulation as potential leverage for increasing creativity and innovation in organizations. People are usually unaware of how affect influences cognitive processing and creativity (Amabile et al., 2005). An awareness and understanding of the dual tuning of cognition through positive and negative affect may be a first step toward making better use of one's own creative potential and facilitating creativity in others (George, 2011). From our perspective, a one-sided focus on increasing positive affect to improve creativity is ill-advised. Creativity requires complexity in terms of affective and cognitive processes and an integration of this complexity (Bledow, Frese, Anderson, Erez, & Farr, 2009). Affect-regulation plays a key role in this integration and in maintaining an adaptive balance between positive and negative affect (Fredrickson & Losada, 2005).

Moreover, people may face different challenges for improving their creativity, depending on how they regulate affect, and we assume that different strategies are effective. For people who remain for a prolonged period in the mode of cognitive processing that is induced by negative affect, strategies that facilitate down-regulation of negative thoughts and feelings may prove beneficial—for instance, techniques of self-relaxation and seeking out a socially supportive work environment (e.g., Grossman, Niemann, Schmidt, & Walach, 2004). By contrast, the creativity of people who quickly down-regulate negative affect may benefit from an increased tolerance of negative thoughts and feelings, such that negative affect is not brushed aside too quickly. A deliberate focus on information that elicits negative affect may be effective, for instance, by questioning preferred alternatives or by reflecting on barriers that could hinder goal pursuit (e.g., Oettingen, Mayer, Thorpe, Janetzke, & Lorenz, 2005). A crucial point is that not all people will benefit from the same strategies.

We argue that a one-sided focus on positive affect is also insufficient for leaders who intend to increase employee creativity. Leaders will be more

effective if they understand and influence the dynamic interplay of positive and negative affect (Lord, Hannah, & Jennings, 2011). In some situations, leaders may be better advised to turn employees' attentions to problematic aspects of a situation and to induce negative affect. A prerequisite for the effectiveness of such a strategy is that employees have the ability to deal with negative affect. In situations in which negative affect is already present, helping employees to down-regulate negative affect and to increase positive affect should be a particularly effective strategy for increasing creativity (cf. House, Spangler, & Woycke, 1991).

To sum up, we return to the analogy of the phoenix. The symbolic meaning of the phoenix is not embedded in its static features, which are observable at any point in time, but in the process of decline and renewal that unfolds over time. In a comparable way, a focus on static variables such as psychological states or traits is insufficient for explaining and influencing creativity in organizations. We think a theoretically valid and practically useful account of creativity in organizations will benefit from a focus on the dynamic processes from which creativity arises.

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Ronald Bledow (ronald.bledow@ugent.be) is an assistant professor of work and organizational psychology at Ghent University. He obtained his Ph.D. in psychology from the University of Giessen. His research interests include creativity and innovation, self-regulation, leadership, and teams. A focus on dynamic processes and the attempt to connect phenomena at multiple levels of analysis are overarching themes of his research.

Kathrin Rosing (kathrin.rosing@uni.leuphana.de) is a postdoctoral research fellow of organizational psychology at the Leuphana University of Lueneburg. She received her Ph.D. in psychology from the Leuphana University of Lueneburg. Her research focuses on creativity and innovation, leadership, and aging in the work context.

Michael Frese (michfrese@gmail.com) has a joint appointment at NUS Business School and at University of Lueneburg. He received his Ph.D. from the Technical University of Berlin. His research includes the psychology of entrepreneurship; factors that influence innovation and creativity in people, teams, and organizations; active performance concepts, such as personal initiative, training (e.g., for entrepreneurship in developing countries); and learning from errors and experience. Guiding concepts are evidence-based management and action regulation theory.