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### The psychology of creativity : moods, minds, and motives

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### Simmering Blues and Depleting Displeasure: How Sadness and Anger Influence Creativity

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Anecdotes and introspective reports from eminent scientists and artists aside, a systematic test of the putative creativity-enhancing effect of anger is still missing. This article fills this void with four experiments examining creativity as a function of anger (vs. sad or mood-neutral controls). Combining insights from the literatures on creativity and on mood and information processing the authors predicted that anger (vs. sadness and mood-neutral control) triggers a less systematic and structured approach to the creativity task, and leads to initially higher levels of creativity (as manifested in original ideation, creative insights, and remote associations). Following work on resource depletion, the authors further predicted that anger more than sadness depletes energy and that, therefore, creative performance should decline over time more for angry than for sad people. Results supported predictions. Implications for creativity, information processing, and resource depletion are discussed.

This chapter is based on Baas, M., De Dreu, C. K. W., & Nijstad, B. A. (2009a). Simmering blues and depleting displeasure: How sadness and anger influence creativity. *Manuscript under review*.

Our capacity for creativity allows us to fly to the moon, to communicate through cellular phones, and to admire great art. Creativity is broadly defined as the production of original and appropriate ideas, products, insights, and problem solutions (e.g., Amabile, 1983), and in the past few decades, we have witnessed a viable stream of research into the psychological principles and processes underlying creativity (e.g., Runco, 2004). This notwithstanding, some puzzles remain, one of them being the role of negative affect, feelings, and emotions during the creative process (e.g., Akinola & Mendes, 2008; Ashby et al., 1999; Baas et al., 2008). Although the effects of negative mood states are not well understood, anecdotal evidence suggests that negative moods, such as anger and frustration, might sometimes enhance creativity. For example, some of the great scientists and artists that were considered geniuses were known for their bad temper (Eysenck, 1993). More than a handful of the creative people interviewed by Csikszentmihalyi (1996) felt their creative production could be traced back to quite upsetting, traumatic experiences. Additionally, some of the most creative scientific discoveries have been attributed to the conflict between competing laboratories, with their respective academic directors being driven by distrust, anger and frustration (White, 2001; see also De Dreu & Nijstad, 2008). For example, Nobel Prize laureate Max Perutz commented on his experiment that proved the structure of the alpha-helix: “The idea was sparked off by my fury over having missed that beautiful structure myself.” (Ferry, 2007, p. 148).

These anecdotes and introspective reports seem to provide some evidence for the idea that anger sharpens the wits and stimulates creative performance. There indeed is some experimental support for this idea. De Dreu and colleagues (2008) showed that compared to happiness, angry people tend to be as creative, and both happy and angry people tend to be more creative than mood-neutral controls (see also Russ & Kaugars, 2001).<sup>9</sup> However, as we will elaborate upon below, this evidence tends to raise more questions than it answers. For example, it leaves unclear what the underlying processes are—why do angry moods produce more creativity than mood-neutral controls and perhaps other negative mood states such as sadness? Also, there is reason to suspect that the creativity-enhancing effects of anger may be of relatively short duration and quickly dissipate over time, but because past work always used creativity tasks of rather short duration this issue cannot be settled without new research.

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<sup>9</sup> A meta-analysis of the research on mood and creativity (Baas et al., 2008) revealed a tendency for researchers to focus on sadness ( $k = 55$ ) or on fear ( $k = 20$ ) but not on anger.

The current study was designed to address these and related issues. Our goal was to provide a more systematic analysis of the role of anger in the creative process and, second, to increase our understanding of the psychological processes involved in creative production among angry (versus sad and mood-neutral) people. We integrate the above referenced work on anger in creativity by De Dreu and colleagues (2008) with insights on affect-regulation (Lerner & Tiedens, 2006) suggesting that anger leads to less systematic idea generation than sadness. Furthermore, building on studies on resource depletion (Gailliot et al., 2007; Wickens, 1984), we argue that the greater activity and the unsystematic approach to creativity tasks among angry individuals may speed up resource depletion, thus leading them to become less creative as time continues; sad people (and mood neutral controls) expend less energy and should therefore be able to maintain a more stable level of creative performance. Specific hypotheses were tested in four experiments, two focusing on idea generation, and two focusing on creative insights.

### **The Creative Force of Anger**

According to the Dual Pathway to Creativity Model (DPCM; Baas et al., 2008; De Dreu et al., 2008), there are two psychologically quite distinct pathways to creative performance. Creative performance is a function of cognitive flexibility on the one hand and persistent probing and hard work on the other (see also Akinola & Mendes, 2008; Boden, 1998; Hirt et al., 2008; Mumford & Gustafson, 1988). According to the flexibility perspective, people must ‘break set’ (e.g., Duncker, 1945; S. M. Smith & Blankenship, 1991) and need flat associative hierarchies (e.g., Eysenck, 1993; Mednick, 1962) to arrive at uncommon associations and to generate many and original responses. The alternative pathway to creativity is to sit down and think long and deep about a topic. Indeed, solving problems often requires effortful and systematic exploration of possible solutions and in depth survey of only a few categories or perspectives (Rietzschel et al., 2007a, 2007b). Creativity requires effort and motivation (Amabile, 1983; Eisenberger & Rhoades, 2001; Hirt, Levine, McDonald, Melton, & Martin, 1997) and the best predictor of creative eminence is (quantitative) productivity (Simonton, 1997). In other words, to generate great ideas and insights, one needs to generate many, and this often boils down to hard work.

DPCM further proposes that creativity is enhanced by any trait or state that stimulates flexibility or persistence. Whether the flexibility and/or persistence pathway is engaged depends first and foremost on the extent to which the individual

is activated. In a first test of DPCM, De Dreu and colleagues (2008) compared, among other things, creative performance by angry, sad, and mood-neutral individuals. Based on the idea that anger mobilizes energy and activates the individual, whereas sadness deactivates and leads to disengagement (Carver, 2004; Depue & Iacono, 1989; Frijda, 1986; Izard & Ackerman, 2000; Klinger, 1975), the authors predicted more creativity among angry than sad or mood-neutral individuals. Results supported this prediction: Compared to mood-neutral controls and sad individuals, those feeling angry generated more ideas of greater originality, and more often correctly solved creative insight problems. Based on the idea that negative moods generally trigger systematic, constrained and analytical information processing (Ambady & Gray, 2002; Schwarz, 1990), De Dreu and colleagues explained these findings in terms of greater persistence and effort rather than greater cognitive flexibility—putatively, anger more than sadness triggers persistence and, therefore, leads to greater creativity.

In the present study, we expected to replicate this finding that anger, as an activating mood state, tends to enhance creativity more than sadness and mood-neutral control conditions. More importantly, however, we expand these initial insights by probing the role of possible information processing differences between angry and sad individuals and, second, possible differences in resource depletion and concomitant interactions between mood state and time-on-task.

### **Mood and Structured Information Processing**

There is a rich and longstanding research tradition linking mood states to bottom-up and systematic versus more top-down and loose information processing styles (e.g., Bless et al., 1996; Mackie & Worth, 1989; Schwarz, 1990). Although previous work suggests that negative moods generally lead to systematic and bottom-up information processing (e.g., Bless et al., 1996; Forgas, 1995; Schwarz, 1990), more recent work shows that the engagement of a particular processing mode depends on the specific negative mood that is activated (Tiedens & Linton, 2001). Specifically, sadness associates with greater accuracy in judgments (Alloy, Abramson, & Viscusi, 1981), reduced reliance on scripts in encoding atypical information (Bless et al., 1996), and leads to a spontaneous engagement in detail-oriented and analytical processing (e.g., Bless et al., 1996; Gasper, 2004a; Mackie & Worth, 1989). Compared to sadness, anger typically associates with greater reliance on the expertise of a source of a persuasive message (Bodenhausen et al., 1994; Tiedens & Linton, 2001), making inferences about others' motives based on

chronically accessible scripts (Tiedens, 2001), and angry people are relatively immune to processing constraints (Small & Lerner, 2008). In other words, sadness promotes systematic, detailed, and bottom-up information processing to a greater extent than anger (e.g., Bodenhausen et al., 1994; Lerner & Tiedens, 2006). Anger, on the other hand, results in greater reliance on general knowledge structures and top-down information processing (Small & Lerner, 2008; Tiedens, 2001).

The initial work on anger and creativity by De Dreu and colleagues (2008) inferred that anger promotes creativity because anger activates the individual to engage in persistent, effortful work. This notion contrasts with the studies on mood and information processing suggesting that, compared to sadness, anger promotes a *less* detailed and bottom-up processing style. In other words, there is reason to believe that the processes held responsible for the creativity-enhancing effects of anger were incorrectly inferred.

In ideation tasks, like the ones used in work on anger and creativity, the use of a less systematic and structured processing mode is reflected in less semantic clustering in idea production (Nijstad & Stroebe, 2006). That is, ideas and insights either belong to the same, or to different semantic categories (e.g., when generating ideas about possible uses for a brick, categories might be to build something, as a weapon, as an instrument; see Guilford, 1967). Successively generated ideas and insights often fall in the same semantic category (category repetitions) but switches among categories occur too (category changes). More semantic clustering occurs with many category repetitions rather than changes, and is indicative of a more systematic and organized approach to idea generation (see also Basden, Basden, Bryner, & Thomas, 1997; Nijstad, Stroebe, & Lodewijkx, 2003). Put differently, when people generate creative ideas, the use of a less systematic and structured approach manifests itself in less semantic clustering in creative production (Nijstad & Stroebe, 2006; Rietzschel et al., 2007a). Based on the above works on information processing as a function of anger versus sadness, we predicted that angry individuals take a less systematic and structured approach to the creativity task than sad individuals. This is our first hypothesis.

### **Creativity Taxes Resources**

Task performance requires energy or resources, such as glucose, and these resources are limited in their availability (e.g., Gailliot et al., 2007; Muraven & Baumeister, 2000). Performance suffers when resources are depleted (Wickens, 1984) and this happens especially when the task becomes more difficult (Wickens &

Kessel, 1980; Xie & Salvendy, 2000), or when the task requires self-control, such as the active overriding or inhibition of thoughts, urges, and impulses (Gailliot et al., 2007; Muraven & Baumeister, 2000). Creativity and problem solving tasks are arguably difficult and taxing tasks, and typically require participants to overcome habitual responses—being creative draws upon energy and resources. Indeed, creative performance typically declines over time from initially higher levels to lower levels in later phases (e.g., Diehl & Stroebe, 1991; Nijstad et al., 2003).

For two reasons it can be expected that individuals feeling angry deplete resources faster than those feeling sad and thus display a greater decline in creative performance. First, in several brainstorming studies, Nijstad et al. (2003) categorized ideas into semantic categories and showed that because switching between semantic categories requires active search, it is more effortful and taxes resources more than continuing idea generation within a particular semantic category (see also Coskun, Paulus, Brown, & Sherwood, 2000; Nijstad & Stroebe, 2006). Thus, the more systematic and structured approach adopted by sad people (i.e., staying in semantic categories longer) requires less energy than the less structured approach (i.e., more switching among categories) adopted by those feeling angry. Second, relative to deactivating states such as sadness, aroused states such as anger mobilize energy and draw more on cognitive as well as physical resources, such as glucose (Blake, Varnhagen, & Parent, 2001; Klinger, 1975). Accordingly, we predicted that angry individuals may be more creative in early phases of the creativity process, but because of resource depletion, creative performance declines over time more for angry than sad individuals.<sup>10</sup> This is our second hypothesis.

### **The Present Studies: Overview and Hypotheses**

To examine the effects of anger and sadness on creativity, we conducted two studies focusing on idea generation, and two studies focusing on creative insight. Because we were interested in the effects of specific moods rather than more general affect, anger and sadness (and a mood-neutral control in Study 3.2 and 3.3) were manipulated using self-generated imagery (De Dreu et al., 2008; DeSteno, Petty, Wegener, & Rucker, 2000; Gasper, 2004a; Strack et al., 1985). Participants

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<sup>10</sup> As mentioned, De Dreu et al. (2008) tested their predictions with creativity tasks of rather short duration (a seven minute brainstorming task, and a 10-item creative insight task). Depletion effects usually show up after longer time-on-task (Diehl & Stroebe, 1991; Nijstad, Stroebe, & Lodewijckx, 1999; Gailliot et al., 2007), and we thus take these earlier findings as supporting the idea that anger leads to more creativity initially.

then engaged in a sixteen-minute brainstorming task (Study 3.1 and 3.2), or a creative insight task that required perceptual (Study 3.3) and conceptual set-breaking (Study 3.4). We tested the predictions that: (1) anger leads to a less structured approach to ideation and problem solving than sadness (Study 3.1 and 3.2); and (2) anger leads to greater levels of creativity than sadness in early but not in later phases of the creativity task (Study 3.1—3.4).

### Study 3.1

#### Method

*Design and participants.* Thirty-two students (age  $M = 20.4$ ,  $SD = 3.1$ ; 10 male) received course credit or 5 Euro (approx. US \$6.50), and were randomly assigned to one of two mood conditions (angry/sad). Dependent variables were creative fluency and originality, and the level of structuring in idea generation.

*Procedure and independent variables.* Participants came to the laboratory and were seated in individual cubicles that were equipped with a computer. Participants were told that they would participate in two different and independent studies, one about autobiographical memory (the task used to manipulate specific moods), and the other about judgment and decision making. Participants were then asked to write down their gender and age, and to write a short essay about a situation that happened to them and that made them feel really angry [sad] and to pay attention to the vivid emotional aspects of the situation they were in. After finishing their autobiographical story, they were asked to report those keywords or (parts of) phrases they considered vital in making them feel angry [sad]. Upon completion of the mood manipulation task, participants continued with a sixteen-minute brainstorming task about ways to improve education at the psychology department. Participants were asked to generate as many ideas as possible and to avoid (self) criticism and evaluation. Participants keyed in their ideas, which were stored. After 16 minutes, participants read on the screen that the time to key in ideas was over. Hereafter, they were debriefed, paid for participation, and dismissed.

*Dependent variables.* A trained rater who was blind to conditions coded the ideas that were generated by the participants. First, the rater counted the number of non-redundant ideas per participant. This was our measure of *creative fluency*. The same rater classified all non-redundant ideas to one of seven distinct semantic categories that cover the education topic (see De Dreu et al., 2008). For example,



ideas concerning teaching materials, teaching format, course evaluation, and examination issues were coded into a category about lectures; ideas such as (architecture of) lecture halls, seminar rooms, and opening hours were coded into a category about university environment. A second rater coded a subset of 200 ideas (34 %). Agreement among raters was good (Cohen's  $\kappa = .84$ ) and differences were solved through discussion.

*Level of structuring* in idea generation was measured with the adjusted ratio of clustering (ARC; Roenker, Thompson, & Brown, 1971). The ARC measures how often an idea is followed by an idea from the same category (a category repetition), corrected for chance and is mathematically independent of the number of ideas generated. ARC scores usually fall between 0 (chance clustering) and 1 (maximal clustering), but negative scores (below chance clustering) are also possible.

*Originality* of ideas was based on the relative infrequency of ideas. Following Torrance (1966) and Guilford (1967) ideas were considered original, and received a score of 1, if they were coded in categories that were used by 1 percent or less of the participants. This resulted in a total of 48 original ideas (8.2 %). We counted the number of original ideas per participant as a measure of originality.

## Results

*Level of structuring.* We investigated the effects of mood on the level of structuring by submitting the adjusted ratio of clustering (ARC) to an ANOVA, with mood as the between-subjects variable. Consistent with Hypothesis 1, angry participants showed lower levels of structuring ( $M = .05$ ,  $SD = .23$ ) than sad participants ( $M = .23$ ,  $SD = .24$ ),  $F(1, 28) = 4.38$ ,  $p < .05$ ; partial  $\eta^2 = .14$ .

*Creative fluency.* To investigate the effects of mood on creative fluency over time, the 16 minutes of brainstorming were broken down in four blocks of four minutes each, and we submitted the number of unique ideas generated per participant in each block to a 2 (mood) X 4 (block) mixed model ANOVA, with the last factor as a within-subjects variable. There was no main effect of mood on the total number of ideas generated across the 16 minutes of brainstorming,  $F < 1.1$ . However, we did find a main effect for Block,  $F(3, 28) = 31.44$ ,  $p < .001$ ; partial  $\eta^2 = .77$ . Production dropped linearly from  $M = 8.41$  in the first block to  $M = 2.19$  in the fourth block, with  $M = 4.50$  and  $M = 3.16$  in the second and third block respectively.

Table 3.1

*Means and Standard Deviations for Creative Fluency as a Function of Mood and Time*

Mood	Time			
	Block 1	Block 2	Block 3	Block 4
Anger	8.94 (3.34)	5.13 (1.86)	3.81 (2.37)	1.69 (1.78)
Sadness	7.88 (4.32)	3.88 (2.50)	2.50 (1.86)	2.69 (1.99)

*Note.* Standard deviations are in parentheses.

We also found our predicted two-way interaction among mood state and block,  $F(3, 28) = 6.36, p < .01$ ; partial  $\eta^2 = .41$ . Table 3.1 shows that angry participants showed a tendency to generate more ideas than sad participants across the first three blocks,  $F(1, 30) = 2.92, p < .10$ ; partial  $\eta^2 = .09$ , whereas this effect reversed in the fourth block,  $F(1, 30) = 2.25, p < .15$ ; partial  $\eta^2 = .07$ . Indeed, whereas angry participants showed a strong linear decrease over time,  $F(1, 15) = 49.73, p < .001$ ; partial  $\eta^2 = .76$ , sad participants showed a weaker decline and their production remained stable in the later time-blocks, as witnessed by a significant quadratic term,  $F(1, 15) = 11.24, p < .01$ , partial  $\eta^2 = .43$ . While performance for angry participants dropped from block 3 to block 4, it remained constant for sad participants,  $F(1, 30) = 14.23, p < .01$ , partial  $\eta^2 = .32$ .

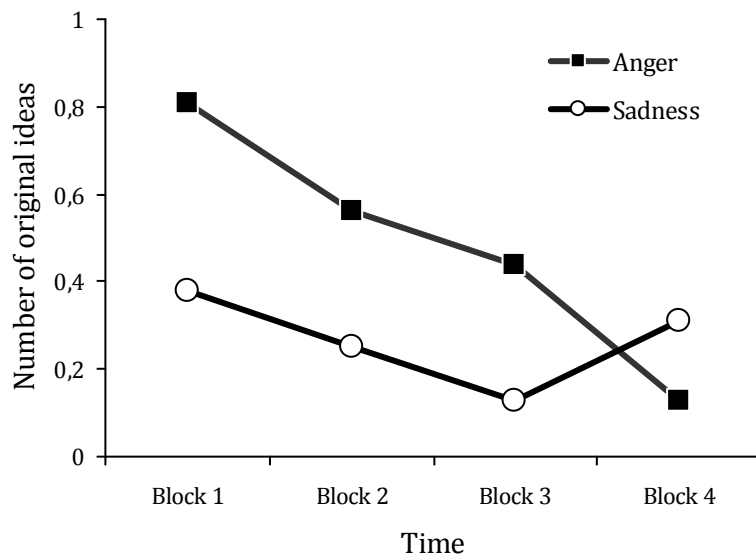


Figure 3.1. Originality as a Function of Mood and Time

*Originality.* We submitted the number of original ideas generated per participant in each four-minute block to a 2 (mood) X 4 (block) mixed model ANOVA, with the last factor as a within-subjects variable. We found that across time blocks, angry participants tended to produce more original ideas ( $M = 1.94$ ) than sad participants ( $M = 1.06$ ),  $F(1, 30) = 2.79, p < .11$ ; partial  $\eta^2 = .09$ . Furthermore, results revealed a two-way interaction among mood state and block,  $F(3, 28) = 2.96, p < .05$ ; partial  $\eta^2 = .24$ . Figure 3.1 shows that angry participants generated more original ideas than sad participants across the first three blocks,  $F(1, 30) = 5.96, p < .05$ ; partial  $\eta^2 = .17$ , but originality did not differ in the fourth block,  $F < 1.2, ns$ . Indeed, whereas the number of original ideas of angry participants decreased linearly over time,  $F(3, 28) = 4.62, p = .01$ ; partial  $\eta^2 = .33$ , this decrease was not significant for sad participants,  $F < 1$ .

### **Discussion and Introduction to Study 3.2**

Results supported the idea that anger is associated with a less structured approach to ideation and problem solving than sadness (Hypothesis 1). Furthermore, we found that angry, compared to sad, individuals generated more ideas and were more original in early but not in later phases of the creativity task (Hypothesis 2). This support for our second hypothesis is consistent with the idea that anger depletes energy faster than sadness. However, we cannot exclude an alternative explanation in terms of idea depletion (e.g., Nijstad et al., 1999). People usually start out by generating conventional ideas that are based upon highly accessible knowledge that comes to mind easily (Perkins; 1981; Ward, 1994). Once these relatively accessible ideas have been suggested, it becomes increasingly difficult to come up with further ideas (Diehl & Stroebe, 1991; Nijstad et al., 1999). Because angry people approach a task with high energy levels, an idea depletion account would predict that angry participants start out generating many (accessible) ideas in the beginning of a session but find it increasingly difficult to come up with further ideas at the end of a session. Sad participants, in contrast, start slow but are better able to maintain idea production for a longer period.

To examine this alternative account, we included in Study 3.2 a manipulation of brainstorming format that was based upon problem decomposition (see e.g., Coskun et al., 2000). Participants in Study 3.2 were asked to brainstorm about ways to protect and improve the environment. Following Nijstad et al. (2003) this topic was decomposed in four subtopics: how can people (1) reduce the amount of (chemical) waste; (2) reduce the pollution of air, water and soil; (3) reduce the

consumption of energy and the use of natural resources; and (4) preserve landscape, animals and plants. Participants received four minutes to generate ideas for each subtopic. The manipulation consisted of the order of presentation of subtopics. In the category switching condition, subtopics randomly changed every minute and every subtopic was presented once in every four minute time-block; in the within category condition, subtopics randomly changed every four minutes, so that participants could systematically explore each subtopic at their own pace and participants generated ideas within only one subtopic in each four-minute time-block.

The manipulation of brainstorming format was expected to moderate the effects of mood states on both the level of structuring and on creative production over time. First, in the category switching condition, no systematic survey of categories is possible and the level of structuring should be low regardless of mood state. In the within category condition, a systematic survey of categories is possible and sad participants should show a higher level of structuring than angry participants. Thus, we expected support for Hypothesis 1 only in the within category condition. Second, because in the category switching condition, every subtopic is presented within each of the four (four-minute) time blocks, idea depletion within each subtopic would thus lead to a decline in performance over time blocks. Moreover, because both sad and angry participants have to switch categories every four minutes (which consumes cognitive resources) both should suffer from resource depletion. Therefore the decline in performance should be similar across mood conditions. However, idea depletion should not play a role in the within-category condition, because participants can start with a new subtopic every time block. This should lead to a stable level of performance across time-blocks (see also Coskun et al., 2000). If resource depletion plays a role, which we predict especially among angry participants, then also a decline in creative performance is expected in the within category condition. Put differently, we expected new support for Hypothesis 2 but only in the within-category condition; in the category switching condition we expected a decline in creative performance regardless of mood state.

## **Method**

*Design and participants.* Participants were 121 students at the University of Amsterdam (38 male) with a mean age of 21.2 years ( $SD = 3.7$ ). They were randomly assigned to one of six different conditions that were obtained by varying mood state (angry/sad/neutral) and brainstorm format (within category/category switching).

The participants received 5 Euro or partial credit toward fulfilling a course requirement. Dependent variables were creative fluency, originality, and the level of structuring in idea generation.

*Procedure and independent variables.* The procedure and manipulation of anger and sadness were the same as in Study 3.1, except that we added a mood-neutral condition in which participants were asked to write a short essay about the route they took to the psychology faculty (see Friedman et al., 2007). Also, we used a different topic for the sixteen-minute brainstorming task: what can people do to help preserve and improve the environment. All participants read that the environment topic could be broken down in four subtopics: how can people (1) reduce the amount of (chemical) waste; (2) reduce the pollution of air, water and soil; (3) reduce the consumption of energy and the use of natural resources; and (4) preserve the landscape, animals and plants. During the brainstorming task, these four subtopics were constantly displayed on the screen and the subtopic to generate ideas about was highlighted in red. In the category switching condition, highlighted subtopics changed each minute within each of the four (four-minute) time blocks, following a Latin-square design. In the within category condition, participants were randomly provided with a highlighted subtopic that changed every four minutes. Subtopic, order, or their interaction had no effects and is further ignored.

*Dependent variables.* These were the same as in Study 3.1. Note that we used a different topic and the concomitant category system (see Nijstad et al., 2003). A random subset of 307 ideas (9%) was coded by four raters to establish inter-rater agreement. Inter-rater agreement (Cohen's  $\kappa$ ) ranged from .60 to .71. Given this good reliability, raters were assigned a subset of ideas and coded all unique ideas into categories. As in Study 3.1, ideas were considered original, and received a score of 1, if they were coded in categories that were used by only 1 percent or less of the participants. This resulted in a total of 526 original ideas (9.6 %).

The category system in this study had 50 categories, and this provided the basis for the computation of the ARC. Because the number of categories (50) is much higher than the number of subtopics used in our manipulation (4), it was possible to compute the ARC even while participants generate ideas within subtopics (i.e., different categories were possible within each subtopic).

## Results

*Level of structuring.* The ARC was submitted to a 3 (mood) X 2 (brainstorm format) ANOVA. An effect of brainstorm format,  $F(1, 113) = 13.15, p < .001$ ; partial  $\eta^2 = .10$ , showed that participants in the category switching condition showed lower levels of structuring ( $M = .25, SD = .20$ ) than participants in the within category condition ( $M = .38, SD = .20$ ). Consistent with Hypothesis 1, results further showed that sad participants had a higher level of structuring ( $M = .38, SD = .23$ ) than angry ( $M = .27, SD = .19$ ) and mood-neutral participants ( $M = .28, SD = .20$ ),  $F(2, 113) = 3.86, p = .02$ ; partial  $\eta^2 = .06$ . Finally, we found an interaction between brainstorm format and mood,  $F(2, 113) = 3.61, p = .03$ ; partial  $\eta^2 = .06$ . In the category switching condition, participants had low levels of structuring regardless of mood state,  $F < 1$  ( $M = .24, SD = .21$  for angry;  $M = .25, SD = .19$  for sad; and  $M = .25, SD = .22$  for mood-neutral participants). However, in the within category condition sad participants showed higher levels of structuring ( $M = .51, SD = .20$ ) than angry ( $M = .30, SD = .18$ ) and mood-neutral participants ( $M = .32, SD = .17$ ),  $F(2, 113) = 7.50, p < .01$ ; partial  $\eta^2 = .12$ .

*Creative fluency.* To investigate the effects of mood and brainstorm format on creative fluency over time, the 16 minutes of brainstorming were broken down in four blocks of four minutes each, and we submitted the number of unique ideas generated per participant in each block to a 3 (mood) X 2 (brainstorm format) X 4 (block) mixed model ANOVA, with the last factor within-subjects. A main effect for Block showed that production dropped linearly from  $M = 8.74$  in the first block to  $M = 6.27$  in the fourth block with  $M = 7.81$  and  $M = 7.06$  in the second and third block respectively,  $F(3, 113) = 19.26, p < .001$ ; partial  $\eta^2 = .34$ . In addition, we found a significant two-way interaction among brainstorm format and block,  $F(3, 113) = 19.71, p < .001$ ; partial  $\eta^2 = .34$ . Within the category switching condition, we found a linear main effect of block ( $F(3, 113) = 39.65, p < .001$ ; partial  $\eta^2 = .51$ ), showing a linear decrease in production over time across mood conditions. In contrast, we found that idea production in the within category condition remained stable over time,  $F < 1$ . Consistent with the idea that the relatively accessible ideas within each of the four subtopics come to mind easily, participants in the category switching condition started out with more ideas ( $M = 10.10$ ) than participants in the within category condition in the first block ( $M = 7.31$ ),  $F(1, 115) = 16.68, p < .001$ ; partial  $\eta^2 = .13$ . However, because it becomes increasingly difficult to come up with further ideas, participants in the category switching condition produced less ideas ( $M =$

5.29) than participants in the within category condition in the fourth block ( $M = 7.31$ ),  $F(1, 115) = 10.05, p < .01$ ; partial  $\eta^2 = .08$ .

Consistent with Study 3.1 and hypotheses, these effects were qualified by a significant three-way interaction among mood state, brainstorm format, and block,  $F(6, 228) = 2.48, p < .05$ ; partial  $\eta^2 = .06$ . In the category switching condition, we only found a main effect of block ( $F(3, 113) = 39.65, p < .001$ ; partial  $\eta^2 = .51$ ) indicating that angry, sad, and mood-neutral participants showed a comparable decrease in production over time (see also Table 3.2). In contrast, in the within category condition, we found an interaction among mood state and block,  $F(6, 228) = 2.30, p < .05$ ; partial  $\eta^2 = .06$ . As can be seen in Table 3.2, angry participants started out with more ideas ( $M = 8.95$ ) than sad and mood-neutral participants ( $M = 5.75$  and  $M = 7.11$  respectively),  $F(2, 115) = 3.41, p < .05$ ; partial  $\eta^2 = .06$ . However, whereas angry participants showed a linear decrease over time ( $F(3, 113) = 3.78, p < .01$ ; partial  $\eta^2 = .09$ ), sad and mood-neutral participants were able to maintain a stable rate of production ( $F_s < 1$ ).

Table 3.2

*Means and Standard Deviations for Creative Fluency as a Function of Brainstorm Format, Mood, and Time*

Condition	Time			
	Block 1	Block 2	Block 3	Block 4
Switching category condition				
Anger	9.43 (4.57)	8.48 (5.77)	6.83 (4.58)	5.43 (4.47)
Sadness	10.60 (5.04)	7.25 (3.11)	5.60 (3.25)	4.70 (3.23)
Neutral	10.37 (3.80)	8.58 (4.90)	7.53 (4.02)	5.74 (4.42)
Within category condition				
Anger	8.95 (3.51)	8.10 (2.88)	8.00 (2.37)	6.57 (3.09)
Sadness	5.75 (2.88)	6.65 (2.64)	6.55 (3.24)	7.10 (2.53)
Neutral	7.11 (2.32)	7.72 (3.03)	7.94 (3.52)	8.39 (3.09)

*Note.* Standard deviations are in parentheses.

*Originality.* To examine the effects of mood and brainstorm format on originality over time, we submitted the number of original ideas generated per participant in each block to a 3 (mood) X 2 (brainstorm format) X 4 (block) mixed model ANOVA, with the last factor within-subjects. We found that across time blocks, angry participants tended to produce more original ideas ( $M = 3.71$ ) than sad ( $M = 2.49$ ) and mood-neutral participants ( $M = 2.89$ ),  $F(2, 115) = 2.76, p = .07$ ;

partial  $\eta^2 = .05$ . Furthermore, a significant interaction among brainstorm format and block,  $F(3, 113) = 2.85, p = .04$ ; partial  $\eta^2 = .07$ , showed that the number of original ideas decreased across time blocks in the category switching condition,  $F(3,113) = 3.42, p = .02$ ; partial  $\eta^2 = .08$ , but remained stable in the within category condition,  $F(3, 113) = 1.1, ns$ . Accordingly, participants in the category switching condition generated less original ideas in the fourth block ( $M = .46$ ) than participants in the within category condition ( $M = .83$ ),  $F(1, 115) = 6.56, p = .01$ ; partial  $\eta^2 = .05$ .

Consistent with earlier findings, we also found an interaction among mood state and block,  $F(6, 228) = 2.53, p = .02$ ; partial  $\eta^2 = .06$ . Figure 3.2 shows that across time the number of original ideas remained stable for sad and mood-neutral participants,  $F_s < 1.1$ . For angry participants, however, the number of original ideas decreased over time,  $F(3,113) = 4.38, p < .01$ ; partial  $\eta^2 = .10$ . Interestingly, and consistent with Study 3.1, in the second and third block, angry participants generated more original ideas ( $M = 2.17$ ) than sad ( $M = 1.03$ ) and mood-neutral participants ( $M = 1.67$ ),  $F(2, 115) = 5.59, p < .01$ ; partial  $\eta^2 = .09$ . No such effects were observed for the first ( $F < 1.9, ns$ ) and fourth block ( $F < 1, ns$ ).

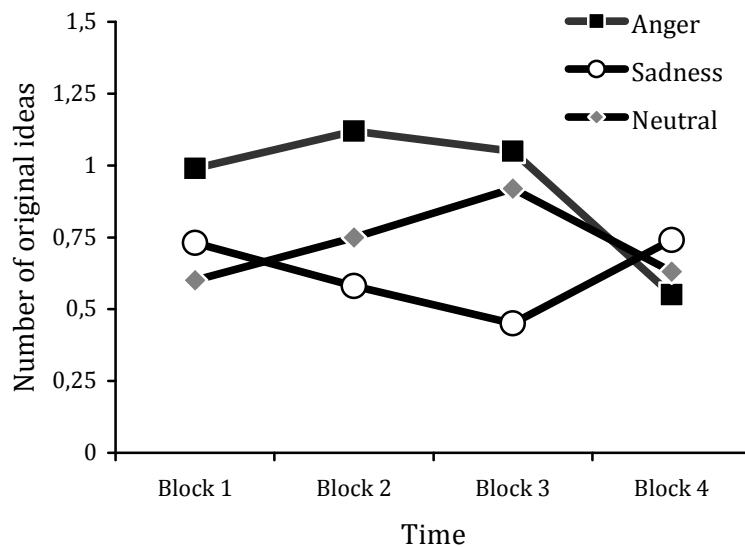


Figure 3.2. Originality as a Function of Mood and Time

### Discussion and Introduction to Study 3.3

Consistent with Hypothesis 1, angry and mood-neutral individuals were less structured in generating ideas than sad individuals, but only when the systematic survey of categories was possible (i.e., in the within category condition).



Furthermore, angry individuals initially generated more ideas and were more original than sad and mood-neutral participants but the production of ideas and originality declined over time for angry individuals more than for sad and mood-neutral individuals (supporting Hypothesis 2). For creative fluency, this pattern of results emerged in the within-category condition, and not in the category switching condition and is therefore unlikely to be due to idea depletion. Indeed, no idea depletion should occur in the within category condition, and that angry participants showed a decline over time in that condition therefore is consistent with a resource depletion account.

Findings thus far pertain to idea generation, and an issue is whether the decline in productivity over time for angry individuals also generalizes to other creativity tasks, such as creative insight problem solving. Creative insight problems differ from brainstorming tasks in that they have one correct solution and typically require restructuring of information to discover this solution (Gilhooly & Murphy, 2005; Schooler & Melcher, 1995). In Study 3.3 we assessed performance on the Snowy Pictures Test (Ekstrom, French, Harman, & Dermen, 1976), a test that consists of 24 insight problems that involve recognizing pictures of familiar objects that are hidden within visual noise. We predicted that angry individuals perform better initially but, as time proceeds, also display a greater drop in performance than those in sad and neutral mood states (Hypothesis 2).<sup>11</sup>

## Method

*Design and participants.* Seventy-five undergraduate students of the University of Amsterdam (27 male) with a mean age of 21.4 years ( $SD = 4.1$ ) participated for 5 Euros and were randomly assigned to one of three different mood conditions (angry/sad/neutral). The dependent variable was the number of correctly solved snowy pictures.

*Procedures, mood manipulations, and Snowy Pictures Test.* These were the same as in Study 3.2, except that we replaced the brainstorming task with the Snowy

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<sup>11</sup> Because insight problems vary substantially in difficulty (e.g., Dutton & Brown, 1997; Mednick & Mednick, 1967), we pre-tested the SPT and found that the first 12 items ( $M = 5.71$ ) were much easier to solve than the second 12 items ( $M = 2.53$ ),  $F(1, 16) = 52.31, p < .01$ ; partial  $\eta^2 = .77$ . Because of the low solution rate for the difficult items, with only 21% solved, we anticipated floor effects for the difficult items, and included item difficulty as a within-subjects variable in our analyses. We expected support for Hypothesis 2 to emerge especially among the easier items.

Pictures Test (SPT: Ekstrom et al., 1976). The 24 items of the SPT immediately followed the mood manipulation and were presented in a random order. The number of correctly solved items was our measure of creative performance.

## Results

*Creative performance.* To create a similar phasing as in the first two studies, performance across 24 insight problems was broken down into four blocks of six problems. We also distinguished between 12 relatively easy and 12 relatively difficult pictures and then submitted the number of correctly solved pictures per participant in each block to a 3 (mood: angry, sad, neutral) X 2 (item difficulty: easy vs. difficult) X 4 (block) mixed model ANOVA, with the last two factors within-subjects. Results showed that more easy pictures ( $M = 6.28$ ) than difficult pictures ( $M = 2.63$ ) were solved,  $F(1, 72) = 232.10$ ,  $p < .001$ ; partial  $\eta^2 = .76$ , confirming our pretest results in Footnote 11. A main effect for Block showed that the number of solved pictures dropped from  $M = 2.36$  in the first block to  $M = 1.87$  in the last block with  $M = 2.40$  and  $M = 2.28$  in the second and third block respectively,  $F(3, 70) = 3.22$ ,  $p = .03$ ; partial  $\eta^2 = .12$ .

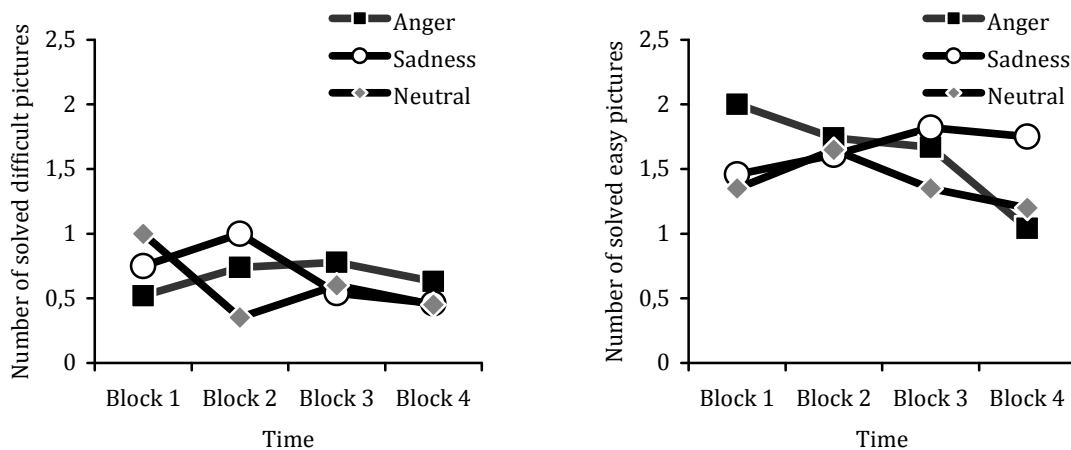


Figure 3.3. Perceptual Insights as a Function of Mood and Time for Difficult Problems (Left Panel) and for Easier Problems (Right Panel)

These main effects were qualified by a three-way interaction among mood state, item difficulty, and block,  $F(6, 142) = 3.09$ ,  $p < .01$ ; partial  $\eta^2 = .12$ . For the difficult items, no significant effects were found,  $F_s < 1.9$ , ns (see also Figure 3.3, Left

Panel). The overall rate of performance was quite low (22%) suggesting the lack of effects here may be due to a floor effect. Indeed, for the easy items, we found our predicted interaction among mood state and block,  $F(6, 142) = 2.23, p = .04$ ; partial  $\eta^2 = .09$ . Consistent with Hypothesis 2, Figure 3.3 (Right Panel) shows that angry participants started out with solving more easy pictures ( $M = 2.00$ ) than sad and mood-neutral participants ( $M = 1.46$  and  $M = 1.35$  respectively),  $F(2, 72) = 3.91, p = .02$ ; partial  $\eta^2 = .10$ ; planned contrasts showed that angry individuals outperformed sad and mood-neutral individuals combined,  $t(72) = 2.79, p < .01$ . But whereas angry participants showed a linear decrease over time,  $F(3, 70) = 4.89, p < .01$ ; partial  $\eta^2 = .17$ , insight performance of sad participants and mood-neutral participants remained stable,  $F_s < 1$ . As a result, angry participants had fewer correctly solved easy pictures in the last block ( $M = 1.04$ ) than sad participants ( $M = 1.75$ ), with the mood-neutral condition falling in between ( $M = 1.20$ ),  $F(2, 72) = 4.05, p = .02$ ; partial  $\eta^2 = .10$ . In all, these findings support Hypothesis 2.<sup>12</sup>

### Discussion and Introduction to Study 3.4

The new support for Hypothesis 2 that anger triggers more creativity early on but not in later phases suggests two things. First, it reveals that the creativity-enhancing effect of anger generalizes from idea generation to insight performance. Second, by using a perceptual insight task, we overcame the problem that (conceptual) idea depletion would be responsible for the decline in creative performance over time—together with the findings in Study 3.2, this new support renders an explanation for the relatively steep decline in creative performance among angry participants in terms of idea depletion difficult to maintain.

Whereas the combined findings of Study 3.1 – 3.3 are fully consistent with an explanation in terms of resource depletion, a direct test of this explanation would be desirable and this was the main goal of Study 3.4. We replaced the SPT by the Remote Associates Test (RAT; Mednick, 1962) to probe conceptual rather than perceptual insight and included a persistence measure that is typically used in research on resource depletion. Specifically, we investigated how long participants tried to solve an unsolvable anagram that directly followed the RAT. We also

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<sup>12</sup> The number of correctly closed easy snowy pictures per block obviously depended on the number of easy pictures that participants received in each block. Therefore, we conducted the same analyses in which we controlled for the number of easy snowy pictures that participants received in each block (for each block, the number of closed easy snowy pictures was divided by the number of received easy pictures). This resulted in similar effects and identical conclusions.

included a self-report measure of resource depletion. We expected to replicate earlier findings on creative performance over time, but also that angry participants, following the creativity task, would be less persistent on the unsolvable anagram and would report more depletion than sad participants. Finally, we expected that self-reported resource depletion would mediate the effect of mood on the decline in creative performance over time.

A secondary goal of Study 3.4 pertained to our mood manipulation. Although previous work has shown that our manipulation procedure was successful in inducing anger and sadness (e.g., De Dreu et al., 2008; DeSteno et al., 2000; Gasper, 2004a), the reader may rightfully note that feelings of anger and sadness, as induced through self-generated imagery, dissipate over time, and that the greater decline in creativity among angry rather than sad participants can at least partially be due to stronger mood dissipation in the anger than sad conditions. Of course, such a suspicion would be inconsistent with the fact that in Study 3.3, angry participants had lower performance than sad participants towards the end of the creativity task. However, to further exclude this possibility we included, in Study 3.4, self-report measures of anger and sadness after participants had performed the creativity task. We expected that, even though angry participants would perform equally or even worse than sad participants at the end of the task, participants in the anger condition would report more anger and less sadness than participants in the sad condition.

## **Method**

*Design and participants.* Seventy-eight undergraduate students of the University of Amsterdam (20 male) with a mean age of 20.9 years ( $SD = 4.3$ ) participated for 5 Euros and were randomly assigned to one of two different mood conditions (angry/sad). Dependent variables were the number of correct RAT-items, persistence on an unsolvable anagram, and self-reported resource depletion, anger, and sadness.

*Procedures and mood manipulations.* These were the same as in Study 3.3, except that we excluded the mood-neutral condition and replaced the SPT with 30 problems from the RAT that were presented in random order. The RAT consists of 10 relatively easy, 10 moderate, and 10 relatively difficult problems (Mednick & Mednick, 1967). Following the RAT, participants continued with an anagram task that was presented as a test of language abilities. Participants were presented with

four anagrams, one of which was actually unsolvable. Participants were told to unscramble the letters and key in the correct solution. They were further told that they should work on the anagrams as long as they wanted and could stop by hitting the “stop-button” on the screen. After the anagram test, participants answered a short questionnaire, were paid for participation, and dismissed.

*Dependent variables.* We coded the number of correct RAT solutions (range between 0 and 30). Because we found interactions between mood and item difficulty in Study 3.3, we also distinguished between 10 relatively easy, 10 moderate, and 10 relatively difficult problems. Time spent on the unsolvable anagram was taken as a measure of persistence (see also Muraven & Baumeister, 2000). We also measured resource depletion by asking participants to rate on a 5-point Likert scale (0 = *not at all* to 5 = *very much*) how fatigued and washed-out (energetic, alert; reverse coded) they felt ( $\alpha = .78$ ). Finally, we measured mood by asking participants to rate how angry, frustrated [sad, down] they felt (0 = *not at all* to 5 = *very much*).

## Results and Discussion

*Post-task mood states.* Ratings on anger and sadness were submitted to separate ANOVA's, with mood as the between-subjects factor. Participants in the anger condition reported more anger ( $M = 1.62$ ) than participants in the sad condition ( $M = 1.40$ ),  $F(1, 76) = 4.61, p < .05$ ; partial  $\eta^2 = .06$ . Alternatively, participants in the sad condition reported more sadness ( $M = 1.68$ ) than participants in the anger condition ( $M = 1.43$ ),  $F(1, 76) = 4.68, p < .05$ ; partial  $\eta^2 = .06$ . In other words, our mood induction persisted until after the creativity task.

*RAT performance.* Performance across 30 insight problems was broken down into two blocks of 15 problems.<sup>13</sup> We also distinguished between the 10 relatively easy, 10 moderate, and 10 relatively difficult RAT problems and then submitted the number of correct solutions per participant in each block to a 2 (mood: angry, sad) X 3 (item difficulty: easy vs. moderate vs. difficult) X 2 (block) mixed model ANOVA, with the last two factors within-subjects. First, a main effect for item difficulty,  $F(2, 75) = 244.12, p < .001$ ; partial  $\eta^2 = .87$ , showed that participants solved more easy problems ( $M = 6.90$ ) than moderate problems ( $M = 4.76$ ),  $F(1, 76) = 90.62, p < .001$ ;

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<sup>13</sup> Thirty items cannot be broken down into four blocks (as we did in Study 3.3). However, breaking down RAT performance in three blocks of 10 items produced identical results.

partial  $\eta^2 = .54$ , and more moderate problems than difficult problems ( $M = 1.55$ ),  $F(1, 76) = 174.01, p < .001$ ; partial  $\eta^2 = .70$ . Furthermore, a main effect for Block showed that the number of solved RAT problems dropped from  $M = 6.94$  in the first block to  $M = 6.26$  in the second block,  $F(1, 76) = 7.82, p < .01$ ; partial  $\eta^2 = .09$ .

Consistent with previous results, ANOVA revealed a two-way interaction among mood state and block,  $F(1, 76) = 10.22, p < .01$ ; partial  $\eta^2 = .12$ . In the first block angry participants solved more RAT problems ( $M = 7.74$ ) than sad participants ( $M = 6.18$ ),  $F(1, 76) = 8.62, p < .01$ ; partial  $\eta^2 = .10$ . However, whereas angry participants showed a performance decrease over time ( $F(1, 76) = 17.51, p < .01$ ; partial  $\eta^2 = .19$ ), sad participants were able to maintain a stable level of performance ( $F < 1$ ). As a result, RAT-performance in the final block did not differ for angry and sad participants ( $M = 6.24$  and  $M = 6.28$  respectively),  $F < 1$ . Thus, we have new evidence for Hypothesis 2 that further attests to the generality of the effect – the creativity-enhancing but depleting effect of anger holds for idea generation, perceptual insight performance, and conceptual creativity.

*Persistence and resource depletion.* As expected, ANOVA revealed that angry participants spent less time on the unsolvable anagram (55.13 seconds) than sad participants (86.29 seconds),  $F(1, 76) = 3.87, p = .05$ ; partial  $\eta^2 = .05$ . Moreover, angry participants reported more resource depletion ( $M = 3.24$ ) than sad participants ( $M = 2.93$ ),  $F(1, 76) = 5.27, p < .05$ , partial  $\eta^2 = .07$ .

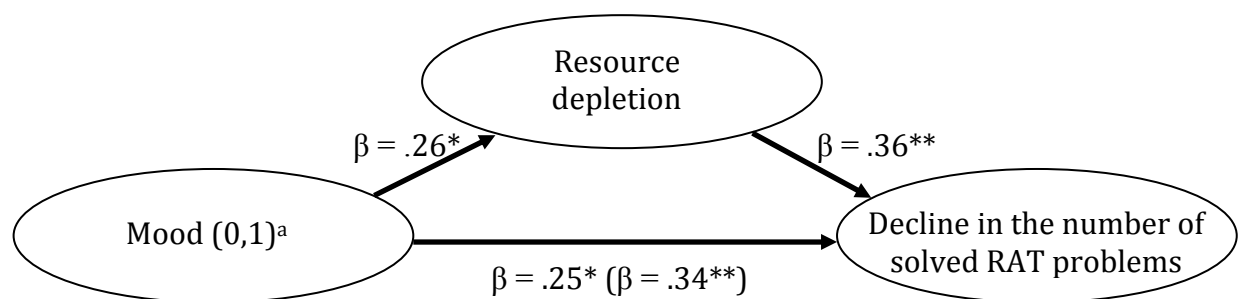


Figure 3.4. Mediation of the Effect of Mood on Decline in Insight Performance by Resource Depletion

Note. <sup>a</sup>Sadness = 0; Anger = 1.

\* $p < .05$ .

\*\* $p < .01$ .

*Mediation by resource depletion.* To test for mediation, we computed a series of regression analyses along the criteria set forth by Kenny, Kashy, and Bolgers

(1998) in which we compared the effect of mood (sadness set as 0 versus anger set as 1) on the difference in insight performance between block 1 and 2 (with greater difference indicating greater decline). As can be seen in Figure 3.4, self-reported resource depletion regressed significantly on mood condition ( $\beta = .26, t = 2.30, p < .05$ ). When we regressed the decline in RAT performance on mood after controlling for self-reported resource depletion, the originally significant effect of mood ( $\beta = .34, t = 3.20, p < .005$ ) dropped but remained significant ( $\beta = .25, t = 2.43, p < .05$ ); the effect of resource depletion was significant ( $\beta = .36, t = 3.45, p < .005$ ). A Sobel-test confirmed that the mediation was significant,  $z = 1.97, p < .05$ . In other words, compared to sadness, anger leads to greater decline in creative performance through resource depletion.

### **Meta-analytic Summary of Experimental Results**

The four experiments together addressed two questions. First, do angry people adopt a less structured approach to idea generation than sad individuals? Second, does anger lead to greater levels of creativity than sadness in early but not in later phases of the creativity task? We obtained evidence for both questions. With regards to the first question, we found that anger produces lower levels of structuring in idea generation than sadness (Study 3.1 and 3.2). Our prediction that anger leads to greater levels of creativity than sadness in early phases of the creativity task received stronger support in Study 3.3 and 3.4 than in Study 3.1 and 3.2. Study 3.1 showed a non-significant tendency for angry individuals to produce more ideas and to be more original than sad people in the first four minutes of idea generation, and in Study 3.2, Hypothesis 2 received support only in the within category condition with regards to creative fluency.

To obtain a firmer insight into the results, we conducted a meta-analysis of the anger-sad contrast across our four studies for the first block, the final block, and the overall effect across blocks. For Study 3.1 and 3.2, fluency and originality were standardized and averaged in a creativity composite score; for Study 3.3 and 3.4, we used insight performance across difficulty level. Results for the anger-sad contrast for the first block revealed good support for the prediction that anger leads to greater levels of creativity than sadness early on in a creativity task. Using the Hedges'  $g$  effect size based on a random effects model (Hedges & Olkin, 1985), we found a moderate effect showing that anger was associated with more creativity than sadness ( $N = 249, \text{Hedges' } g = .43, SE = .13, 95\% \text{ Confidence Interval} = .18, .68; \text{Variance across effects: } Q_w = 1.56, ns$ ). Second, for the final block, we found a

marginally significant and small effect showing that anger was associated with less creativity than sadness ( $N = 249$ , Hedges'  $g = -.22$ ,  $SE = .13$ , 95% Confidence Interval =  $-.47, .02$ ; Variance across effects:  $Q_w = 2.77$ , ns). Third and finally, we found a small to moderate effect showing that across blocks, anger was associated with more creativity than sadness ( $N = 249$ , Hedges'  $g = .31$ ,  $SE = .13$ , 95% Confidence Interval =  $.06, .56$ ; Variance across effects:  $Q_w = 2.47$ , ns). Together, these meta-analytic results suggest that anger is associated with more creativity than sadness. However, and consistent with Hypothesis 2, anger was associated with enhanced creative production early on in a creativity task, but not in later phases of the creativity task.

### **Conclusions and General Discussion**

Triggered by anecdotes and introspective reports from eminent scientists and artists, we examined whether and why anger promotes creativity. Some initial findings suggested anger stimulates creativity, but left unclear why and when this would be the case. Accordingly, we examined the effects of anger in comparison to sadness and mood-neutral controls on a variety of creativity indicators – creative fluency, originality of ideas, perceptual and conceptual problem solving, and the level of structuring during creative ideation. Across four experiments, anger indeed enhanced creativity more than sadness and mood-neutral states but only initially and not in later phases of the creativity task. Furthermore, anger associated with a less structured and systematic approach to the creativity task and such unstructured thinking is relatively taxing. Indeed, our findings suggest that the relatively steep decline in creative productivity among angry individuals is due to resource depletion – angry people burn a lot of energy early on, which makes them relatively creative but also renders them fatigued faster than sad or mood-neutral people. Such fatigue shows up in substantially reduced creative performance at later stages and in less persistence on difficult problems.

Our results make a number of contributions. They substantiate and qualify earlier qualitative and experimental evidence for the role of anger in the creativity process. They reveal that differences in information processing tendencies between angry and sad individuals previously found in the domains of persuasion and person perception generalize to more pro-active tasks and creativity in particular. And they provide first-time evidence that mood states can have differential effects on resource depletion. In the remainder of this section, we explore these contributions in some more detail and highlight possible avenues for future research.



### **Revisiting the Mood-Creativity Equation**

Ours is not the first study on the effects of mood on creative performance. In fact, there is a large literature on the role of positive mood states showing that people feeling happy and elated (but not serene or relaxed) tend to be more cognitively flexible, use broader and more inclusive cognitive categories, and are more fluent and original (e.g., Ashby et al., 1999; Baas et al., 2008). In addition, there is substantial work on the effects of feeling sad and depressed, showing that, in general, these negative mood states have little impact on creative performance (Baas et al., 2008; for some important moderators of the link between sadness and creativity, see e.g., Friedman et al., 2007; Hirt et al., 1997). To some extent, these findings fit the notion, embedded in the Dual Pathway to Creativity Model (De Dreu et al., 2008) that activating moods, such as happiness, promote creativity, whereas deactivating moods, such as feeling relaxed or sad, do not influence creative performance.

Despite these decades of research on mood and creativity, anger, as a specific mood state, has been almost entirely ignored, and the present study redressed this unfortunate state of affairs. Because anger arouses and activates, and sadness does not, we predicted that anger potentially leads to more creativity, a prediction consistent with initial findings reported in De Dreu et al. (2008) and with findings showing that anger leads to similar levels of creativity as happiness (another activating mood state; Russ & Kaugars, 2001). When considering initial creativity – in the first blocks of time – we found support for this prediction and together with these earlier findings, it is reasonable to conclude that the mood's hedonic tone (negative vs. positive) cannot account for this effect. It seems more likely that the initial creativity-enhancing effect of anger, compared to sadness and mood-neutral controls, is due to the fact that anger arouses and activates.

In the present studies we uncovered two additional effects that qualify the general idea that anger promotes creativity. First, and consistent with persuasion and person perception studies (e.g., Bodenhausen et al., 1994; Lerner & Tiedens, 2006; Tiedens & Linton, 2001), we observed that angry individuals take a less systematic and structured approach to idea generation than sad individuals. Specifically, we found less semantic clustering and more self-induced yet unstructured switching between cognitive categories among angry individuals than among their sad counterparts. Thus, the initial work on anger and creativity by De Dreu and colleagues (2008) incorrectly inferred that anger promotes creativity because anger activates the individual to engage in persistent, focused, and effortful

work—instead, anger activates but also triggers individuals to take a “wilder” approach to the creativity task. This fits the notion that the effects of anger on cognition are quite similar to those of happiness (Carver & Harmon-Jones, 2009; Lerner & Tiedens, 2006). Like happiness, anger might trigger the flexibility pathway, leading individuals to engage in cognitively flexible, loose, and unstructured processing with greater initial levels of creativity as a result. Future research may delve further into this possibility.

Second, and related to the less structured and bottom-up approach of angry individuals, we found good evidence that over time, angry individuals dropped substantially in creative performance whereas sad and mood-neutral individuals were able to maintain a more stable performance level. Three possible explanations for this effect were proposed and tested. One explanation invoked the notion of idea depletion—initially many ideas come to mind but, as time continues, it becomes increasingly difficult to come up with new ideas. This explanation did not stand the test in Study 3.2. Despite the fact that in the within-category condition participants could start brainstorming on a new subtopic every time block, which should have led to a stable level of creative performance across time-blocks (see also Coskun et al., 2000), creative production decreased in the anger condition, but not in the sadness and mood-neutral conditions. Moreover, idea depletion cannot account for the mood x time interactions we observed for perceptual insight performance in Study 3.3 or the conceptual creativity task in Study 3.4.

Another explanation, mentioned in the introduction to Study 3.4, was that the angry mood state gradually became less intense. Emotional episodes vary in duration and with a median lifetime of 20 minutes, sad episodes generally last longer than angry episodes that have a median lifetime of more than 16 minutes (Verduyn, Delvaux, Van Coillie, Tuerlinckx, & Van Mechelen, 2009; see also Scherer et al., 1986). Although we cannot rule out an explanation in terms of differential mood dissipation completely, we believe two reasons make this explanation less likely. First, the self-generated imagery mood induction that we used has been shown to effectively induce anger and sadness (see e.g., De Dreu et al., 2008; DeSteno et al., 2000; Tiedens & Linton, 2001) and a 15–20 minute lag between the mood induction and the measurement of dependent variables is “a duration well within the usual time period for experiments involving emotion induction tasks” (Fong, 2006, p. 1021). Indeed, we found that, after completion of the RAT and the persistence task in Study 3.4, angry participants reported more anger and less sadness than sad individuals. Second, because moods gradually fade out, a mood

dissipation account would predict that creative performance would become more similar for the anger and sadness conditions as time continues. However, a meta-analysis across four studies actually shows that angry participants tend to produce lower levels of creativity than sad participants towards the end of the creativity task. Put differently, (differential) mood dissipation is a less likely account for our results.

The third possibility built on the resource depletion literature—being creative requires energy and as energy gets depleted, creative performance suffers. The results of all four studies were consistent with such a resource depletion account. Auxiliary findings in Study 3.4 provided further support for the resource depletion account, showing that subsequent to the depleting creativity task, angry individuals were less persistent on a difficult task (an unsolvable anagram) than sad individuals and they reported being more depleted afterwards. Moreover, the relatively steep decline in creative performance among angry individuals was mediated by feelings of depletion. In short, the “wilder” task-approach by angry, compared to sad, individuals pays off in initially higher levels of creativity but requires energy, which gets depleted and thereby reduces creativity especially in later phases.

That anger is more activating and arousing yet also associated with faster resource depletion than sadness triggers some new questions. For example, work on the effects of positive moods on creativity shows that happiness triggers greater creativity than feeling relaxed and serene (Baas et al., 2008; De Dreu et al., 2008; Madjar & Oldham, 2002). This effect has been explained in terms of the higher levels of arousal and activation engendered by happiness. Current findings suggest that, like anger, happiness promotes creativity in early phases of the creativity task but due to resource depletion, over time associates with more significant drops in performance than, for example, relaxation and serenity. In light of this, it is noteworthy that a meta-analysis (Baas et al., 2008) uncovered that the effects of positive activating moods (happiness and elation) on creativity are weaker in creativity tasks of long rather than short duration (see also Kaufmann & Vosburg, 2002). Thus, it is possible that any activating mood state, negative as well as positive might be associated with resource depletion and lower levels of creativity later in a creativity task. New studies could examine a resource depletion account for the effects of happiness on creative performance over time.

The idea of resource depletion more generally has some important consequences beyond its currently uncovered implications for the effects of mood on creativity. For example, the finding that creativity is sometimes enhanced after a

period of incubation (i.e., while not thinking about a problem; see S. M. Smith & Blankenship, 1991) might be explained because energy resources are replenished after a period of rest. Consistent with this idea is the finding that people produce higher levels of creativity if they spend an incubation period relaxing or performing a low cognitive demand task rather than performing a taxing high cognitive demand task (e.g., Browne & Cruse, 1988; M. I. Posner, 1973).

### **Mood and Information Processing**

Current results were consistent with work in the areas of persuasion and person perception showing that angry individuals tend towards a top-down, loose processing style whereas those feeling sad are more likely to adopt a structured, systematic, and bottom-up information processing style (e.g., Lerner & Tiedens, 2006). The current support for this notion that anger triggers less structured information processing than sadness is, however, important for two reasons. First, as far as we know, the current findings provide first-time evidence that mood-related differences in structured information processing not only pertain to “external” information processing where the individual encodes and processes external (experimenter provided) stimuli, but also to more “internal” information processing where the individual engages in the (internal) generation of ideas, insights, or remote associations.

Second, our reasoning and findings suggest that an unstructured process is more effortful (and thus depleting) than a more structured and bottom-up approach. This may appear in sharp contrast to the dominant view in the information processing literatures that systematic and deliberate information processing is more effortful than shallow, heuristic information processing. We note that there may be an important qualitative difference between external and internal information processing tendencies. External stimuli such as an advertisement can be dismissed or accepted in a heuristic fashion or, alternatively, processed in a more systematic and more effortful manner (Chaiken & Trope, 1999; Gasper, 2004a). When it comes to internal (self-generated) stimuli, the very same process is required to decide whether an idea or insight is relevant, original, and fitting the problem. But before such a heuristic versus more systematic analysis of the stimuli can take place, this very material needs to be generated or otherwise created. We suspect that this generation phase is more taxing when conducted in an unstructured rather than structured, bottom-up approach. The frequent switching between semantic categories and the fast moving back-and-forth between possibilities is more taxing

and tiring than sticking to a few semantic categories and producing “trains of thought” – ideas and insights that belong to the same cognitive category and build on each other in an incremental fashion (see also Coskun et al., 2000; Nijstad & Stroebe, 2006).

Finally, when it comes to the determinants of structured versus unstructured information processing, it has been suggested anger associates with a more unstructured, heuristic processing style than sadness because anger signals personal control and high certainty while sadness signals situational control and low certainty (e.g., Lerner & Keltner, 2000; C. A. Smith & Ellsworth, 1985). In turn, feeling certain and in control promotes heuristic information processing, whereas feeling uncertain and commanded by the situation promotes systematic information processing (Lerner & Tiedens, 2006). Anger therefore results in greater reliance on general knowledge structures and top-down information processing, while sadness signals that careful assessment of the situation is required, thereby promoting systematic, bottom-up, and detailed information processing. We did not assess this sense of control and/or certainty and future research is needed to assess its possible mediating function. Furthermore, other mood states than anger and sadness can be distinguished in terms of their associated sense of control and certainty, and an interesting avenue for future research is to systematically examine how this dimension mediates effects of specific mood states on creative performance.

## **Conclusion**

Creativity researchers have long struggled with the relationship between negative moods and creativity, leading some to conclude that “there is also a large literature on negative affect, which indicates that the impact of negative affect [on creativity] is more complex and difficult to predict than is the case for positive affect” (Ashby et al., 1999, p. 532). The present study is the first to systematically compare the effects of anger with sadness and mood neutral control conditions and showed that the relation between negative affect and creativity is complex indeed, but that nevertheless meaningful predictions can be derived. Thus, anger leads to less systematic idea generation than sadness and to more creativity in early phases of a creativity task but our findings also show that the going gets tough towards the end. As such there seems truth in the observation that “anger makes dull men witty, but it keeps them poor” (Francis Bacon, *Apophthegms*).