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Hope, Pride, and Processing During Optimal and Nonoptimal Times of Day

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We examine the conditions under which the distinct positive emotions of hope versus pride facilitate more or less fluid cognitive processing. Using individuals' naturally occurring time of day preferences (i.e., morning vs. evening hours), we show that specific positive emotions can differentially influence processing resources. We argue that specific positive emotions are more likely to influence processing and behavior during nonoptimal times of day, when association-based processing is more likely. We show in three experiments that hope, pride, and a neutral state differentially influence fluid processing on cognitive tasks. Incidental hope facilitates fluid processing during nonoptimal times of day (compared with pride and neutral), improving performance on tasks requiring fluid intelligence (Experiment 1) and increasing valuation estimates on tasks requiring that preferences be constructed on the spot (Experiments 2 and 3). We also provide evidence that these differences in preference and valuation occur through a process of increased imagination (Experiment 3). We contribute to emotion theory by showing that different positive emotions have different implications for processing during nonoptimal times of day.

Keywords: emotion, cognitive processing, circadian rhythm, positive mood, hope and pride

Different positive emotions can influence cognitive processing and performance in very specific ways. For instance, hope and pride are both common positive emotions associated with common achievement scenarios. However, these two emotions may create different effects on later processing because of the unique themes, appraisals, and behavioral tendencies embodied by each emotion. Specifically, hope may elicit striving toward desired outcomes, encouraging a cognitive style that stimulates fluid processing and imagination, while pride may elicit more self-focused reflection on accomplishments, creating an opposite style. At times, however, we seem to inhibit, correct, or control for these effects, disengaging even while hopeful or striving even while feeling pride. What might account for the presence or inhibition of these specific effects of positive emotions? We demonstrate that one answer to this question includes individuals' naturally occurring time of day preferences for morning versus evening hours. We use time of day to manipulate the availability of inhibitory resources (Hasher, Zacks, May, Gopher, & Koriat, 1999; May & Hasher, 1998) and therefore the amount of association-based (vs. controlled) processing (Bodenhausen, 1990; May, Hasher, & Foong, 2005). Based on reasoning about distinct emotion associations, we predict and find that incidental hope (compared with incidental pride and neutral states)[1] facilitates fluid cognitive processing during nonoptimal times of day, resulting in better performance on a fluid intelligence task and a stronger propensity to find value in relatively novel goods.

Much emotion research has focused on the effects of positive affect, mood, and positive versus negative emotional states. Although important strides have been made in understanding the distinct effects of incidental negative emotions (Lerner & Keltner, 2000, 2001), comparatively little work has been done to distinguish the different consequences of specific positive emotions. Most research involving positive affect and emotion argues that various positive emotional states have similar effects on behavior (Fredrickson, 1998, 2001; Isen, 2001; for notable exceptions see Algoe & Haidt, 2009; Algoe, Haidt, & Gable, 2008; Bartlett & DeSteno, 2006). A large body of research has suggested that positive affect universally increases cognitive flexibility (Isen, 2001; Isen & Daubman, 1984) and improves problem-solving (Estrada, Isen, & Young, 1997). Additional research has suggested that positive emotions function to broaden momentary thought-action repertoires (Fredrickson, 2001), extend habitual ways of

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[1] We manipulated emotions via an incidental emotion task (Lerner & Keltner, 2001). We examine the effects of incidental emotion (i.e., emotion generated by an initial task that is irrelevant to the focal task, which is the source of dependent measures) as opposed to integral emotion (i.e., emotion that is relevant to or generated by the focal task).

thinking (Fredrickson & Branigan, 2005), and build cognitive resources (Fredrickson, Cohn, Coffey, Pek, & Finkel, 2008; Fredrickson, Tugade, Waugh, & Larkin, 2003). In this article, we contribute to emotion theory by showing that different specific positive emotions can differentially influence cognitive flexibility.

Researchers have found that the influence of emotion can be quite labile. Work on mood freezing (Bushman, Baumeister, & Phillips, 2001; Hirt, Devers, & McCrea, 2008; Manucia, Baumann, & Cialdini, 1984) shows that individuals' beliefs about their emotion can change whether or not the emotion influences behavior. Moreover, the effect of emotion is often contingent on cognitive load, which has been shown to affect emotional processing in different consumption contexts (Rottenstreich, Sood, & Brenner, 2007; Shiv & Fedorikhin, 2002). These findings suggest that the magnitude of emotion's effect can be increased or decreased based on the availability or perceived availability of an individual's resources.

One naturally occurring factor that influences the availability of resources is an individual's circadian rhythm. During different times of day (i.e., morning vs. evening), individuals have been found to feel and operate at their personal best or not (i.e., optimally or nonoptimally) based on their personal circadian rhythms. Individuals' circadian rhythms influence cognitive resource availability (Kruglanski & Pierro, 2008) and govern cognitive function (Yoon, May, & Hasher, 2000). Thus, one important factor that may amplify or lessen the effects of emotion is time of day. Specifically, during nonoptimal times of day resources are less readily available, and therefore automatic, association-based processing (Kahneman & Frederick, 2005; Stanovich & West, 2002) is more likely (Bodenhausen, 1990; May et al., 2005).

In this article, we investigate whether specific positive emotions can affect cognitive performance through their unique, learned associations. We argue that the core relational themes, appraisals, beliefs, and action tendencies associated with any particular emotion are learned and automatic, serving a "steering function" and helping to generate emotion-appropriate behavior (Lang, 1994; Leventhal & Tomarken, 1986). These unique associations have different implications for processing. Thus, we predict distinctions among specific positive emotions under conditions that encourage more automatic and association-based processing.

We contend that association-based emotion mechanisms are likely to be more prevalent during nonoptimal times of day when processing resources are reduced and inhibitory control is lower (Hasher et al., 1999). At these times, associative type processing is likely to be more prevalent, leading to a greater influence for specific emotional associations on cognitive task performance (Stanovich & West, 2002), including the valuation of items. In summary, although the vast majority of empirical work has treated positive emotions as an undifferentiated group producing similar effects for processing, we propose differential effects for distinct positive emotions under conditions favoring more association-based processing.

More specifically, in our studies, we contrast the emotions *hope* and *pride*. The unique associations with hope suggest that a valued goal is possible, while associations with pride suggest a valued goal has already been achieved. Hope is differentially associated with concepts such as striving, possibility, effort, or the future, whereas pride is associated with concepts such as achievement, fulfillment, or the past. We believe that the distinct set of associations for each emotion can have important processing implications, particularly for fluid processing tasks requiring mental exploration or cognitive flexibility.

Hope and pride were selected as the emotions of interest for this research not only because they are distinct positive emotions but also because they both regularly occur in a variety of achievement contexts across an individual's life span. Some common situations that elicit both hope and pride include athletic contests; getting fit or losing weight; and finding a job. Individuals regularly experience hope and pride in these contexts, and the same individual is likely to experience this pair of emotions in succession (i.e., before and after an important outcome). Because hope and pride often are intimately linked to desirable important outcomes, both emotions are likely to be triggered throughout the day by numerous stimuli that bring valued outcomes to mind. In such situations, an individual's valuation of items may be higher under certain conditions (i.e., emotional states and times of day).

In sum, we predict that hope versus pride will affect processing in distinctly different ways during nonoptimal times of day, particularly for fluid-processing tasks such as construction of valuations. Next, we examine more specifically how different positive emotions and nonoptimal times might, in combination, influence processing on specific decision tasks. We then present evidence from three experiments demonstrating that hope and pride differentially influence fluid processing during nonoptimal times of day. We show that during nonoptimal times of day hope improves performance on a fluid intelligence task (Experiment 1) and increases valuation estimates for a task where preferences for novel objects must be determined in real time (Experiment 2). We further show that hope impacts preference and valuation through the process of imagination (Experiment 3).

Positive Emotions

In this article, we focus on the core themes, beliefs, thoughts, and action tendencies associated with two distinct positive emotions—hope and pride—and suggest some important ways in which these specific positive emotions may differ. We argue that these different emotion associations for hope and pride are learned and automatic, serving a "steering function" (Lang, 1994; Leventhal & Tomarken, 1986) for goal-oriented behavior.

Hope is an emotion characterized by an individual's "yearning for better and believing the wished-for improvement is possible" (Lazarus, 2006, p. 16). Hope signals not only that a "current life circumstance is unsatisfactory" (Lazarus, 1999, p. 653) but also that a concrete positive goal is expected (Staats & Stassen, 1985). Hopeful thought reflects a capability to derive pathways to desired goals and to motivate goal pursuit (Snyder, Harris, Anderson, & Holleran, 1991). Hope-related cognitions and associations involve visualization and mental representation of positively valued abstract future situations (Stotland, 1969) as well as tendencies toward cognitive flexibility and mental exploration of novel situations (Breznitz, 1986; Snyder, 1994). High-hope individuals also demonstrate better problem-solving abilities than low-hope individuals (Chang, 1998). In sum, hope is associated with motivated goal-striving, problem-solving, and mental exploration of novel situations. Thus, the associations with hope seem likely to elicit flexible, goal-oriented behavior in the moment, often leading to changes in one's current state.

Pride has been characterized as "enhancement of one's ego-identity by taking credit for a valued achievement" (Lazarus, 2006, p. 16) and experiencing enhancement of one's self, or one's social worth, by being credited for a highly valued accomplishment (Lazarus, 1991). Pride may have evolved to provide information about an individual's current level of status and acceptance (Tracy & Robins, 2007a, 2007b; Tracy, Robins, & Lagattuta, 2005). Pride involves specific self-evaluative processes and thoughts and is considered a self-conscious emotion (Tangney, Dalgleish, & Power, 1999). Thus, pride-related cognitions involve internal attributions and self-credit for valued events (Smith & Lazarus, 1993; Weiner, 1985) and reflect experienced success in which an individual currently feels good about him or herself. In sum, pride is associated with goal-satiation, achievement, and self-satisfaction. Therefore, unlike hope, the associations with pride seem unlikely to motivate goal-oriented behavior aimed toward making a change in one's current state.

Circadian Rhythm and Nonoptimal Times of Day

A circadian rhythm is a daily periodicity consisting of an approximately 24-hour cycle in the biochemical, physiological, or behavioral processes of living beings. Circadian rhythm influences cognitive resource availability (Kruglanski & Pierro, 2008) and governs cognitive function (Yoon, May, & Hasher, 2000). An instantiation of this rhythm is an individual's morningness-eveningness preference, that is, the degree to which an individual feels and operates at his or her personal best during mornings versus evenings. This tendency defines an individual's optimal versus nonoptimal time of day (Horne & Ostberg, 1976), which in turn influences cognitive performance across the day (Yoon et al., 2000).

During nonoptimal times of day, processing resources are less readily available (Bodenhausen, 1990). Lower levels of processing resources lead to less use of effortful, controlled, deliberate processing and greater reliance on automatic, associative, and affective processing (Kahneman & Frederick, 2005; Stanovich & West, 2002). Moreover, lower levels of processing resources are associated with reductions in inhibition, influencing the momentary contents of working memory (Hasher et al., 1999). This lower inhibition may clutter or enrich contents in working memory (May, 1999; May & Hasher, 1998; Rowe, Valderrama, Hasher, & Lenartowicz, 2006), with implications for performance that depend on task demands. For instance, recent evidence suggests that implicit memory retrieval is likely to be facilitated by more nonconscious, associative processing and hence be better at nonoptimal times of day, whereas explicit retrieval is likely to be better at optimal times of day (May et al., 2005). Thus, during nonoptimal times of day, inhibition is lower and associative processing is more likely to affect behavior.

Positive Emotions, Nonoptimal Times, and Fluid Processing

When processing resources and inhibition are more limited (i.e., during nonoptimal times of day), we expect incidental emotion to have a larger impact on processing. During nonoptimal times of day, reliance on associative processing should increase, making the core themes, thoughts, and action tendencies associated with an incidental emotional experience more accessible. Conversely, during optimal times of day individuals will be more likely to correct for or block out affective information because of heightened inhibitory control, particularly if affective information is incidental, and hence likely to be perceived as irrelevant to the task at hand. The greater accessibility of and receptivity to affective information at nonoptimal times should enhance the influence of incidental emotional associations on subsequent judgments and behaviors. Thus, during nonoptimal times of day lower inhibition and greater reliance on associative processing may make the emotion's associated thoughts and tendencies more influential.

In this article, we focus on the differential effects of hope versus pride during nonoptimal times of day. Specifically, we show how hope and pride differentially influence judgment in contexts requiring *fluid* processing. Both fluid processing and fluid intelligence refer to the ability to reason and solve new problems independently of previously acquired knowledge and are critical for a wide variety of cognitive tasks (Cattell, 1971; Jaeggi, Buschkuehl, Jonides, & Perrig, 2008). Fluid processing requires openness and the ability to let in information or inputs and is associated with abstract reasoning and mental exploration. We expect that emotional states that engender greater cognitive flexibility and mental exploration (e.g., hope) will facilitate performance on problems or tasks requiring fluid processing more than emotional states that do not (e.g., pride), particularly during nonoptimal times of day. It is important to note that we do not expect emotional states to impact performance on tasks requiring *crystallized* intelligence (i.e., tasks that require skills and knowledge from past experience), even at nonoptimal times. Research suggests that highly practiced responses (i.e., elements of crystallized knowledge) are invariant across the day; however, attentional regulation over incoming information and outgoing responses that are not highly practiced (i.e., fluid intelligence) is particularly vulnerable to time of day effects (Hasher, Goldstein, & May, 2005). We argue that this more contingent nature of fluid, versus crystallized, tasks will extend to the impact of emotional associations. Thus, we hypothesize that hope will increase fluid processing (relative to pride) during nonoptimal times of day.

Experimental Overview and Hypotheses

We test our hypothesis in three different experimental task contexts. The first experiment uses an established paradigm from the literature on circadian rhythm and involves fluid versus crystallized intelligence measures with clear performance criteria. Previous research has shown that individuals perform better on fluid intelligence tasks during their own optimal time of day (Goldstein, Hahn, Hasher, Wiprzycka, & Zelazo, 2007). In contrast, individuals' performance on crystallized intelligence tasks requiring access to and production of well-learned or familiar responses is unaffected by time of day (May, 1999). In the first experiment, we replicate this established time of day effect in a neutral emotional state (Goldstein et al., 2007) and then extend these findings by showing that positive incidental emotion moderates the relationship between nonoptimal time of day and performance on fluid intelligence tasks. The second experiment examines the fluid processing phenomenon in the context of preference assessment, a fundamental psychological process which involves determining one's personal estimate of an object's worth. Recent views of preference assessment (Bettman, Luce, & Payne, 1998; Kahneman, Knetsch, & Thaler, 2005; Lerner, Small, & Loewenstein, 2004), especially for nonfamiliar items, have argued that it is a constructive process (Bettman et al., 1998) and hence requires fluid processing. That is, preferences may often be determined on the spot at the time of assessment rather than being retrieved or based on preexisting estimates. We show that two different positive emotions (hope and pride) differentially influence individuals' willingness to pay during nonoptimal times of day (see Cryder, Lerner, Gross, & Dahl, 2008, for influences of sadness on buying prices). The third experiment replicates our effects for preference and valuation and provides direct evidence for the process by which hope has its effects (i.e., increased imagination and mental exploration).

We hypothesize that during nonoptimal times of day hope will promote more fluid processing, that is, more mental exploration and generation of possibilities, than pride. In Experiment 1 we use an intelligence task where fluid processing appears to facilitate generation of possible solutions and ultimately performance. In Experiments 2 and 3 we use two different preference valuation tasks where fluid processing seems likely to facilitate generation of possible or potential uses for considered items. As a result, we expect hope, but not pride, to increase performance on measures of fluid problem-solving (Experiment 1) and valuation of items in assessing preferences (Experiments 2 and 3) during nonoptimal times of day.

Experiment 1

Method

Participants. A total of 103 adults (78 women and 25 men) ranging in age from 20 to 74 (M = 43.3 years, SD = 13.09) completed the computer-based study in a laboratory or online. Participants were recruited through email requests and online postings. The sample included university employees recruited from the campus community and general population adults provided by a national online data provider (Greenfield Online). All participants completed a pretest online and then were asked either to report to the behavioral lab or to log on to a Web site to complete the main study during a randomly assigned window of time. As the results reported below do not differ between these two groups, the data were collapsed.

Procedure and materials. Experiment one consisted of a 2 time of day (optimal vs. nonoptimal) × 3 emotion induction (hope, pride, neutral) between subjects factorial design.

Task 1 (prescreener). Approximately 1 week before participating in the main experiment, participants were asked to complete the Horne and Ostberg (1976) Morningness-Eveningness Questionnaire (MEQ), a validated individual measure of when people reach their functional peak during the day (i.e., "optimal time of day"). Participants were categorized as morning-types or evening-types based on established scoring procedures (see Bodenhausen, 1990; Kruglanski & Pierro, 2008) and then randomly assigned to take the main experiment in the morning (7:00 a.m.–9:30 a.m.) or the evening (4:00 p.m.–6:30 p.m.). Thus, participants were randomly assigned to take the study at their "optimal" time of day or "nonoptimal" time of day.[2]

Task 2 (emotion induction). Upon arrival for the main experiment, participants were randomly assigned to an emotion induction condition (hope, pride, neutral). Following Lerner and Keltner's (2001) procedure, participants in the hope or pride conditions were asked to (1) think about three to five things that make them most hopeful (proud) and (2) describe in more detail "one situation that makes you, or has made you, feel most hopeful (proud)." The remaining participants (neutral condition) were asked to write about their own regular daily routine. A series of linguistic (Pennebaker, Booth, & Francis, 2007) and content analyses were conducted on each participant's writing sample to ensure that the emotion induction had its intended effect.[3] The total amount of time participants spent on the emotion induction was recorded by the computer. The amount of time spent on the emotion induction was included as a covariate in all three studies to ensure time spent on task or depletion did not account for our results.

Task 3 (intelligence tasks). Next, participants were asked to complete two measures of intelligence. The first task was a measure of fluid intelligence called "Matrix Reasoning," taken from the Wechsler Abbreviated Scale of Intelligence (WASI 1999; see Goldstein et al., 2007). This task involved a series of 20 pictures. In each picture there was a missing piece and participants were asked to choose which of five possible options would best complete the picture. Next, participants were asked to complete a test of crystallized intelligence consisting of 20 vocabulary questions (Kaplan & Saccuzzo, 2005, see Goldstein et al., 2007) using analogies and sentence completion taken from a GRE preparation booklet (Green & Wolf, 2003).

Results

The focal dependent measure in this study was performance on the fluid intelligence picture task, which was measured as the number of questions answered correctly (out of 20). Similarly, performance on the crystallized vocabulary task was measured as the number of questions answered correctly (out of 20).

Replication of basic time of day effect. We first report replication of the basic effect that participants in a neutral emotional state perform better on fluid, but not crystallized, intelligence measures at optimal times. For the neutral condition only, an ANOVA revealed a main effect of time of day on the picture task, $F(1, 31) = 4.03$, $p < .05$, with better performance at optimal times ($M_{\text{optimal}} = 16.6$, $SD = 1.39$) than at nonoptimal times ($M_{\text{nonoptimal}} = 15.0$, $SD = 2.81$). There was no effect of time of day on crystallized intelligence, that is, the vocabulary task ($F < 1$). In testing the main hypotheses below,

[2] Participants recruited at the university reported to the lab at their assigned time and participants recruited online were allowed to sign-on and take the main experiment only in their assigned time slot. No-show rates did not differ by optimal versus nonoptimal times of day in Study 1 ($p >$ .5), Study 2 ($p >$ .3), or Study 3 ($p >$ .3).

[3] Linguistic (LIWC2007) and content analyses show that hope and pride were significantly higher than neutral on all measures of affective processing (i.e., total affect, positive emotion, and negative emotion). Hope and pride were equal in positive emotion and total affect in Studies 1 and 3; hope was higher than pride in Study 2. Hope and pride were equal in negative emotion and anxiety in all three studies. Hope and pride were also equal in word count and words per sentence.

the vocabulary score was included as a covariate to control for differences in verbal ability.[4]

Main hypothesis. The primary purpose of Experiment 1 was to understand the effect of emotion on fluid task performance at optimal versus nonoptimal times of day. To this end, we conducted an ANOVA with emotion condition and time of day (optimal vs. nonoptimal) as predictors, fluid intelligence (picture task) performance as the dependent variable, and vocabulary performance and total time on the emotion induction as covariates. As expected, results revealed a 2-way interaction of emotion condition and time of day, $F(2, 95) = 3.27$, $p = .04$; see Figure 1. In probing this interaction, we first analyzed the impact of emotion at nonoptimal times of day using planned contrasts. As predicted, hope led to better performance than pride at nonoptimal times of day; $F(1, 95) = 4.51$, $p < .04$; $M_{\text{hope nonoptimal}} = 16.94$ ($SD = 2.41$), $M_{\text{pride nonoptimal}} = 15.21$ ($SD = 3.87$). Hope also led to better performance than neutral at nonoptimal times of day; $F(1, 95) = 4.43$, $p = .04$, $M_{\text{hope nonoptimal}} = 16.94$ ($SD = 2.41$), $M_{\text{neutral nonoptimal}} = 15.00$ ($SD = 2.81$). Results revealed no difference between neutral and pride ($F < 1$). Next, we analyzed the impact of emotion at optimal times of day. As predicted, the difference between emotions did not impact performance at optimal times of day (hope vs. pride, $F < 1$; hope vs. neutral, $F(1, 95) = 1.69$, $p = .20$; neutral vs. pride $F < 1$). It is interesting to note that within the hope condition, participants at their nonoptimal time of day actually performed better than their optimal counterparts ($F(1, 95) = 3.69$, $p = .06$; $M_{\text{hope optimal}} = 15.44$ ($SD = 2.71$), $M_{\text{hope nonoptimal}} = 16.94$ ($SD = 2.41$).

Thus, the results of Experiment 1 show that two different positive emotions, hope and pride, affect processing differentially at nonoptimal times of day. Specifically, hope increases fluid processing and improves performance during nonoptimal times of day compared with pride and a neutral emotional state. We argue that individuals experiencing hope during nonoptimal times of day are guided by hope-related associations and are more likely to engage in mental exploration, that is, visualizing shapes and generating solutions, when solving matrix reasoning problems, improving task performance. In Experiment 2, we examine the implications of facilitating fluid processing in a task in which preferences are determined in real-time (i.e., constructive preferences).

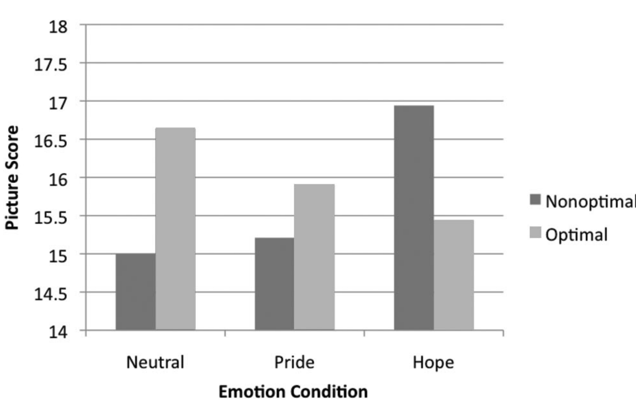

Figure 1. Mean picture scores in Experiment 1 as a function of emotion condition and time of day (optimal vs. nonoptimal).

Experiment 2

Method

Participants. A total of 117 university students (74 women and 43 men) ranging in age from 18 to 29 ($M = 21$ years, $SD = 1.68$) were recruited to take a decision-making study in the university's behavioral lab.

Procedure and materials. The research design was a 2 time of day (optimal vs. nonoptimal) × 3 emotion induction (hope, pride, neutral) between subjects factorial design. The time of day and incidental emotion manipulations were accomplished exactly as in Experiment 1. After the emotion induction, participants were asked to indicate how much they would be willing to pay for a variety of items; willingness to pay is one standard approach for assessing an individual's preference for an item (Bettman et al., 1998). Seven items were adopted from Vohs and Faber (2007), designed to reflect items for which participants would have little repeat-purchasing experience (e.g., stove or fine jewelry as opposed to repeat-purchase items such as food or rent) and thus little crystallized knowledge to draw from in constructing their willingness to pay estimates. We believe that in this task the fluid processing associated with hope will facilitate generation of usage possibilities for relatively unfamiliar items, potentially leading to increased willingness to pay.

Results

We conducted an ANOVA with emotion condition and time of day (optimal vs. nonoptimal) as predictors, the total amount of money that a participant was willing to pay for the collection of items as the dependent variable, and total time spent on the emotion induction as a covariate. Results revealed a 2-way interaction of emotion condition and time of day, $F(2, 110) = 3.14$, $p = .05$ (Figure 2). To test the hypothesis that hope would lead to greater valuation of items than pride in the nonoptimal condition, we ran a contrast, $F(1, 110) = 7.01$, $p < .009$ that confirmed the prediction; $M_{\text{hope nonoptimal}} = \$4,113.71$ ($SD = 5,212.89$), $M_{\text{pride nonoptimal}} = \$1,410.36$ ($SD = 428.26$). We also ran a contrast to test the hypothesis that hope would lead to greater valuation than neutral in nonoptimal conditions ($F(1, 110) = 4.49$, $p = .04$; $M_{\text{hope nonoptimal}} = \$4,113.71$ ($SD = 5,212.89$), $M_{\text{neutral nonoptimal}} = \$2,391.63$ ($SD = 1,518.16$). Results revealed no difference between neutral and pride, $F(1, 110) = .79$, $p = .38$, although pride was directionally lower. Further, as predicted, the emotion inductions did not significantly impact performance at optimal times of day (all Fs < 1). Although not predicted, for the pride condition, participants in the nonoptimal condition were willing to pay significantly less than their counterparts in the optimal condition, $F(1, 110) = 4.80$, $p = .03$; $M_{\text{pride optimal}} = \$3,420.70$ ($SD = 2,594.31$), $M_{\text{pride nonoptimal}} = \$1,410.36$ ($SD = 428.26$). Within the hope condition, participants at their nonoptimal time of day were willing to pay directionally more than their optimal counter-

[4] Neither the emotion condition ($p > .8$) nor the interaction of emotion condition and time of day ($p > .8$) influenced performance on the vocabulary task.

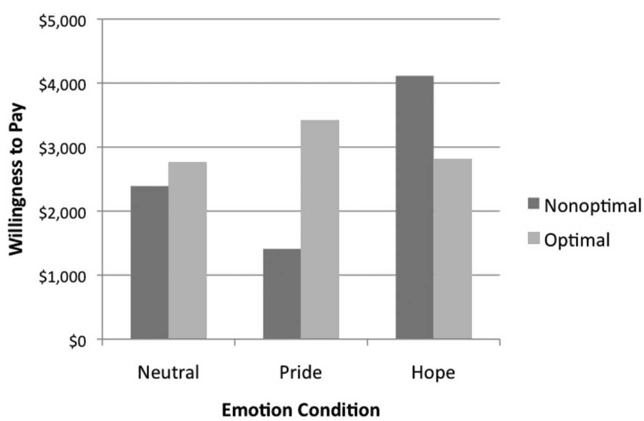

Figure 2. Mean willingness to pay estimates in Experiment 2 as a function of emotion condition and time of day (optimal vs. nonoptimal).

parts, $F(1, 110) = 1.84$, $p = .18$; $M_{\text{hope optimal}} = \$2,811$ (SD = 2,944.64), $M_{\text{hope nonoptimal}} = \$4,113.71$ (SD = 5,212.89).

Thus, Experiment 2 again demonstrates that two different positive emotions, hope and pride, affect processing differentially at nonoptimal times of day. Specifically, hope increases individuals' willingness to pay for items with which they have little prior knowledge or experience compared with pride and a neutral condition during nonoptimal times of day. We argue that individuals experiencing hope during nonoptimal times of day are guided by hope-related associations, resulting in greater mental exploration when constructing willingness to pay estimates. We argue that this increased mental exploration (e.g., visualizing possible uses for the products) increases individuals' preference assessments, that is, the valuation placed on the items. In Experiment 3, we directly test this process.

Experiment 3

Method

Participants. A total of 88 university students (31 women and 57 men) ranging in age from 18 to 26 (M = 19.6 years, SD = 1.64) were recruited to take a decision making study on campus. Experiment 3 was administered via laptop computers brought to an undergraduate dormitory.

Procedure and materials. The research design was a 2 time of day (optimal vs. nonoptimal) × 2 emotion induction (hope vs. pride) between subjects factorial design. The time of day and incidental emotion manipulations were accomplished exactly as in studies 1 and 2. After the emotion induction, participants were shown pictures and descriptions of three innovative, new products with which they had no prior experience.[5] To directly test the proposed mechanism by which hope and pride differentially affect individuals' mental exploration, participants were asked to indicate how well they could imagine situations in which they could use each product (where 1 = *very difficult to imagine* and 9 = *very easy to imagine*). Next, in order to capture individuals' overall assessments of the products, we asked participants to indicate how interested they would be in trying each product (where 1 = *not at all interested* and 9 = *very interested*) and how much they would be willing to pay for each item. Finally, to control for participants' chronic attitudes toward trying new things, participants were asked to rate their agreement with nine statements designed to measure their chronic attitudes toward new product risk (e.g., I am the kind of person who would try any new product once; Raju, 1980) on a 7-point Likert scale (where 1 = *completely disagree* and 7 = *completely agree*; $\alpha = .76$). This measure was not affected by the emotion or time of day manipulations ($ps > .15$).

Given that participants were shown products that were quite novel, they had little crystallized knowledge to draw from in constructing their product assessments. Accordingly, the fluid processing associated with hope was expected to facilitate participants' ability to imagine uses for the products, and thus enhance their preference and valuation, particularly at nonoptimal times of day.

Results

In order to test our hypothesis that the effect of hope and pride differentially impacts product assessments at nonoptimal (but not optimal) times of day, we conducted an ANOVA with emotion condition and time of day (optimal vs. nonoptimal) as predictors, and total time on the emotion induction and chronic attitude toward new product risk (Raju, 1980) as covariates. The dependent variable, designed to capture individuals' overall product assessments, was a standardized index including both the total amount of money that participants were willing to pay for the set of items and their mean rating of their interest in the new products.[6] Results for this index revealed a 2-way interaction of emotion condition and time of day, $F(1, 82) = 3.97$, $p = .05$ (Figure 3). To test the hypothesis that hope would lead to a more positive assessment of items than pride in the nonoptimal condition, we ran a contrast, $F(1, 82) = 5.86$, $p < .02$ that confirmed the prediction; $M_{\text{hope nonoptimal}} = .36$ (SD = .93), $M_{\text{pride nonoptimal}} = -.17$ (SD = .68). As predicted, the hope and pride emotion inductions did not significantly impact assessments at optimal times of day ($F < 1$).

Having established that the effect of emotion on product assessment depends on time of day optimality, we sought to test the mechanism for our hypothesis, that is, why hope leads to more positive assessments than pride during nonoptimal times of day. We argue that individuals experiencing hope during nonoptimal times of day exhibit increased mental exploration and imagination for using the products.[7] Thus, we followed the steps recommended by Muller et al. (2005) for establishing mediated moderation. First, as indicated above, the effect of emotion on product assessment is moderated by time of day, $\beta = .32$, $t(82) = 1.99$, $p = .05$. Second, results reveal that the effect of emotion on individuals' reported ability to imagine using

[5] Products included: Pure shots of oxygen (O_2) from small aluminum canisters to give energy; a mobile library the size of a cell phone that reads books to you and acts as a scribe; a cell phone with unlimited reach, even in remote areas across the world, with several weeks of battery life. We thank Dave Alexander for sharing stimuli with us.

[6] The willingness to pay estimate and interest ratings were significantly correlated ($r = .30$, $p < .005$).

[7] We also coded the writing samples for evidence of other potential intervening processes (e.g., certainty, complexity, distraction, emotion intensity) suggested by reviewers as alternative mechanisms. When included in the analyses, these variables were not significantly related to our dependent measures.

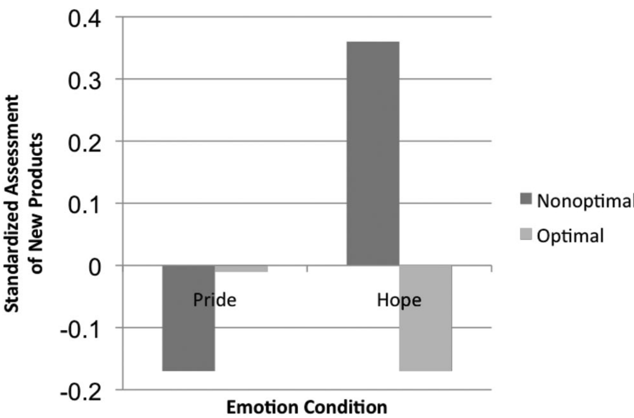

Figure 3. Standardized assessments of new products in Experiment 3 as a function of emotion condition and time of day (optimal vs. nonoptimal).

the products depends on time of day optimality, $\beta = .39$, $t(82) = 2.45$, $p = .02$. Third, the partial effect of the ability to imagine using the products on product assessment is significant, $\beta = .62$, $t(80) = 5.14$, $p < .0001$, when controlling for emotion condition, time of day condition, the interaction of emotion and time of day conditions, and the interaction of the ability to imagine and time of day (as well as the two covariates used in each model: total time on emotion induction and chronic attitudes toward new product risk). It is important to note that the original interaction of interest—emotion by time of day optimality—is no longer significant when the imagination mediator is included, $\beta = .08$, $t(80) = .59$, $p = .56$, indicating full mediated moderation.

In sum, Experiment 3 further demonstrates that different positive emotions, hope and pride, differentially affect processing at nonoptimal times of day. Specifically, hope enhances individuals' assessments of new items with which they have little prior knowledge or experience relative to pride during nonoptimal times of day. We further demonstrate that this effect is mediated by an enhanced ability to imagine uses for products. These findings support our hypothesis that hope-related associations facilitate greater mental exploration, which in turn, increases individuals' preference and valuation assessments, during nonoptimal times of day.

General Discussion

Our findings demonstrate that different positive emotions can have different effects on task performance at nonoptimal times of day. For tasks requiring crystallized knowledge or experience, performance is invariant with respect to emotion or time of day. However, in the case of tasks requiring fluid processing, emotion and time of day combine to determine performance. In particular, the effects of hope and pride diverge during nonoptimal times of day. Experiment 1 shows that hope facilitates fluid processing and improves performance on a fluid intelligence task with clear performance criteria during nonoptimal times of day. Experiment 2 shows that hope increases fluid processing and valuation estimates in a context where preferences are constructed on the spot during nonoptimal times of day. Experiment 3 shows that hope increases preference and valuation by increasing imagination and mental exploration during nonoptimal times of day. Together these experiments suggest that fluid and constructive processing styles can be differentially influenced by the goal orientations and associations linked with different positive emotions in predictable situations, that is, during nonoptimal times of day. We suggest that these effects occur because of lower inhibition during nonoptimal times of day. Our findings are consistent with previous work emphasizing the importance of understanding thoughts and behavioral tendencies associated with specific emotions (Han, Lerner, & Keltner, 2007). Experiment 1 offers evidence that lower inhibition can lead to better performance for hope as opposed to pride. However, there may be situations when lower inhibition and greater mental exploration are undesirable. Thus, an important question for future research is under what conditions and for what tasks might hope improve versus degrade judgment quality at nonoptimal times of day.

Our work contributes to emotion theory by addressing the question of when different positive emotions motivate and facilitate different types of behaviors. Most research has suggested relatively undifferentiated positive affect and emotion mechanisms (Fredrickson, 1998, 2001; Isen & Daubman, 1984; Isen, 2001). However, we identify an important condition (nonoptimal time of day) under which distinct positive emotions differentially motivate and facilitate unique behaviors. Thus, our work points to differential effects of distinct positive emotions that may coexist with more generalized mechanisms such as broaden and build.

Our work also expands on prior work on circadian rhythm demonstrating that fluid intelligence is degraded under nonoptimal times of day but further shows that associations with hope actually seem to reverse this effect. Our findings are consistent with a view of fluid intelligence task performance as relatively labile and subject to influence from a wide array of cognitive and emotional factors. Our work is also consistent with other recent research (e.g., see Rowe et al., 2006) indicating that, for some task contexts, performance under nonoptimal times of day might actually be better than performance during optimal times or nonemotional conditions (Levens & Phelps, 2008). We argue this may be particularly true when experiencing specific emotions (in our experiments, hope). In the case of hope in our first study, it appears that lowered inhibitory control under nonoptimal times of day allowed positive, goal-striving associations with hope to have stronger effects, ultimately resulting in better performance on a fluid intelligence task.

Our research identifies time of day as an important member of a class of moderators impacting when individuals are more or less likely to be influenced by their emotions. Thus, optimal versus nonoptimal time of day may be a useful methodological tool for researchers interested in isolating or manipulating emotion-based effects. In addition, previous research has shown that older adults demonstrate superior cognitive performance for emotional information (relative to nonemotional information) and that these effects are most evident when emotional content is positively valenced (Carstensen & Mikels, 2005). It is interesting to note that older adults also show less inhibition (Hasher et al., 1999). Based on these findings, our emotion specific effects for fluid processing during nonoptimal times of day may be more pronounced for older adults. This would also suggest that emotion-association effects on processing (e.g., which we demonstrate with nonoptimal time of day) may be more prevalent with age.

Finally, it is worth noting that we demonstrate our effects using incidental emotions (i.e., emotions not directly relevant to the task at hand). For emotions directly relevant to the focal task (i.e., integral emotions), correction processes may be more likely. Future research should further examine how emotion type (e.g., integral vs. incidental), specific emotions (e.g., hope vs. pride), resource availability, and task constraints combine to shape task performance.

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