

IS COGNITIVE PERFORMANCE CHANGED BY HOPE AND JOY?

by

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## THESIS ABSTRACT

### IS COGNITIVE PERFORMANCE CHANGED BY HOPE AND JOY?

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Two positive emotions – hope and joy – were examined with regard to whether they affect performance on creative thinking and critical thinking tasks. Previous theory and research on hope and joy, as well as on positive affect, suggested that joy would cause a greater increase in creative thinking and hope would cause a greater increase in critical thinking. These differences were empirically tested by manipulating the emotional state of participants and measuring performance on creative and critical thinking measures. We measured creative fluency with the Alternate Uses Task, creative choice with a “Top 2” selection of alternate uses, critical editing by comparing the “Top 2” to best uses, and critical reading with an SAT-style “passage-based reading”(PBR). Creative fluency was improved by joy when the PBR was administered first, suggesting that emotional state plays a role in creativity but is moderated by additional factors. Participants’ selection of Top 2 responses were not found to be significantly influenced by emotional state, but further research is suggested to improve the validity of this measure. Critical reading was not influenced by emotion. These results build on the existing knowledge of hope and joy and cognitive performance – including some support of a functionalist view of positive emotions.

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## **Introduction**

### **Background and Significance**

This research was conducted to further scientific knowledge of the effects that emotional state has on cognitive performance. Specifically, the current research looked at the effects that joy and hope have on creative thinking and critical thinking. These effects are important for two reasons. They are important first as basic research; knowledge of these emotions builds on the existing scientific literature – increasing our ability to describe the effects of each emotion and our understanding of how individuals interact and function within their environment. Secondly, this research has applicable outcomes; knowledge about how emotions affect cognitive performance is useful in education, organizational psychology, and motivational psychology. While evidence exists that positive affect and hope increase certain types of cognitive performance (Isen, 2008; Snyder, Lopez, Shorey, Rand & Feldman, 2003), joy and hope had not been directly compared, and not on any of these tasks.

Emotions are currently theorized to be caused by appraisals of situations (e.g., Frijda, 1989; Roseman, 2004). For instance, joy can arise when a situation is appraised as consistent with appetitive motives (rewarding) and certain to occur (Roseman, 2001; Roseman, 2013). These same emotions have a number of components, including behaviors, goals, and perhaps facial expressions (Roseman, 2013; Scherer, 2005). Zajonc (1998) divides emotions from cognition by specifying that emotions are manifested by an approach/avoidance tendency and cognition is manifested by a true/false understanding. Emotions can be considered states of readiness for dealing with situations (Frijda, 1986; Shiota, 2014).

Recently there has been a growing focus on positive psychology (Fredrickson, 2001; Seligman & Csikzentmihalyi, 2000; Sheldon & King, 2001). Positive emotions have received increased attention because of this shift toward studying the positive side of affective variables (Fredrickson, 2001; Fredrickson, 2004; Fredrickson, 1998; Roseman, 2013). Positive psychology and positive emotions are attracting greater interest as findings show that non-pathological and positive experiences have important health and psychological outcomes (Fredrickson & Levenson, 1998; Fredrickson & Losado, 2005; Cohen & Pressman, 2006; Lyubomirsky, King, & Diener, 2005). This is exemplified by the first handbook of positive psychology (Snyder & Lopez, 2002) followed by the first handbook of positive emotions (Tugade, Shiota, & Kirby, 2014). Fredrickson has proposed the Broaden and Build Theory of Positive Emotions (Fredrickson, 1998; Fredrickson, 2001; Fredrickson, 2004; Fredrickson & Levenson, 1998; Fredrickson & Losada, 2005). This functionalist perspective asserts that positive emotions broaden our scope of thinking about the world, and also that positive emotions build our cognitive, social, and physical resources. Thus, experienced emotions change how we think and how we act. The Broaden and Build theory has been supported empirically in a variety of situations (e.g., Fredrickson & Branigan, 2005). Positive emotions and negative emotions can be interpreted as survival adaptations. The emotion fear creates responses that allow escape (from a predator, for example), and we are interested in whether emotion hope creates responses that facilitate reaching for desires and goals (by enabling behaviors that are needed to achieve the goals).

The main purpose of the present study is to test whether hope has a different effect on certain types of cognitive performance than joy. This builds upon existing

research which shows that positive affect causes improvement to certain cognitive performances. Isen (2008) reviews a variety of channels through which positive affect increases flexibility and improves decision-making. Lyubomirsky et al. (2005) found that positive affect is a better predictor of good decision-making when a problem is seen as important, which suggests that hope will lead to better decision-making than joy, as hope is predicated upon desire for goals, and goals may be important.

**Joy.** Joy tends to increase attentional scope (Fredrickson & Branigan, 2004). Joy is felt when things are going well, and we are sure of it (Roseman, 2001). Joy may be less likely to have an explicit object of focus than hope (Roseman, 2001). Joy has been described as a form of free activation (Frijda, 1986, p.89) - "[it] is in part aimless, unasked-for readiness to engage in whatever interaction presents itself and in part readiness to engage in enjoyments." In Frijda, Kuipers, and ter Schure (1989), joy was associated with increased readiness for approach behaviors and exuberant behaviors. Joy appraisals were characterized by pleasantness and certainty. Similarly, in Roseman, Swartz, Newman, and Nichols (2010), joy experiences were associated with the self-reported responses "feel as if everything were more vivid" and "feel a sense of lightness in your movements." Fredrickson (1998), p. 305, who describes joy as part of the Broaden and Build theory of Positive Emotions, sees joy as "pointing to no single set of actions" and notes that joy leads to "play, especially imaginative play, is to a large degree unscripted." Specifically, "joy...broadens an individual's thought-action repertoire."

**Hope.** Hope occurs when something is desired, but not yet attained (Snyder et al., 1991). Perhaps because of this, hope is a great motivator while working towards a goal (Atkinson, 1957). Hope has been described as being goal, pathway, and agency oriented



(Snyder, Feldman, Shorey & Rand, 2002), where goals are desired outcomes and pathways are cognitive structures and processes that aid goal achievement by providing means to reach goals. Agency is the perceived capacity to reach a goal (Snyder, Rand, & Sigmon, 2003). Hope has been shown to increase development of alternative pathways, positive beliefs about oneself, and academic achievement (cf. Snyder et al., 2003). Hope of success has been correlated with goal striving in the achievement and motivation literature. For instance, amongst female soccer players, hope of success was more highly correlated with striving for perfection than was fear of failure, and hope of success was more related to internal attribution of success (Stoeber & Becker, 2008). Also, students with higher levels of hope have been shown to procrastinate less on a variety of school assignments (Alexander & Onwuegbuzie, 2007).

**Dependent variables.** In order to further understanding of hope and joy as potentially adaptive responses, we looked at their effects on performance on cognitive tasks. We attempted to find tasks that would prove suited to each emotional state (hope and joy), and which would test different cognitive abilities. This research dealt with four dependent variables encompassing creative thinking (creative fluency and creative choice) and critical thinking (critical editing and critical reading). The two creative thinking variables represented two separate parts of a creative process – generation (i.e., coming up with ideas) and refinement (i.e., continuing with the best ideas). The two critical thinking variables represented different decision-making tasks – critical editing (i.e., choosing the best ideas among items of varied value) and critical reading (deciding which of various alternatives is the best answer to a question).

The central question in this study was whether different positive emotions affect

particular cognitive performances differently, rather than merely as a factor of positive affect in general. Lyubomirsky et al. (2005) show that people experiencing positive affect may be better at using strategies to process information when they find the task personally relevant. Positive affect has been shown to have mixed effects on decision-making but is beneficial in certain circumstances, for instance when the task is important (Lyubomirsky et al., 2005)--which suggests that people experiencing hope should perform better at decision-making. Insofar as a person feeling hope has a goal, so too would a task associated with that goal be important to that person. While the importance of different goals varies, we are asking participants to recall an experience where they felt intense hope, and so the associated goal may be at least somewhat important. Since experiencing hope requires a goal, the emotion may be associated with importance.

For these two tasks it was plausible to think that the hypotheses would be supported. There is already evidence that joy and positive affect increase both divergent thinking and verbal reasoning ability (Isen, 2008; Lyubomirsky et al., 2005). There is also evidence suggesting that hope, being associated with goals and thus personal importance, might increase critical thinking beyond just what positive affect will (Lyubomirsky et al., 2005). The current study contributes to the distinctions between the effects of hope and joy on creative and critical thinking.

### **Hypothesis 1 (a and b)**

Participants induced to feel hope were predicted to show greater performance at critical thinking than participants induced to feel joy. Those induced to feel joy were predicted to show greater performance at critical thinking than participants in the neutral condition. The independent variable is the emotional state that the participant was

induced to experience (Joy/Hope/Neutral), and the dependent variable is how well the participant performed at critical thinking (low performance...high performance). The independent variable is a categorical variable, and the dependent variable is continuous. Thus, the hypothesis was that specific emotions would cause different performance levels. Specifically, the neutral group would have the lowest scores, the joy group would have intermediate scores, and the hope group would have the highest scores. This hypothesis was tested using two facets of critical thinking (hypotheses 1a and 1b): critical reading and critical editing.

### **Hypothesis 2 (a and b)**

Participants induced to feel joy were predicted to show greater performance on creative thinking than those participants induced to feel hope or a neutral emotion. The independent variable was the emotion that the participant was induced to experience (Joy/Hope/Neutral), and the dependent variable was how well the participant performed at creative thinking (low performance...high performance). The independent variable was a categorical variable, and the dependent variable was a continuous variable. Thus, the hypothesis was that specific emotions would cause different performance levels. Specifically, the neutral group would have the lowest scores, the hope group would have intermediate scores, and the joy group would have the highest scores. This hypothesis was tested using two facets of creative thinking (hypotheses 2a and 2b): creative fluency and creative choice.

## Method

### Overview

After consent was obtained, participants listened to an audio recording asking them to recall an emotion-eliciting event and attempt to re-experience it. Table 1 presents these and other procedures which include a manipulation check, two sections measuring dependent variables broken up by a manipulation refresher, and a section asking qualitative and demographic information for the study.

Table 1  
*Summary of Experimental Procedure*

Step Number	Procedure Description
1	Arrival and Consent
2	Spoken Instructions about the study and headphone use
3	Emotion Induction: Hope / Joy / Neutral (audio track for relived experiences)
4	Manipulation check (current emotion state) and possible mediating variables check
5	Task 1: Group I: AUT; Group II: PBR (assigned at random)
6	Emotion Induction refresher: Hope / Joy / Neutral (audio track and relived experiences)
7	Task 2: Group I: PBR; Group II: AUT (whichever task not performed first)
8	Questions measuring possible moderating variables
9	Questions on content of recalled experience
10	Demographics (age, sex)
11	Debriefing (handed out debriefing sheet & asked participants questions)

*Note.* AUT = Alternate Uses Task. PBR = Passage Based Reading.

This study experimentally tested four hypotheses (1a, 1b, 2a, 2b). These hypotheses concern possible differences in cognitive performance caused by the

experience of different emotional states (Joy/Hope/Neutral). The measures used to test the cognitive differences were the alternate uses task (AUT), a Top 2 (most creative) selection task based on the AUT, and an SAT style “Passage Based Reading” (PBR) comprehension task. The number of responses on the AUT task, and the average creativity rating of the responses on the Top 2 selection task were used to measure creative thinking. The PBR and a comparison of the participants’ Top 2 selection against independently rated best 2 responses for that participant were used to measure critical thinking. The reasons for using these particular measures are discussed below.

The design of this experiment has emotions and order as between-subjects factors. Since the same participants completed all four dependent measures, these could be considered repeated measures or separate variables. Participants were randomly assigned to the joy group, the hope group, or the neutral group, and were also randomly assigned to a task order. The data collected on the dependent variables, possible moderating variables, and possible mediating variables were analyzed between these groups.

### **Manipulations**

The manipulation of participants’ emotional state was based upon that used by a number of researchers (e.g., Ekman, Levenson, & Friesen, 1983; Salovey & Birnbaum, 1989). These manipulations have been useful in inducing positive and negative affect as well as neutral emotional state. For the current study, we employed the manipulation to elicit specific positive and neutral emotional states, rather than happy, sad, or neutral moods.

These manipulations were evaluated for reliability and construct validity by Salovey and Birnbaum (1989). Their mood manipulation was compared to scores on a

Six-Item Mood Check (Amrhein, Salovey, & Rosenhan, 1981) and the Happiness subscale from the Differential Emotions Scale (Izard, 1971). These scales indicated a difference in mood at a  $p < .001$  level using a one way MANOVA (Salovey & Birnbaum, 1989). This mood induction procedure was previously used successfully, (e.g., Salovey & Singer, 1989; Brewer, Doughtie, & Lubin, 1980). Similar manipulations were also used to elicit emotions (e.g., Ekman, Levenson, & Friesen, 1983; Roseman, Wiest, & Swartz, 1994). Since we adapted the instructions for use with discrete emotions, we performed pilot testing to insure that they were manipulating emotions correctly. In order to do this, we ran pilot sessions in a lab group of undergraduate and graduate students and eventually tested the full manipulation on pilot undergraduate and graduate participants. The effectiveness of the manipulation was further checked on actual participants during data analysis (see Results section below).

### **Measures of Creative Thinking**

**Alternate uses task: measure of creative fluency.** Divergent creativity is a common facet of creativity, and the ability to come up with novel ideas seems to be a fundamental aspect of creative thinking (e.g., Guilford, Christensen, Merrifield, & Wilson, 1978; Silvia et al., 2008). It's a likely candidate for being affected by mental state, as divergent creativity may be impeded by self-evaluation (Silvia & Phillips, 2004). The alternate uses task has been used in various experiments for 50 years to measure creativity (Guilford et al., 1978). Divergent creative thinking is measured by asking participants to think of uncommon uses for common objects such as a shoe, a key, and an automobile tire. These three objects were selected at random from among 6 objects used on the Alternate Uses Form B from Guilford, Christensen, Merrifield, and Wilson, 1978.

We wanted to use objects from this form because we had original scoring instructions for these items. We selected three items in order to have a shorter measure than the original six item form. We found that using three or fewer items was not uncommon in the recent literature (e.g., Silvia et al., 2008). Performance on this task has often been used as an operationalization of creative thinking or divergent creativity. Employing it here to test the differences between joy and hope allowed this study to be related to the existing literature on creativity. Participants were not expected to be familiar with the task, because it is not commonly used outside of research studies. Nevertheless, participants' familiarity with the task was checked (see below). The creativity required to come up with alternate uses has not changed since the introduction of the AUT. Following the method used in Guilford et al. (1978) for scoring the alternate uses task, the creative fluency measure is the total number of unique (not repeated by the same participant) answers given, excluding any answers that are either impossible uses or actual, intended uses of the item (for instance, using a brick to make a bicycle would be impossible, and using a brick to make a sidewalk is an intended use). The reliability and validity of this creative fluency measure has been assessed in a wide variety of ways, as indicated in Guilford et al. (1978).

According to Guilford et al. (1978), the alternate uses task is based on factor analyses looking at different types of flexibility of thinking, where unusual uses significantly loaded on a factor called spontaneous flexibility. Guilford et al. (1978) point out that no single instrument is expected to fully measure creativity, a viewpoint that is still held today (e.g., Silvia et al., 2008). Besides divergent thinking, Guilford et al. (1978, p.4), say there are “at least 29 other abilities” that are important to creativity,

and “there are 25 transformation abilities, 20 of which are outside the divergent-production category.” Still, according to Silvia et al. 2008, p. 68, “Divergent thinking is central to the study of individual differences in creativity.” In 1978 many studies were already utilizing alternate uses, and it remains a popular method of researching divergent creativity today. A Google Scholar search for “Alternate Uses” + Guilford returns over 900 articles, including over 500 since 2000. Research recent topics include *Intelligence, general knowledge and personality as predictors of creativity* (Batey, Furnham & Safiullina, 2010), *Creativity versus conscientiousness: Which is a better predictor of student performance?* (Chamorro-Premuzic, 2006), and *Emotion in children's play and creative problem solving* (Russ & Kaugars, 2001). In the latter study, p. 215, the authors said that “The Alternate Uses Test was chosen to measure divergent thinking because an impressive array of reliability and validity studies with children have been conducted with this measure.”

One reason to study creative fluency is that creativity has some correlation with intelligence (Guilford et al., 1978) and academic achievement. The alternate uses task was found to correlate somewhat with academic achievement with creativity tested in grade 8 and academic achievement measured in grade 12. According to Guilford et al. (1978), Owen, Feldhusen, and Thurston (1970, referenced by Guilford et al.) were able to increase prediction of nursing students' GPA from .55 to .74 for fourth semester GPA, using multiple regression incorporating creative fluency. The correlations raise the point that creativity is indicative of important cognitive processes that are helpful for the individual, indicative of academic ability, and that success on this measure is predictive of future success even when holding other variables constant. As discussed in Nusbaum



and Silvia (2011), the relationship between intelligence and creativity is an ongoing debate, with evidence suggesting that they are separate but somehow related abilities.

Scoring of this measure is explained fully in Appendix I. The basic process is to count the number of alternate uses given by each participant within the four minutes allowed, but discounting any that are duplicates (for the participant), actual intended uses, or impossible uses.

We used the task instructions from Guilford et al. (1978) rather than the instructions from Silvia et al. (2008). This was done intentionally to better match the original task and to measure implicit creativity rather than intentional creativity. The main difference in the instructions was that Silvia et al. (2008) specifically instruct participants to think of creative uses, whereas Guilford et al. (1978) asks participants to just think of uses other than the common use. The instructions used by Guildford et al. (1978) thus measure a more implicit expression of creativity, because the participants are not consciously intending to be creative, per se.

**Top 2 selection on the AUT: measure of creative choice.** In order to complement the generation task of the AUT, we want to look also at the creativity of those responses, so we asked the participants to select their Top 2 most creative uses among their responses to the AUT creative fluency measure. This final output is a measure of creativity showing best alternate uses according to the participant. Their ability to select their own work is a necessary step in many creative processes.

We adapted Silvia et al.'s (2008) measure of self-selected responses on the AUT by modifying their selection to apply to our multi-item task. Their top 2 selection was for just the brick item and allowed unlimited responses on that item, whereas our participants

were asked to choose two from amongst all of their responses for three items (shoe, key, tire), where there were a maximum of six responses per item (per Guilford et al., 1978). Asking our participants to choose top two responses across items made the task more similar to Silvia et al., 2008.

The creativity of these uncommon uses was then subjectively scored by three raters; the author and two other psychology graduate students. For each of the two selected alternate use responses, the ratings are averaged across the three raters. For hypothesis 1b, the average rating given by the raters to these two responses is the measure of creative choice. This measure represents the culmination of the participant's creative process for creating uncommon uses (generation, and then selection). Raters followed Silvia et al.'s (2008, p. 85), system for scoring alternate use responses –

“Creativity can be viewed as having three facets. Creative responses will generally be high on all three, although being low on one of them does not disqualify a response from getting a high rating. We will use a 1 (not at all creative) to 5 (highly creative) scale.

#### 1. Uncommon

Creative ideas are uncommon: they will occur infrequently in our sample. Any response that is given by a lot of people is common, by definition. Unique responses will tend to be creative responses, although a response given only once need not be judged as creative. For example, a random or inappropriate response would be uncommon but not creative.

#### 2. Remote

Creative ideas are remotely linked to everyday objects and ideas. For example,

creative uses for a brick are “far from” common, everyday, normal uses for a brick, and creative instances of things that are round are “far from” common round objects. Responses that stray from obvious ideas will tend to be creative, whereas responses close to obvious ideas will tend to be uncreative.

### 3. Clever

Creative ideas are often clever: they strike people as insightful, ironic, humorous, fitting, or smart. Responses that are clever will tend to be creative responses. Keep in mind that cleverness can compensate for the other facets. For example, a common use cleverly expressed could receive a high score.”

For example, in a previous study (Silvia et al., 2008), alternate uses for brick such as “sidewalk” or “make a patio” received a score of 1, and responses like “a nail file” and “make it into a superhero called The Wall and have him fight Erosion Man” received scores of 3 and 5 respectively. In the present study, using a shoe to be “the top end of a lacrosse stick to catch the ball” received a 5, and using a key to “dip in paint and use its shape on a painting” received a 4. Response like “tire swing” for a tire, or “to lock something” for a key, received scores of 1 in the present study. For additional explanation of scoring, see Appendix I.

Following Silvia et al. (2008), three raters were used. In that study, raters accounted for 4-8% of variance in scores, whereas participants accounted for 50-60% of variance between scores. Silvia et al. found that 57% of the variance in Top 2 scores between participants was accounted for by corresponding differences in Big-Five personality type and whether the student was an arts major, which suggests that the

measure has some criterion validity. In the factor analysis, openness was heavily loaded on the divergent thinking variable ( $B=.467$ ), and conscientiousness was negatively associated ( $B=-0.386$ ). In the current study, inter-rater reliability was analyzed using the intra-class correlation coefficient (Shrout & Fleiss, 1979).

### **Measures of Critical Thinking**

**Comparing top 2 AUT selection to best 2: measure of critical editing.** For hypothesis 2b, the scores of the participants' top two selected uses were compared with the best two (most creative) responses, according to raters' averaged scores. Thus, this measures the participants' ability to select their most creative responses from all the responses they generated. For example, if their actual best responses were given scores of 3 and 5 by the raters (average: 4), and their own chosen best responses were given scores of 1 and 5 (average 3), then they would have a critical editing score of  $4-3 = 1$ . This score ranges from 0 (high critical editing) to 4 (low critical editing).

**SAT passage based reading: measure of critical reading.** SAT style verbal reasoning tests are ubiquitous in American standardized testing. This allowed us to test the participants' performance on a familiar task. The task is our operationalization of our critical reading variable, because it required the participant to focus on particular pieces of information from the passage, ignoring irrelevant information, and choosing the correct answer. This forced the participant to use selective attention and decision-making processes. It is also important that they have had previous experience with this sort of task, so that they were able to utilize previously learned heuristics, an important factor in this measure.

The critical reading section of the SAT has a reported correlation of .49 with first

year college GPA scores (Collegeboard, 2009a). This can be considered evidence of criterion validity, insofar as GPA is related to critical thinking ability.

We used a passage based reading task from *10 Real SATs*, published and written by CollegeBoard (2003), which is the publisher of the SAT itself. The selected passage described researchers doing behavioral experiments on vervet monkeys. The participants were asked to carefully read the passage and then answer 12 questions about the details of the reading. Participants are given line numbers and words to indicate the relevant passage. For instance a selection of the passage reads:

When a leopard  
approaches, the monkeys climb into trees. But leopards are  
20 good climbers, so the monkeys can escape them only by  
climbing out onto the smallest branches, which are too  
weak to support a leopard. When the monkeys see a martial  
eagle, they move into thick vegetation close to a tree trunk  
or at ground level.

A question based on that section follows:

“4. In lines 18-24 ("when a leopard...level"), the author juxtaposes two kinds of behavior in order to

- (A) show how the presence of more than one observer in the field yields conflicting information
- (B) provide evidence that challenges an accepted theory about monkey communication
- (C) compare a unique form of defense to a more common form of defense
- (D) explain how the monkeys imitate behavior of other animals
- (E) emphasize the usefulness of different responses in different situations”

For question 4, the correct answer is E.

The 12 items on the measure were scored according to SAT scoring guidelines (+1 for each correct answer, - ¼ for each incorrect answer, and 0 for questions left blank) and the groups were statistically compared between-groups using a standard Analysis of Variance. For further details on SAT scoring see Appendix II.

### **Moderating Variables**

For all of these hypotheses there were possible moderating variables. Although no effect was expected due to sex or task order, age, or task familiarity, effects of these possible moderating variables were assessed. Familiarity was assessed using two questions. For instance, for the AUT, participants were asked “Thinking back to the questions that asked you to list alternate uses for common objects. How unfamiliar or familiar are you with this type of question?” and they responded on a six item likert scale (Extremely Unfamiliar/Moderately Unfamiliar/Slightly Unfamiliar/ Slightly Familiar/Moderately Familiar/Extremely Familiar).

### **Mediating Variables**

Possible confounding variables were considered, and were examined in the data analysis. Affect valence (negative to positive) and arousal (sleepy to awake) could play a mediating role in the effect of the emotional manipulation on performance. For example, a possible route of mediation could be that affect valence, arousal, or both vary by emotion state and that affect also determined performance on creative thinking tasks. If we then found that affect varied with emotion state, it could have been the level of affect rather than the emotion state that determined performance on creative thinking tasks.

### **Participants**

The 113 participants were mostly Rutgers-Camden students drawn from the psychology department subject pool. The majority of these participants were enrolled in an Introductory Psychology class, but students from other classes sometimes participate for extra credit. While there is some self-selection involved with who is taking the class, it is a very popular class taken by a wide range of students as psychology is the most popular major on campus. Others were recruited for cash payments of \$10 via flyers posted around the Rutgers campus. Despite individual differences in creativity and critical thinking, the random assignment to experimental groups reduced any threat to internal validity.

Data from a Cooperative Institutional Research Program (CIRP) First Year Student Survey shows that 69.1 percent of undergraduate first-time first-years at Rutgers-Camden were White, 14.9 percent Black, 12 percent Puerto Rican or other Latino, 9.6 percent Asian (Office of Institutional Research and Academic Planning, 2009). According to the data, over 95% of the first year students are between the ages of 18 and 25 years old.

While the majority of the American population would be suited to participate in these tasks, these students offer a number of advantages. As Rutgers undergraduates, they have at least at a high-school education level, and they are very likely to have taken the SAT for the university's admissions requirements. It is useful that the students are enrolled in an Introductory Psychology class, as that means it is unlikely that they would have been exposed to the alternate uses task in a higher level psychology class.

A total of 9 participants were recruited with the \$10 cash payments, 8.0% of the total participants used, the remainder participated for course credit or extra credit. The

participants recruited via flyer were not distinguished in our data, in order to maintain anonymity and confidentiality. These participants from outside the subject pool added diversity to our sample.

The experiment posed minimal risk to the participants. They were told that their participation was voluntary, that they were not required to participate, and that they were free to withdraw at any point during the experiment without losing any benefit. The students were all over 18. No participants expressed any ongoing distress from the experiment. Only a handful of participants expressed that the procedure elicited negative memories and emotions. All of these participants said that they were feeling alright afterwards, and that they were not interested in a follow-up interview or seeing a counselor.



## Results

### Assessment of Random Assignment

Table 2 shows means and standard deviations for age, PBR familiarity, and AUT familiarity, by emotion and order condition. To assess whether possible moderating variables were equally distributed across conditions by random assignment, we ran ANOVAs to test the effects of emotion (joy/hope/neutral) and order (AUT-first/PBR-first) on age, PBR familiarity, and AUT familiarity. We also ran a  $\chi^2$  test to determine whether sex was randomly distributed across emotion and task order. There were no significant differences in age found across conditions. There was a marginally significant difference found for PBR familiarity between emotion conditions,  $F(2,112)=2.90$ ,  $p=.059$ . Across condition orders, post hoc Tukey Tests showed PBR familiarity was lower in the hope condition ( $M=3.16$ ) than in the neutral condition ( $M=3.97$ ),  $p=.042$ . Tukey Test comparisons of the PBR familiarity in the joy ( $M=3.84$ ) and neutral conditions were non-significant, as were comparisons of the joy and hope conditions. Also, as shown in Table 2, participants in the AUT-first condition ( $M=4.14$ ,  $SD=1.31$ ) were significantly more familiar with the PBR than participants in the PBR-first condition ( $M=3.19$ ,  $SD=1.71$ ),  $t(2)=3.31$ ,  $p=.001$ . There were no significant differences found for AUT familiarity or age by condition. No significance was found in the tests for sex by emotion  $\chi^2(2, N=113) = 2.13$ ,  $p=.345$  or sex by order  $\chi^2(2, N=113) = .07$ ,  $p=.965$ .

### Interrater Reliability in Creativity Ratings

Table 3 shows means and standard deviations for each rater's scoring of AUT responses. In order to test whether the raters were consistent with each other in how the

subjective scoring of alternate uses was performed, we calculated an intraclass correlation

Table 2

*Means and SD of Age, PBR Familiarity, and AUT Familiarity by Emotion Condition and Task Order*

Emotion	Order	N	AGE		PBR Familiarity		AUT Familiarity	
			Mean	SD	Mean	SD	Mean	SD
Hope	AUT-FIRST	18	19.95	1.65	4.28	1.18	2.61	1.72
	PBR-FIRST	19	18.61	4.75	2.11	1.52	2.84	1.68
	Total	37	19.26	3.61	3.16 <sub>b</sub>	1.74	2.73	1.68
Joy	AUT-FIRST	19	19.40	1.64	3.95	1.39	2.32	1.25
	PBR-FIRST	18	21.31	4.36	3.72	1.53	2.67	1.53
	Total	37	20.33	3.36	3.84	1.44	2.49	1.39
Neutral	AUT-FIRST	19	20.99	5.20	4.21	1.40	3.47	1.65
	PBR-FIRST	20	20.20	3.54	3.75	1.59	2.60	1.31
	Total	39	20.59	4.39	3.97 <sub>b</sub>	1.50	3.03	1.53
Total	AUT-FIRST	56	20.12	3.32	4.14 <sub>a</sub>	1.31	2.80	1.60
	PBR-FIRST	57	20.02	4.30	3.19 <sub>a</sub>	1.71	2.70	1.49
	Total	113	20.07	3.83	3.66	1.59	2.75	1.54

*Note:* AUT = Alternate Uses Task. PBR = Passage Based Reading.

<sub>a</sub>=Means are significantly different from each other. <sub>b</sub>=Means are significantly different from each other

Table 3

*Rater Mean Scoring and Standard Deviations*

Rater	N	M	SD
Rater 1	1240	2.02	1.09
Rater 2	1240	1.55	0.88
Rater 3	1240	1.36	0.71

*Note.* Creativity measured from 1(not at all creative) to 5 (highly creative)

coefficient (3, 3) for consistency, which is described as the two-way mixed model (cf.

Shrout & Fleiss, 1979). The first 3 represents Model 3, which means each rater rated

every response, and we are only interested in the three specific raters that we used in this study (we are not generalizing to other, future, raters). The second 3 means that we are looking at the reliability of our three raters averaged ratings for each item. We chose an average measurement because we are only concerned with the current reliability of these raters on these specific items, and are not trying to estimate whether only one rater would provide a sufficiently reliable measure. This ICC (3,3) = .813, shows considerable consistency between raters when rating alternate uses.

### **Manipulation Checks**

Table 4 presents the mean felt intensity of the all emotions in our manipulation check (state hope, joy, sadness, fear, anger, and affection), with their standard deviations, for each emotion condition. To check whether the emotion manipulation worked as intended, we performed ANOVAs comparing the effects of condition on currently felt (state) joy and hope. State joy was significantly predicted by condition,  $F(2,112)=44.81$ ,  $p<.001$  and state hope was significantly predicted by condition,  $F(2,112)=29.38$ ,  $p<.001$ . As shown in Table 4, state joy was highest in the joy condition ( $M=3.46$ ,  $SD=0.84$ ) and state hope was highest in the hope condition ( $M=3.57$ ,  $SD=1.32$ ). A linear contrast test (joy:2, hope:-1, neutral: -1) showed that the joy condition resulted in significantly higher state joy than the hope and neutral conditions, contrast  $t(110) = 8.73$ ,  $p<.001$ . Another linear contrast (hope:2, joy: -1, neutral:-1) showed that the hope condition resulted in significantly higher state hope than the joy and neutral conditions,  $t(110) = 7.50$ ,  $p<.001$ . These results indicate that the manipulation worked as intended in producing the expected emotion. However a Tukey test showed that participants in the hope condition,  $M=2.24$ ,  $SD=1.04$ , also had significantly higher joy than the neutral condition,  $M=1.51$ ,

Table 4

*Mean and SD State Emotions by Condition*

Condition	Emotion													
	Hope State		Joy State		Sadness State		Fear State		Anger State		Affection State			
<i>N</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		
Hope	37	3.57 <sup>a</sup>	1.32	2.24 <sup>a</sup>	1.04	1.8	1.29	1.59 <sup>a</sup>	1.09	1.41	0.86	2.62	1.57	
Joy	37	1.97 <sup>b</sup>	1.19	3.46 <sup>b</sup>	0.84	1.27	0.77	1.22	0.58	1.11	0.39	3.30 <sup>a</sup>	1.58	
Neutral	39	1.56 <sup>b</sup>	1.07	1.51 <sup>c</sup>	0.82	1.56	1.02	1.23 <sup>b</sup>	0.41	1.39	0.75	2.18 <sup>b</sup>	1.41	
Total	113	2.35	1.47	2.39	1.21	1.55	1.06	1.30	0.77	1.30	0.71	2.69	1.58	

*Note.* The mean score here reflects how much an emotion was being felt from 1 (not at all) to 5 (extremely). Means in a column with different subscripts are significantly different (based on the Tukey test) at the  $p < .05$  level).

$SD=.52, p=.002$ . This indicates that participants in the hope condition were not feeling *only* hope, as was desired. Despite this, a Tukey test showed that participants in the joy condition experienced significantly more state joy than participants in the hope condition,  $p<.001$ .

### MANOVA on Emotion, Order, and Sex

None of the dependent variables are correlated over  $r=.90$ : creative fluency with creative choice ( $r=.46, p=.000$ ), creative fluency with critical editing ( $r=.34, p=.002$ ), creative fluency with critical reading ( $r=.18, p=.052$ ), creative choice with critical editing ( $r=-.27, p=.014$ ), creative choice with critical reading ( $r=.10, p=.36$ ), and critical editing with critical reading ( $r=-.08, p=.002$ ). Because no correlation was above  $.9$ , multicollinearity is not indicated. Table 5 presents estimated marginal means and standard errors for emotion on the four dependent variables.

Table 5  
*Estimated Marginal Means for Emotion*

Emotion	<i>N</i>	Creative Fluency		Creative Choice		Critical Editing		Critical Reading	
		<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>
Hope	37	7.41	.73	1.82	.15	.74	.11	5.52	.62
Joy	37	8.95	.70	1.87	.14	.81	.11	5.80	.59
Neutral	39	7.79	.66	2.07	.133	.65	.10	4.67	.564

*Note.* *M*=Estimated Marginal Mean. *SE*=Standard Error. Means are presented for each DV. Creative fluency, 0=low fluency to 18=high fluency; 0 to 6 for each of 3 items. Creative choice, 1=not at all creative to 5=highly creative. Critical editing, lower is better, 0=high critical editing to 4=low critical editing. Critical reading, -3=low critical reading to 12=high critical reading.

We ran a MANOVA looking at whether emotion, task order, or sex had a multivariate effect across the dependent variables: creative fluency, creative choice, critical editing, and critical reading. Emotion did not have a significant effect across DVs. Table 6 presents marginal means broken down by sex. Sex had a marginally significant effect on cognitive performance across DVs,  $F(4, 67)=2.10, p=.091$ , Wilk's  $\Lambda=.889$ , partial  $\eta^2=.11$  (tests of univariate effects are presented below). Order did not have a significant effect on cognitive performance across DVs.

Table 6

*Estimated Marginal Means for Sex*

Sex	<i>N</i>	Creative Fluency		Creative Choice		Critical Editing		Critical Reading	
		<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>
Female	54	8.44	.55	1.79	.11	.79	.08	5.00	.463
Male	59	7.66	.60	2.05	.12	.67	.09	5.66	.505

*Note.* *M*=Estimated Marginal Mean. *SE*=Standard Error. Means are presented for each DV. Creative fluency, 0=low fluency to 18=high fluency; 0 to 6 for each of 3 items. Creative choice, 1=not at all creative to 5=highly creative. Critical editing, lower is better, 0=high critical editing to 4=low critical editing. Critical reading, -3=low critical reading to 12=high critical reading.

Table 7 shows means and standard deviations by emotion and order for each of the four DVs. There was a marginally significant interaction between emotion and order  $F(4, 67)=1.73, p=.098$ , Wilk's  $\Lambda=.822$ , partial  $\eta^2=.093$ . There was no interaction between emotion and sex. There was a significant interaction between order and sex,  $F(4, 67)=2.72, p=.037$ , Wilk's  $\Lambda=.860$ , partial  $\eta^2=.14$ . The nature of this interaction was

Table 7  
*Creative Thinking and Critical Thinking Means by Emotion and Order*

Emotion	Creative Fluency			Creative Choice			Critical Editing			Critical Reading		
	AUT-1 <sup>st</sup>	PBR-1 <sup>st</sup>	Total	AUT-1 <sup>st</sup>	PBR-1 <sup>st</sup>	Total	AUT-1 <sup>st</sup>	PBR-1 <sup>st</sup>	Total	AUT-1 <sup>st</sup>	PBR-1 <sup>st</sup>	Total
<b>Hope</b>	<i>M</i> 7.58	7.62	7.60	1.76	1.83	1.80	0.74	0.77	0.75	6.25	4.65	5.42
	<i>SD</i> (3.12)	(4.44)	(3.79)	(0.81)	(0.72)	(0.75)	(0.60)	(0.48)	(0.53)	(2.75)	(2.93)	(2.90)
	<i>n</i> 12	13	25	12	13	25	12	13	25	12	13	25
<b>Joy</b>	<i>M</i> 6.77	11.21	9.07	1.73	1.96	1.85	0.68	0.95	0.82	4.90	6.42	5.69
	<i>SD</i> (2.68)	(3.40)	(3.77)	(0.73)	(0.61)	(0.67)	(0.60)	(0.59)	(0.60)	(2.90)	(2.97)	(2.99)
	<i>n</i> 13	14	27	13	14	27	13	14	27	13	14	27
<b>Neutral</b>	<i>M</i> 7.93	7.60	7.77	2.01	2.08	2.04	0.52	0.82	0.67	5.05	4.28	4.67
	<i>SD</i> (4.57)	(2.10)	(3.50)	(0.85)	(0.69)	(0.76)	(0.44)	(0.57)	(0.52)	(3.68)	(2.96)	(3.31)
	<i>n</i> 15	15	30	15	15	30	15	15	30	15	15	30
<b>Total</b>	<i>M</i> 7.45	8.81	8.15	1.85	1.96	1.91	0.64	0.85	0.75	5.36	5.11	5.23
	<i>SD</i> (3.57)	(3.73)	(3.69)	(0.79)	(0.66)	(0.73)	(0.54)	(0.54)	(0.55)	(3.16)	(3.04)	(3.08)
	<i>n</i> 40	42	82	40	42	82	40	42	82	40	42	82

*Note:* Means are presented for each DV. Creative Fluency, 0=low fluency to 18=high fluency; 0 to 6 for each of 3 items. Creative choice, 1=not at all creative to 5=highly creative. Critical editing, lower is better, 0=high critical editing to 4=low critical editing. Critical reading, -3=low critical reading to 12=high critical reading. Standard deviations (SDs) are shown in parentheses below each mean. AUT=Alternate Uses Task. PBR=Passage Based Reading.

further explored in univariate analyses reported below. There was no three way interaction between emotion, order, and sex.

### **Further Testing of the effects of Hope and Joy on Creative and Critical Thinking**

Following the MANOVA, we performed univariate analyses to see whether emotion, order, or sex affected performance on creative fluency, creative choice, critical editing, and critical reading. We also performed linear contrasts to determine if emotion means were in the order we predicted (joy-hope-neutral for creative thinking, hope-joy-neutral for critical thinking).

**Univariate tests on measures of creative thinking. *Creative fluency.*** Table 8 presents the means of creative fluency by emotion, order, and sex. To determine whether emotion, task order, or sex had a main effect or interaction effect on creative fluency, a 3x2x2 ANOVA was run. There was no main effect for emotion, but there was an interaction effect for task order X emotion,  $F(2,112)=5.92, p=.004$ . Figure 1 shows the interaction effect of emotion and task order on creative fluency. There was no three way interaction between emotion, order, and sex.

Bonferroni adjusted simple main effects indicated that, as predicted, in the PBR-first order condition, participants in the joy condition ( $M=11.06, SD= 3.30$ ) had significantly higher scores on creative fluency than participants in the hope condition ( $M=7.79, SD= 3.98$ ),  $p=.04$ , and the neutral condition ( $M=6.95, SD= 2.56$ ),  $p=.005$ . Bonferroni adjusted simple main effects between emotions in the AUT-first condition order were non-significant.

We ran a linear contrast on creative fluency (pooled across task order) with the



Table 8

*Creative Fluency Means and Standard Deviations by Emotion, Order, and Sex*

Emotion		AUT-FIRST			PBR-FIRST			Total		
		Female	Male	Total	Female	Male	Total	Female	Male	Total
Hope	<i>M</i>	8.80	7.75	8.33	8.10	7.44	7.79 <sub>b</sub>	8.45	7.59	8.05
	<i>SD</i>	(4.69)	(3.28)	(4.04)	(4.23)	(3.91)	(3.98)	(4.36)	(3.52)	(3.96)
	<i>N</i>	10	8	18	10	9	19	20	17	37
Joy	<i>M</i>	6.22	7.80	7.05	11.50	10.50	11.06 <sub>a</sub>	9.00	9.00	9.00
	<i>SD</i>	(2.39)	(3.33)	(2.95)	(3.78)	(2.73)	(3.30)	(4.12)	(3.29)	(3.69)
	<i>N</i>	9	10	19	10	8	18	19	18	37
Neutral	<i>M</i>	8.17	9.54	9.11	7.11	6.82	6.95 <sub>b</sub>	7.53	8.29	8.00
	<i>SD</i>	(2.99)	(5.88)	(5.10)	(2.09)	(2.99)	(2.56)	(2.45)	(4.89)	(4.01)
	<i>N</i>	6	13	19	9	11	20	15	24	39
Total	<i>M</i>	7.72	8.52	8.16	8.97	8.07	8.53	8.39	8.31	8.35
	<i>SD</i>	(3.66)	(4.52)	(4.14)	(3.91)	(3.51)	(3.71)	(3.81)	(4.04)	(3.92)
	<i>N</i>	25	31	56	29	28	57	54	59	113

*Note.* Means are presented for creative fluency (0=low fluency to 18=high fluency, up to 6 for each of 3 items) above standard deviations, which are in parentheses (*SD*). Means with different subscripts are significantly different (based on the bonferonni adjusted simple effects test) at the  $p < .05$  level).

predicted order of means being Joy (1)-Hope (0)-Neutral (-1). This was not significant:

$t(2)=1.11, p=.27$ . The means were generally in the predicted direction though: Joy

( $M=9.00, SD=3.69$ ), Hope ( $M=8.05, SD=3.96$ ), and then Neutral ( $M=8.00, SD=4.10$ ).

In the 3x2x2 ANOVA there were no main effects for sex (Males:  $M=8.31, SD=4.04$ ; Females,  $M=8.39, SD=3.81$ ;  $t=.000, p=.99$ ), or order, (AUT-first:  $M=8.16, SD=4.14$ ; PBR-first,  $M=8.53, SD=3.71, t=.73, p=.47$ ).

Other possible moderators were not correlated with creative fluency: AUT

familiarity ( $r=.16, p=.10$ ) and age ( $r=.11, p=.26$ ).

Figure 1

*Interaction of Emotion and Order on Creative Fluency*

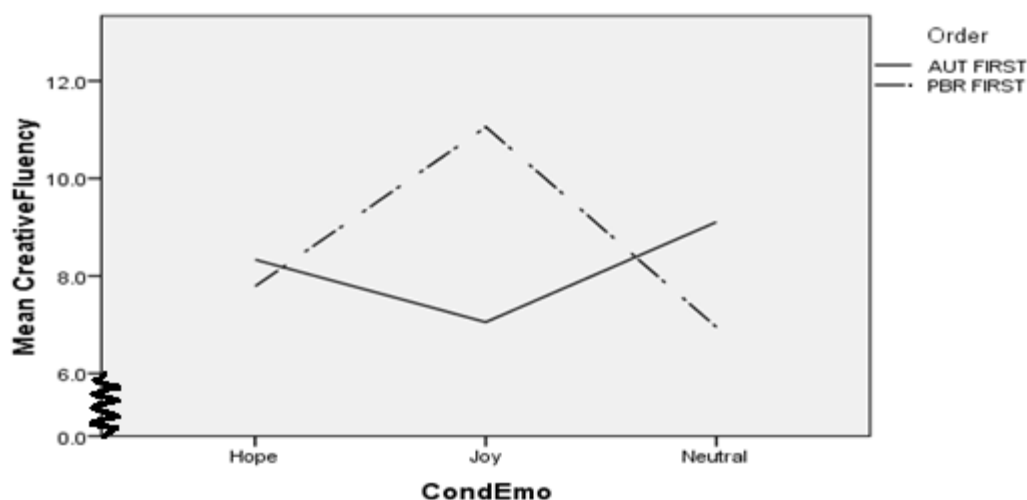


Figure 1. Interaction of emotion and order on creative fluency. AUT = Alternate Uses Task. PBR = Passage Based Reading. CondEmo = Emotion Condition.

**Creative choice.** Table 9 presents the means of creative choice by order, sex, and emotion. To determine whether emotion, task order, or sex had a main effect or interaction effect on creative choice, a 3x2x2 ANOVA was run. There were no main effects for emotion. There was no interaction between emotion and order; there was no interaction between emotion and sex. There was no three way interaction between emotion, order, and sex.

We ran a linear contrast on creative choice with the predicted order of means being Joy (1)-Hope (0)-Neutral (-1). This was not significant  $t(2)=-1.00, p=.321$ . Creative choice scores indicated non-significantly higher creativity in the neutral condition, ( $M=2.04, SD=0.76$ ), than in the joy condition,  $M=1.85, SD=0.67$ , or the hope condition,  $M=1.80, SD=0.75$ .

Table 9

*Creative Choice Means and Standard Deviations by Emotion, Order, and Sex*

Emotion		AUT-FIRST			PBR-FIRST			Total		
		Female	Male	Total	Female	Male	Total	Female	Male	Total
Hope	<i>M</i>	1.83	1.67	1.76	1.63	2.17	1.83	1.72	1.92	1.80
	<i>SD</i>	(1.00)	(.51)	(.81)	(.68)	(.72)	(.72)	(.82)	(.64)	(.75)
	<i>N</i>	10	8	18	10	9	19	20	17	37
Joy	<i>M</i>	1.64	1.83	1.73	1.69	2.33	1.96	1.67	2.08	1.85
	<i>SD</i>	(.85)	(.61)	(.73)	(.49)	(.60)	(.61)	(.66)	(.63)	(.67)
	<i>N</i>	9	10	19	10	8	18	19	18	37
Neutral	<i>M</i>	2.22	1.87	2.01	1.75	2.45	2.08	1.95	2.13	2.04
	<i>SD</i>	(.92)	(.82)	(.85)	(.55)	(.66)	(.69)	(.74)	(.79)	(.76)
	<i>N</i>	6	13	19	9	11	20	15	24	39
Total	<i>M</i>	1.88	1.81 <sub>b</sub>	1.85	1.69 <sub>b</sub>	2.33 <sub>a</sub>	1.96	1.78	2.06	1.91
	<i>SD</i>	(.91)	(.67)	(.79)	(.55)	(.63)	(.66)	(.73)	(.69)	(.73)
	<i>N</i>	25	31	56	29	28	57	54	59	113

*Note.* Means are presented for creative choice, 1 (not at all creative) to 5 (highly creative) above standard deviations, which are in parentheses (*SD*). Means with different subscripts are significantly different (based on the Bonferroni adjusted simple effects test) at the  $p < .05$  level).

In the 3x2x2 ANOVA there were no main effects for sex (Males:  $M=2.06$ ,  $SD=0.69$ , Females,  $M=1.78$ ,  $SD=0.73$ ,  $t=1.61$ ,  $p=.113$ ) or order (AUT-first:  $M=1.85$ ,  $SD=0.79$ , PBR-first,  $M=1.96$ ,  $SD=0.96$ ,  $t=.97$ ,  $p=.33$ ).

We found that there was a significant interaction between order and sex on creative choice,  $F(1, 70)=5.21$ ,  $p=.026$ , partial  $\eta^2=.07$ . Males ( $M=1.81$ ,  $SD=.67$ ) and females ( $M=1.88$ ,  $SD=.91$ ) were not different in the AUT-first task order, but males

( $M= 2.33$  ,  $SD= .63$ ) did significantly better than females ( $M= 1.69$  ,  $SD= .55$ ) on the creative choice measure in the PBR-first task order (Bonferroni adjusted test of simple effects,  $p=.007$ ). Males' creative choice performance when they had PBR-first,  $M= 2.33$ ,  $SD= .63$ , was also significantly better than when they had the AUT-first,  $M= 1.81$ ,  $SD= .67$ , Bonferroni adjusted test of simple effects,  $p=.03$ . Task order was not significant for females.

Other possible moderators -- AUT familiarity ( $r=.15$ ,  $p=.18$ ) and age ( $r=-0.02$ ,  $p=.89$ ) -- were not correlated with creative choice.

We ran a similar 3x2x2 ANOVA on another measure of creativity, the average creativity of all AUT responses. This found similar results to creative choice. There were no main effects for emotion or interactions effects of emotion X order or emotion X sex. There was a marginally significant effect of sex,  $F(1, 101)=3.90$ ,  $p=.051$ , with Males ( $M=1.69$ ,  $SD=.37$ ) showing higher creativity than Females ( $M=1.56$ ,  $SD=.32$ ). There was no interaction between order X sex and no three way interaction of emotion X order X sex.

**Univariate tests on measures of critical thinking. *Critical editing.*** As per the discussion in the method section, our measure of critical editing is the difference of the best two alternate uses, as determined by raters, minus participants selected top two alternate uses. *So, a higher mean represents worse performance.*

Table 10 presents the means of critical editing by order, sex, and emotion. To determine whether emotion, task order, or sex had a main effect or interaction effect on critical editing, a 3x2x2 ANOVA was run. There was no main effect of emotion on

critical editing, and there were no interaction effects for emotion X order or emotion X sex. There was no three way interaction between emotion, order, and sex.

Table 10

*Critical Editing Means and Standard Deviations by Emotion, Order, and Sex*

Emotion		AUT-FIRST			PBR-FIRST			Total		
		Female	Male	Total	Female	Male	Total	Female	Male	Total
Hope	<i>M</i>	.67	.83	.74	.92	.53	.77	.80	.68	.75
	<i>SD</i>	(.64)	(.61)	(.60)	(.50)	(.38)	(.48)	(.56)	(.51)	(.53)
	<i>N</i>	10	8	18	10	9	19	20	17	37
Joy	<i>M</i>	.62	.75	.68	1.10	.75	.95	.88	.75	.82
	<i>SD</i>	(.74)	(.46)	(.60)	(.73)	(.23)	(.59)	(.75)	(.34)	(.60)
	<i>N</i>	9	10	19	10	8	18	19	18	37
Neutral	<i>M</i>	.36	.63	.52	1.06	.55	.82	.76	.59	.67
	<i>SD</i>	(.50)	(.40)	(.44)	(.52)	(.52)	(.57)	(.61)	(.44)	(.52)
	<i>N</i>	6	13	19	9	11	20	15	24	39
Total	<i>M</i>	.56	.72	.64	1.03 <sub>b</sub>	.61 <sub>a</sub>	.85	.81	.67	.75
	<i>SD</i>	(.62)	(.46)	(.54)	(.57)	(.39)	(.54)	(.63)	(.42)	(.55)
	<i>N</i>	25	31	56	29	28	57	54	59	113

*Note.* Means are presented for critical editing, lower is better (0=high critical editing to 4=low critical editing), above standard deviations, which are in parentheses (*SD*).

We ran a linear contrast on critical editing with the predicted order of means being Hope (-1), Joy (0), Neutral (1). This was not significant  $t(2)=-0.54, p=0.59$ . Although critical thinking was predicted to be superior in the hope condition, critical editing scores were non-significantly better in the neutral condition,  $M=0.67, SD=0.52$ , as compared with the hope condition,  $M=0.75, SD=0.55$ , and the joy condition,  $M=0.82, SD=0.60$ .

Order and sex did not have main effects on critical editing. There was a significant interaction between order and sex on critical editing,  $F(2, 70)=6.20, p=.015$ , partial  $\eta^2=.08$ . The means are displayed in Table 10 (in the Total row). Males ( $M=0.61, SD=0.39$ ) performed better than females ( $M=1.03, SD=0.57$ ) in the PBR-first condition, Bonferroni adjusted test of simple main effects,  $p=.02$ , but the sexes were similar in the AUT first condition (Males,  $M=0.72, SD=0.46$ ; Females,  $M=0.56, SD=0.62$ , Bonferroni adjusted test of simple main effects,  $p=.28$ ).

Other possible moderators--AUT familiarity ( $r=-0.04, p=.72$ ) and age ( $r=-0.37, p=0.74$ )--were not correlated with critical reading.

**Critical reading.** Table 11 presents the means of critical reading by emotion, order, and sex. To determine whether emotion, task order, or sex had a main effect or interaction effect on critical editing, a  $3 \times 2 \times 2$  ANOVA was run. There was no main effect of emotion on critical reading, and no interaction effects for emotion X sex, but there was a marginally significant interaction effect for emotion X order,  $F(2,112)=2.92 p=.06$ . However, none of the post-hoc comparisons between groups were significant. Figure 2 depicts the unadjusted interaction effect of emotion X order on critical reading. There was no three way interaction between emotion, order, and sex.

We ran a linear contrast on critical reading with the predicted order of means being Hope (1)-Joy (0)-Neutral (-1). This was not significant  $t(2)=0.54, p=0.59$ . The means were not in the predicted direction: Hope ( $M=4.78, SD=2.93$ ), Joy ( $M=5.10, SD=3.33$ ), and then Neutral ( $M=4.47, SD=3.48$ ).

Table 11  
*Critical Reading Means and Standard Deviations by Emotion, Order, and Sex*

Emotion	AUT-FIRST			PBR-FIRST			Total			
	Female	Male	Total	Female	Male	Total	Female	Male	Total	
Hope	<i>M</i>	5.13	6.13	5.57	4.30	3.72	4.03	4.71	4.85	4.78
	<i>SD</i>	(2.63)	(3.03)	(2.77)	(3.08)	(2.96)	(2.95)	(2.82)	(3.15)	(2.93)
	<i>N</i>	10	8	18	10	9	19	20	17	37
Joy	<i>M</i>	3.75	5.05	4.43	4.55	7.38	5.81	4.17	6.08	5.10
	<i>SD</i>	(3.26)	(2.86)	(3.04)	(3.37)	(3.35)	(3.57)	(3.25)	(3.22)	(3.33)
	<i>N</i>	9	10	19	10	8	18	19	18	37
Neutral	<i>M</i>	5.46	5.21	5.29	4.75	2.84	3.70	5.03	4.13	4.47
	<i>SD</i>	(3.79)	(3.93)	(3.78)	(2.89)	(3.07)	(3.07)	(3.17)	(3.69)	(3.48)
	<i>N</i>	6	13	19	9	11	20	15	24	39
Total	<i>M</i>	4.71	5.40	5.09	4.53	4.42	4.47	4.61	4.93	4.78
	<i>SD</i>	(3.11)	(3.31)	(3.21)	(3.02)	(3.57)	(3.27)	(3.04)	(3.44)	(3.24)
	<i>N</i>	25	31	56	29	28	57	54	59	113

*Note.* Means are presented for critical reading (-3=low critical reading to 12=high critical reading) above standard deviations, which are in parentheses (*SD*).

In the 3x2x2 ANOVA there were no main effects for sex, Males:  $M=4.93$ ,  $SD=3.44$ , Females,  $M=4.61$ ,  $SD=3.04$ ,  $t=0.65$ ,  $p=.518$ , or order, AUT-first:  $M=5.09$ ,  $SD=3.21$ , PBR-first,  $M=4.47$ ,  $SD=3.27$ ,  $t=.86$   $p=.39$ .

Among other possible moderators, AUT familiarity ( $r=-0.05$ ,  $p=.61$ ) and age ( $r=0.08$ ,  $p=0.42$ ) were not correlated with critical reading. However, PBR familiarity was significantly correlated with scores on critical reading,  $r=.27$ ,  $p=.004$ , indicating that participants who were more familiar with the PBR task did better on its measure of critical reading.

Figure 2

*Interaction of Emotion and Order on Critical Editing*

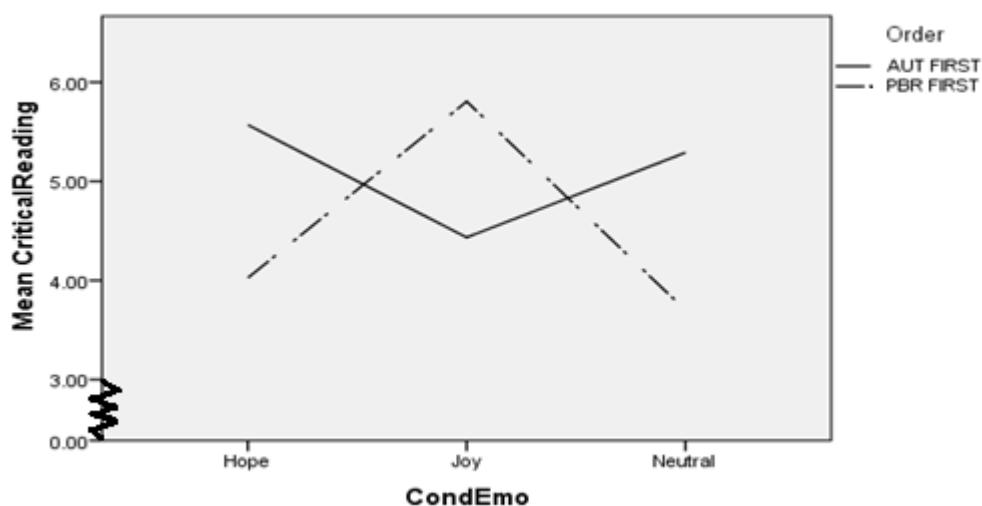


Figure 2. Interaction of emotion and order on critical reading. AUT = Alternate Uses Task. PBR = Passage Based Reading. CondEmo = Emotion Condition.

As we had poor randomization of the moderating variable PBR familiarity across emotion and order, we ran an ANCOVA controlling for this as a covariate in testing the effects of emotion, order, and sex on critical reading. Adjusted marginal means by emotion, sex, and order for critical reading are presented in Table 12. The resulting corrected model was marginally significant,  $F(3,112)$ ,  $p = .052$ . Though critical reading was predicted to be highest in the hope condition, Bonferroni adjusted simple main effects were non-significant between the adjusted means of hope condition: 5.11, joy condition: 5.09, and neutral condition: 4.30. In this model, PBR familiarity alone was significant in predicting creative reading performance,  $F(1,112)=7.64$ ,  $p=.002$ . After controlling for PBR familiarity, emotion X order becomes non-significant,  $F(2,100)=2.06$ ,  $p=.13$ . Controlling for PBR familiarity, there were no main effects for emotion,  $F(2,100)=0.75$ ,  $p=.47$ , order,  $F(1,100)=0.01$ ,  $p=.91$ , or sex,  $F(1,100)=1.48$ ,  $p=.23$  and no interaction effects between emotion X sex,  $F(2,100)=2.10$ ,  $p=.13$  or sex X order,



$F(2,100)=.40, p=.529$ . We also performed a linear contrast on this model with the hypothesized means (Hope:1, Joy:0,Neutral:-1) which was non-significant when predicting critical reading,  $t(2)=1.13, p=.29$ .

Table 12

*Critical Reading Adjusted Marginal Means and Standard Errors by Emotion, Sex, and Order*

Emotion		AUT-FIRST			PBR-FIRST			Total		
		Female	Male	Total	Female	Male	Total	Female	Male	Total
Hope	<i>M</i>	4.63	5.93	5.28	5.29	4.59	4.93	4.96	5.25	5.11
	<i>SD</i>	(1.00)	(1.10)	(0.75)	(1.05)	(1.08)	(0.79)	(0.70)	(0.76)	(0.52)
	<i>N</i>	10	8	18	10	9	19	20	17	37
Joy	<i>M</i>	3.42	5.03	4.22 <sub>b</sub>	4.35	7.55	5.95 <sub>a</sub>	3.89	6.29	5.09
	<i>SD</i>	(1.04)	(0.98)	(0.72)	(0.99)	(1.10)	(0.74)	(0.72)	(0.74)	(0.51)
	<i>N</i>	9	10	19	10	8	18	19	18	37
Neutral	<i>M</i>	4.67	5.10	4.88	4.42	3.02	3.72 <sub>b</sub>	4.52	4.06	4.30
	<i>SD</i>	(1.30)	(0.86)	(0.78)	(1.04)	(0.94)	(0.70)	(0.84)	(0.64)	(0.53)
	<i>N</i>	6	13	19	9	11	20	15	24	39
Total	<i>M</i>	4.24	5.35	4.80	4.69	5.05	4.87	4.46	5.20	4.83
	<i>SD</i>	(0.67)	(0.57)	(0.44)	(0.58)	(0.61)	(0.43)	(0.44)	(0.41)	(0.30)
	<i>N</i>	25	31	56	29	28	57	54	59	113

*Note.* Means are presented for critical reading (-3=low critical reading to 12=high critical reading) above standard deviations, which are in parentheses (*SD*). Means with different subscripts are significantly different (based on the Bonferroni adjusted simple effects test) at the  $p < .05$  level).

After controlling for PBR familiarity, we also looked at the Bonferroni adjusted test of simple main effects between the groups. In the PBR-first condition, participants in the joy condition,  $M=5.95, SE=0.74$ , performed marginally better than participants in the neutral condition,  $M=3.72, SE=0.70, p=.09$ , and also better than participants in the AUT-

first joy condition,  $M=4.22$ ,  $SE=0.72$ ,  $p=.096$ .

We also performed 3x2x2 ANCOVAs (controlling for PBR Familiarity) looking at how emotion, order, and sex affected the number of correct, incorrect, and blank responses to the PBR task. No effects were found for number of correct or incorrect responses. However, there was a significant effect of emotion on number of blank responses,  $F(2, 100)=3.25$ ,  $p=.04$ . A Bonferroni adjusted test of simple main effects found that joy ( $M=1.18$ ,  $SE=0.38$ ) was significantly lower than neutral ( $M=2.50$ ,  $SE=0.38$ ). There was also a significant three way interaction effect of emotion, order, and sex on number of blank responses,  $F(2, 100)=5.57$ ,  $p=.005$ . Bonferroni adjusted tests of simple means found that males in the PBR-first condition had significantly fewer blank responses in the joy condition ( $M=0.17$ ,  $SE=0.81$ ) than in the neutral condition ( $M=2.83$ ,  $SE=0.69$ ),  $p=.04$ , and marginally less than in the hope condition ( $M=2.62$ ,  $SE=0.80$ ). The other groupings were not significantly different from each other.

### **Checking for Possible Mediators**

To check for possible mediating variables, we first determined whether any of the mediators (unhappy to happy affect, low to high arousal, achievement versus other narrative type) were correlated with the dependent variables. None were significantly correlated. Since the variables were not correlated, no additional steps were taken for mediational analysis.

## Discussion

### Summary of Main Findings

Our manipulation generally worked as intended, with there being significantly more joy in the joy condition than in the hope or neutral conditions, and with there being significantly more hope in the hope condition than in the joy or neutral conditions. However, there was somewhat more joy in the hope condition than there was in the neutral condition. There were no significant multivariate effects of emotional state (hope vs. joy vs. neutral state) across all dependent variables. Univariate analyses found that results for the most often used measure of creativity were consistent with hypotheses: creative fluency was highest in the joy condition. However this was only the case if the alternate uses task was administered after the passage-based reading. The same pattern was not visible for the less established creativity measure, creative choice, on which there were no differences between the joy, hope, and neutral conditions. Nor was this pattern visible for the other measure based on the alternate uses task (critical editing). On critical reading, an often-used measure of critical thinking, effects were influenced by familiarity with the task, and emotion state was not associated with performance results.

Across dependent variables there was a marginal interaction between emotion and task order, and a significant effect of sex. For creative choice and critical editing, men performed better than women, but only when the creativity task was given after the passage-based reading.

### Creative Thinking

**Creative fluency.** Creative fluency was found to be related to emotional state

and task order, whether or not we controlled for AUT Familiarity. When looking at one order in particular, when the AUT was given after the PBR, creative fluency was significantly higher in the joy condition than it was in either the hope or neutral condition (the hope condition was also higher than the neutral condition, but not significantly so). This result supports our hypothesis that emotion can improve performance on creative fluency, with the caveat that there is an interaction effect with task order. We describe three explanations of why performance on creative fluency was only differentiated by emotion in the PBR-first task order. Although any, or all three, may be responsible for the task order effect, we won't know for sure until additional research is completed.

First, creative fluency performance may be best after some mental activation or warmup. That warmup, the interesting PBR task, could have optimally interacted with the joy emotion. Joy is a very excited emotion state (Frijda, 1986), and it's possible that participants actually became more joyful during the manipulation refresher between tasks than they had been following the initial manipulation.

A second possibility is that emotion manipulation may have been dampened by drowsiness or surprise, causing similarities in emotion state between the emotion conditions. The manipulation had the participants close their eyes, focus on a mellow voice and try to relive an experience. Although the emotion varies, this particular induction technique might lead to increased relaxation or even drowsiness, altering the effect of the emotion felt while performing the first task following the manipulation. The refresher was similar (closed eyes, listening to a voice while focused on a memory), but also different. It was shorter and focused specifically on feeling the emotion, rather than searching for a memory and rebuilding the experience. Another cause of emotion state

possibly being diffused is that some participants expressed surprise about the transition from the manipulation to the first task. They said that it was unexpected or very different than the manipulation. If the shift from the manipulation caused significant surprise, it may have confounded their emotional states. Either surprise or relaxation following the initial manipulation might have led to less differentiated emotions during the first task, but allowed for more differentiated emotion states during the second task, following the emotion refresher, in accordance with the results. If they were very relaxed from the initial manipulation, they may have become more joyful or more hopeful over time.

A third possibility relates to the participants' response to the PBR. During debriefing, some participants expressed negative memories associated with the SAT. If the PBR upset some people, or they just found it tiresome, then they may have reacted positively when it was over, or when they realized the second task (the AUT) was not another SAT style task.

It's unlikely that participants in the AUT-first condition would have been thinking about the next task they would have to complete (the SAT-style PBR). Although the PBR had some negative associations, participants were not aware what the tasks were ahead of time. They only knew that there would be tasks of 'alternate uses' and of 'critical thinking'.

**Creative choice.** No significant effects on creative choice were caused by emotion condition. This means either that these emotional states do not have varying effects on creative choice, or that it was a poor measure of the end product of creativity. This measure was intended to assess the final end product of a creative process.

Although we did not find significant results by emotion for creative choice, it did significantly correlate with creative fluency, suggesting that it at least was measuring something close to the intended variable. However, fluency was significantly influenced by emotion and order, whereas creative choice was not. Creative fluency was correlated with creative choice, but average creativity of responses was more highly correlated with creative choice. Having a higher average creativity indicates that the choice should have been easier. It may be that the correlation of average creativity with creative choice made the task of selection easier and less powerful, removing the importance of emotion in differentiating success on the task.

Alternatively, emotion may simply be less important when making decisions (as evidenced the null results of emotion and critical reading in this study) than when generating ideas. Since creative choice involves two creative process, generation and selection, it may be that joy improves generation of creative ideas, but not their selection. Another emotion may be more beneficial to the selection process. Although the creative choice measure relies on the same Top 2 as critical editing, it does not attempt to compare a participant's choice to their other responses. This is meant to reflect a total creative process; the summation of both idea generation and selection of the most creative possibility.

For the alternate uses task, participants received Guilford et al.'s (1978) instructions, which do not explicitly ask the participant to be creative. This makes any effect on the creativity of the participant more implicit rather than intentional. It is possible that if we had specifically told the participants to be creative, as in Silvia et al. (2008), then we might have seen different results. That would mean that creativity is

more available to participants in a certain emotion state, whereas the present study was looking at whether increased creativity came automatically to participants feeling joy.

### **Critical Thinking**

**Critical editing.** No significant results were found for critical editing. We believe that there are significant validity concerns with this measure, for the following reason. We asked the participants to choose among their own answers, but this introduced confounding variability in each participant's task. Each participant, rather than having a standardized task, had to work from their own generated uses. The creativity (according to our rating process) of the most creative alternate use for each participant varied, as did the average creativity rating of a participant's alternate uses. For instance some participants' most creative response scored a 5 and others maxed out at a score of 1. So, the difficulty of the task varied between participants. Some participants had to select among a range of very creative and not at all creative responses, and other participants only had to select between responses of similar creativity.

Although there are a number of ways to compare a participant's responses to their selected Top 2, none of these completely eliminate the issue. We utilized the difference from the two best responses (as scored by the raters) to the Top 2 as selected by the participants. We considered using normalized scores for this, but even then, it's possible that some participants would have been penalized more due to the distribution of their scores, rather than their ability to choose the most creative response. Someone with a wide distribution over many responses would have a more difficult task. Probabilistically, choosing the best out of 10 is harder than choosing the best out of 5.

On the other hand, some with high consistency among their scores, even if they are all low, would have an easier time choosing a top scoring response. A participant who came up with many alternate uses, all highly creative (scored 3 or higher), could feasibly receive a worse score than a student who had all poor responses (all 1s), simply because there was less chance for error. Controlling for number of responses of average creativity would not necessarily level the task either, because the relationship between all these factors is not understood.

**Critical reading.** Critical reading performance was not significantly affected by emotion state. Although there was a significant interaction between emotion and order, this was completely moderated by the poor randomization of familiarity with the task. After controlling for familiarity, there were no significant effects for emotion. Familiarity with this task was correlated with higher performance on the task. We had expected that all participants would be familiar with the SAT based on the vast majority of Rutgers applicants submitting SAT scores. Despite this, there was a significant interaction effect between Emotion and Order on PBR Familiarity.

The PBR may have been too difficult to show effects due to manipulated emotions, or it may have been that the task caused enough anxiety that it muted the emotion manipulation.

We found that the number of blank responses was related to emotion state, with joy leading to the fewest blank responses. This seems to be in line with the fluency shown on the creative fluency results and suggests that joy might lead to increased rapidity of task work in general.



## Limitations

Measuring emotional state in a participant over time is difficult. Despite knowing that our manipulations elicited the intended emotions, we do not know how those emotions persisted after the cognitive measures began. Although the operationalization of our IV is specifically that we induce an emotion state just before these tasks, and not that the participants maintain the emotion state throughout, we would still be better off knowing how the participants' emotion state changed over time. The manipulated emotion may have decreased or increased over time, or the emotion state may have morphed in a more complicated way. For instance, one memory may be associated with another, and emotion state could gradually change as the participant loses focus on their originally recalled emotion. Also, certain aspects of an emotion may persist longer than other aspects. For instance, hypothetically, action tendencies may not last as long as thought-action repertoires. So, manipulation may have affected thought processes, but not choice processes or academic performance.

We also found that, in addition to increased levels of hope, the hope condition also had elevated levels of joy, compared to the neutral condition, though the increase in hope was greater than the increase in joy (in the hope condition). This could mean that the effects of hope and joy were at least partially confounded, decreasing the impact of the task relevant emotion manipulation.

The alternate uses task, despite its frequent use in studies, is only one way to measure creativity. It focuses on quantity, not quality of creativity. It's also possible that some individuals would have greater facility with different types of creativity, and the

AUT is a verbal task. Despite its popularity, the AUTs strengths are sometimes questioned, and alternative measurements are suggested (e.g., Silvia et al. 2008). We've attempted to address this by including creative choice, but there are other creativity tasks that are worth considering. For instance, the Remote Associates Task measures convergent creativity. Here we chose to utilize both creative and critical thinking tasks, but future research could tell us more about different types of creative thinking.

Our measure of creative choice, which is based on the AUT, is a relatively new measure. In this study, it was an easy addition, because we were already administering the AUT. It was beneficial to include it here in order to further study the measure, and to have some measure of creativity other than just fluency, but there may be other ways to measure creative choice. This measure does not exactly match a real world process involving familiar subject matter and problem solving. The AUT was specifically utilized to be sure no one was familiar with the task, so it is not applicable to familiar tasks. Ultimately, creative choice, a measure of a creative end product, might be better measured with a different task that is less constrained by time, and where the participant is giving their all.

Critical editing may not be a valid way of comparing participants, due to the variation in difficulty between subjects. We discussed this above, and have proposed a number of other ways it could be calculated below. Ultimately, the best measure would be a standardized task utilizing the same alternate uses, rather than asking participants to make a selection from among their own work.

The main question for critical reading now is why didn't these emotions influence

performance? We had anticipated hope to improve performance on this task. The main reasoning for this is from two pieces of prior research. There was some evidence that positive affect improved decision-making (e.g., Isen, 2008) and evidence that critical thinking was improved when a task was viewed as important and a person was experiencing positive affect (Lyuobomirsky et al., 2005). It seems most likely that our participants did not actually view the critical thinking tasks as personally important.

Another major limitation is that state joy confounded our hope condition. Participants in the hope condition felt significantly more joy than those in the neutral condition. It unfortunately means that we may not have seen a pure form of hope.

The critical reading measure utilized a task from the SAT. In terms of measuring cognitive abilities in a psychology framework, it is probably less discrete than other measures of critical thinking. It is not designed to directly test a cognitive psychology construct, but rather it is used to predict success in college. A further refinement to our study would be to look specifically at how different emotion states affect information processing and separately how they affect decision-making. As a way of predicting success in college, the SAT is still a useful way to compare individuals.

The application here was not a typical SAT administration. Typically this PBR would be part of a much longer examination with multiple reading, math, and analytical tasks. Our PBR task could be thought of as an individual item that would usually be part of an index for the SAT. The individual measurement should still be predictive, but not as powerfully predictive as an hours long exam would be.

The unexpected effects of order and sex reduced the power of this study, meaning

that there may have been Type II errors due to the increased factors. However, means were not in the correct order for some measures (creative choice and critical editing), so those are less likely to have a Type II error. In a larger sample we might have found more, particularly for the less differentiated AUT-first task order.

### **Future Research**

**Manipulation.** The manipulation here had some room for improvement because the hope condition showed elevated levels of joy compared to the neutral condition. Future research will hopefully determine a way to get participants to experience hope without experiencing joy. One possible way would be to tell to them of a time where they felt hope, but not joy. Currently they were told to select an experience where they felt hope, but not any other emotion. Telling them to specifically avoid joyful experiences might improve the manipulation.

**Creative fluency.** The main avenues for future research should address why task order affected performance, and it should further explore the relationship between types of creative thinking and discrete emotions. Our theory that joy specifically helped in idea generation was partially supported, but additional factors need to be studied.

First, in order to understand the task order effect in this study, we need to understand how emotion state changes during tasks following a manipulation. Performing a manipulation check at various times throughout the study would help significantly to understand the emotional state, affect state, and arousal states. This understanding will lead to other avenues for studying creative fluency. Once the effect of emotion over time is understood, we can look more closely at how the emotion leads to

increased performance in creative fluency.

Secondly, since there is at least some evidence that emotions can play a role in creativity, and further research should be conducted to see if that effect varies by type of creative thinking. Other types of creative thinking (e.g., convergent creativity, problem solving, or artistic work) may or may not be similarly influenced by joy.

Other aspects of the task can be varied as well. This measure of creative fluency was intentionally a novel task. Creativity on known tasks is a separate area for research. Also, joy may be more useful in a playful environment (e.g., perhaps musical improvisation), or some other emotion might be more useful in a business environment or analytical problem solving.

An increase in sample size would also increase power and help to clarify the relationship between emotion, order, and creative fluency.

**Creative choice.** Future research could address questions about whether idea generation and selection are affected differently by emotion states. Research will also improve on the familiarity of the task, allowing the subject to use heuristics and learned problem solving skills to make a creative choice.

We did consider whether average creativity might be a replacement for creative choice. It would certainly improve on creative fluency, which ignores the quality of responses, by focusing on the overall creativity of those responses. However, it does not improve on creative choice, because it penalizes participants who don't restrict themselves when generating ideas. It would be beneficial to participants who focus on only generating good ideas, but it would punish others who have great ideas mixed in

with mediocre ideas.

Additional avenues might include a more robust creative battery of tests to study various facets of creativity. Another would be a within-subjects study to see if certain participants react differently to different emotion states.

**Critical editing.** We think that critical editing should be a measure comparing a selection of ideas against the best possible selection of those ideas. We did that here, but it could be greatly improved upon by standardizing the task. We recommend that a future study be done where participants are each given the same prompts of existing alternate uses and are asked to choose which are the most creative, or rank all of them.

It would be interesting if some participants performed better when selecting from their own ideas as opposed to selecting from someone else's idea. That would indicate that personal experience with the ideas has an effect on a participant's ability to choose among them, whether it limits that ability or enhances it.

**Critical reading.** Future research should fix the major limitations we saw. The level of personal importance could be improved and the manipulation needs to be modified to ensure that we see participants who truly feel hope without feeling joy at the same time. An increase in sample size would also increase power and help to clarify the relationship between emotion and critical reading.

In addition to repeating a similar study with the same dependent measure of critical reading, it would also be useful to consider similar measures of verbal fluency, decision-making, and critical thinking. The passage based reading was utilized as a familiar task, but ultimately a more common daily task might feel more comfortable for

participants, especially those that have negative associations with the SAT. A task that is performed daily would be more familiar to the participants than something they did in the past (such as the SAT), and they would be more prepared to do it. Emotions might have a different effect on a task where less thought is required, due to familiarity and use of heuristics. It might also feel more personally important, which has been indicated to improve performance on tasks (Lyuobomirsky et al., 2005).

### **Implications**

The present study was largely intended to determine whether emotion state would have an effect on performance. Given that we found some support that creative fluency is affected by an interaction between emotion and task order, it opens avenues for further research on emotions and creativity. The finding that joy, more than hope, increases creative fluency is a step towards an understanding of these emotions and of creative fluency. Implications are tempered by the unexpected discovery that task order played an important role in emotions effect on creative thinking. This implies that the situation is complex but that future research could be fruitful. As Simonton (2002) points out, alternate uses tasks are very general and do not necessarily predict success in specific creative fields. However, as divergent creativity is generally associated with academic success, they will surely be a continued area of study. Although the current findings need to be replicated, they do open up research in applicable areas. Creative fluency might be a needed skill for tasks like generating ideas for a future event (e.g., planning a work of art or designing landscape architecture), but may not extend to a jazz musician improvising while performing on stage.

Our lack of findings in the other 3 measures does not conclusively rule out emotion's role in creative choice, critical editing, or critical reading. It may be that with an improved manipulation, and with improved measures, we would see differences between emotion states. It may be that the pathways by which emotions affect cognitive performance require very strong emotions, or personally important goals (Lyubomirsky et al., 2005). A lack of findings here does not mean certain emotions may not be suited for specific tasks. Certain emotions may be more motivating to overcome challenging obstacles that require both critical and creative thinking to solve problems. One example is that affection could improve helping tasks that require sympathy, or that require someone to overcome a negative emotion such as disgust in order to perform a task (e.g., as a nurse might experience).



## Appendices

### Appendix I – Alternate Uses Scoring

#### Sample Alternate Uses Task

(x) = selected responses, **bolded** = highest scored by raters

Participant Responses for Shoe	Sample Rater Scoring (1) (2)		
Average			
To crush centipedes	1	2	1.5
To throw at a dog	1	2	1.5
Shoe a horse (x)		2	3
<b>2.5 (x)</b>			
As a hammer for a thumbtack (x)	2	3	<b>2.5 (x)</b>
Ash tray	3	2	<b>2.5</b>
Hide money in	2	3	<b>2.5</b>
To throw at a cat	1	2	1.5
Participant Responses for Key			
To start a car	1	1	1

As screw driver (x)	3	2	<b>2.5 (x)</b>
Jar opener (x)	3	3	<b>3 (x)</b>

### **Participant Response for Automobile Tire**

As a swing (x)	1	2	1.5 (x)
Walls for flower bed	2	3	<b>2.5</b>
Car bumper (x)		1	3
<b>2 (x)</b>			
As a ring	1	1	1

### **Hypothesis 1a – Creative Fluency**

The creative fluency of each participant will be the total number of acceptable responses on each particular task (shoe, key, automobile tire). Unacceptable responses will be based upon Guilford et al.s' (1978) criteria, which are as follows.

1. The scorer should mark all responses (stated use) either acceptable (1) or unacceptable (0).
2. A use, to be acceptable, should be possible for the object. For example, stating that an automobile tire can be used as a ring for the finger is unacceptable under this rule.
3. An acceptable use must be different from the given use, i.e., it must not fall within the class of the given, common use. The scorer should tend to leniency in this

regard, however, a response being ruled out only if it is clearly just a modification of the given use. Saying that a milk carton can be used to “hold orange juice” is not sufficiently different from “used to hold milk,” which is given. On the other hand, the use “to mix paints in” involves more than the idea of containing and therefore qualifies.

4. Where the same idea of use may fit more than one object, e.g., “as a weapon” or “to burn,” credit should be given unless some use is obviously overworked, particularly with the same wording.

5. Vague or very general uses are not acceptable. Examples of such responses are listed below. Note, however, that some seemingly vague responses are listed as acceptable. This is for the reason that they pertain to some unusual, specific attribute of the object.

6. A use that pertains to any conceivable interpretation of the object is acceptable. For example, “shoe” is not only footwear; it may also be part of a brake. A “button” not only appears on clothing, it can be a symbol as for a campaign or a club. A “key” not only unlocks doors; it may belong to a test or a map.

**Examples of responses that are too vague to be accepted:**

To have fun with

To break

To make something

As a weapon (except shoe)

To throw away

As a game

To use the parts

To throw it (except shoe)

To hit with (except shoe)

To burn

To get

Examples, Item by Item:

**1. SHOE (used as footwear)**

**Acceptable**

To crush bugs

Tie on car after wedding

To hit someone with

For dog to chew on

Hide money in

Put out fires

To measure in feet

As a hammer

Drink champagne out of

For a paper weight

Stamp out cigars (cigarettes)

Ash trays

Keep socks in

To throw at a cat (dog; but not both)

### **Unacceptable**

To kick people

Walk on

Fix Them

Shoe a horse (footwear)

Use as leather

Polish them

**2. KEY (used to open a lock)**

**Acceptable**

Open cans (e.g. coffee)

For cleaning nails

As screw driver

To score a test

Shows membership in a club

Jar opener

To decorate wall

Electrical connection

Explain a map

**Unacceptable**

To start a car

To jingle in pocket

To kill someone

**3. AUTOMOBILE TIRE (used on wheel of automobile)**

**Acceptable**

As a hula hoop

As a swing

Walls for flower bed

Bumper (one use only)

As a raft

### **Unacceptable**

As a ring (for finger)

Covering on wagon wheel

The rater for creative fluency will look at each entry for an item, and mark each response acceptable (1) or unacceptable (0). These numbers can then be summed for each participant to get a fluency score.

For this particular example the participant would receive a score of 5 for shoe, 2 for key, and 3 for automobile tire. For shoe two items were unacceptable. Throw at a cat/dog could only be counted once, and shoe a horse is actually a common use of a shoe (footwear). For key, one item was unacceptable. To start a car is a common use of a key. For automobile tire, all items were acceptable.

### **Hypothesis 1b – Creative Choice**

The raters for creative selection will look at all items and rate them. These ratings will be used for both hypotheses 1b and 2b. The items from all participants will be presented randomly to each rater, but for only one item at a time. This will reduce fatigue and exposure bias across participants. This hypothesis involves only those items selected as the most creative by the participant, but raters are not shown which items were selected as most creative by the participant. Raters were trained by reading the instructions below and also practicing on two rounds of samples. The directions for the raters to use were expanded from Silvia et al. (2008) as follows:

#### Instructions for Judging Creativity

Creativity can be viewed as having three facets. Creative responses will generally be high on all three, although being low on one of them does not disqualify a response from getting a high rating. We will use a 1(not at all creative) to 5 (highly creative) scale.

##### 1. Uncommon

Creative ideas are uncommon: they will occur infrequently in our sample. Any response that is given by a lot of people is common, by definition. Unique responses will tend to be creative responses, although a response given only once need not be judged as creative. For example, a random or inappropriate response would be uncommon but not creative.



## 2. Remote

Creative ideas are remotely linked to everyday objects and ideas. For example, creative uses for a brick are “far from” common, everyday, normal uses for a brick, and creative instances of things that are round are “far from” common round objects. Responses that stray from obvious ideas will tend to be creative, whereas responses close to obvious ideas will tend to be uncreative.

## 3. Clever

Creative ideas are often clever: they strike people as insightful, ironic, humorous, fitting, or smart. Responses that are clever will tend to be creative responses. Keep in mind that cleverness can compensate for the other facets. For example, a common use cleverly expressed could receive a high score.

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Generally, a score of 1 is reserved for:

- actual intended uses for the object (e.g., for bricks: making a chimney, wall, or path);

- the most common uses given by the sample (e.g., for bricks: paperweights and doorstops);
- incomprehensible uses (responses that make no sense or seem like fragments or non-responses).

Slightly more creative uses would be given a score of 2, and so on, up to the most creative responses, which would be given a score of 5.

HERE ARE SOME EXAMPLES OF PREVIOUSLY SCORES RESPONSES. FOR EACH POSSIBLE SCORE, WE SHOW 3 RESPONSES.

**Please note: these scores are merely given as examples and you are free to give whatever score you think is appropriate, even for responses similar to these.**

Item	Score of 1	Score of 2	Score of 3	Score of 4	Score of 5
Brick	building a house  make a patio  sidewalk	a remote holder  to kill a bug (by dropping it on the bug)  brick chairs	domino  using it to make something rough or smooth (like sand paper)  a nail file	as a robot's head - in model  attach a mirror = 2 in 1, travel mirror for purse & defense object as well  to scrape superglue off your fingers	make it into a superhero called The Wall and have him fight Erosion Man  aid in color identification for children  a talking object - whoever holds it can talk

AND HERE ARE SOME EXAMPLES OF ANSWERS THAT DEMONSTRATE 1 OR 2 OF THE ELEMENTS, BUT NOT ALL 3.

**Uncommon but not Remote or Clever:**

Using a car tire as a bike tire

**Uncommon and Remote but not Clever:**

Using a shoe as a wall hanging (art)

**Uncommon and Clever but not Remote:**

Using a shoe to hide money from muggers

**Remote but not Uncommon or Clever:**

Using a key as jewelry

**Remote and Clever but not Uncommon:**

Using a tire as a flower bed

**Clever but not Remote or Uncommon:**

Using a shoe to squash bugs

Finally, here is an example that was rated as showing all 3 elements:

**Uncommon, Remote, and Clever**

Tie a brick to a rope to throw the rope over a tree branch so you can hang a punching bag

*End of Creativity Rating Instructions*

Raters were also told to rate each response, and then sort the responses by the score. After sorting, the raters reviewed their own ratings and decided whether they would adjust any of their own ratings. They were allowed to review their ratings for as long as they needed to be satisfied that their ratings were as reliable as possible.

Each response was scored by three raters. For this hypothesis, the scores of each rater were combined using factor analysis to create a latent variable value for each response. This allowed us to combine the rating scores while accounting for the reliability of each rater. , and the two selected items will be averaged, giving us the participants score for each item. For instance, for the item *automobile tire*, the participant has selected “as a swing” and “car bumper” as the Top 2 creative uses. These items received averaged scores (between raters) of 1.5 ( $(1 + 2) / 2 = 1.5$ ) and 2 ( $(1 + 3) / 2 = 2$ ), respectively. Thus, the participants score for this item would be 1.75 ( $(1.5 + 2) / 2$ ), the

average of the Top 2 selected items.

### **Hypothesis 2b – Critical Editing**

All items will be using the same rater scores used in hypothesis 1b. To obtain the participants score for this hypothesis, the selected Top 2 creative choices will be compared to the 2 highest rated (by the raters) items. For instance, looking again at the use of an *automobile tire*, the respondent did not select as her top 2 the same ones that are rated as top 2 by the raters. The top 2 selected by the participant are “as a swing” (rated 1.5) and “car bumper” (rated 2), whereas the top 2 selected by the raters are “walls for flower bed” (rated 2.5) and “car bumper” (rated 2). Thus the participants selected score is 1.75 (the final score from hypothesis 1b) and the raters top scored items score an average of 2.25.

## Appendix II – SAT Scoring

Following the scoring of the SAT, 1/4 point will be deducted for every wrong answer, no points will be added or subtracted for unanswered questions, and 1 point will be added for every correct answer. For instance, for our study, there are 12 questions asked. Each question is equal in determining final score. If the participant answered 7 correctly, left 2 unanswered, and answered 3 incorrectly, then their score would be  $7*1 + 2*0 + 3*-1/4 = 7.25$ . In the SAT test, the raw score overall is rounded to the nearest whole number, but that will not be done here as we are dealing with a significantly smaller sample of questions and subsequently a smaller range of scores.

## Appendix III - Manipulation

**Audio played in headphones is “in quotes”, it is also displayed on screen.**

(NOTE: Text in ALL CAPS is only displayed on screen, not played in Audio)

(TEXT YOU SHOULD BE ABLE TO HEAR THROUGH HEADPHONES:

“To begin, please think of an experience at some point in your life that caused you to feel [intense joy, intense hope, completely neutral]. Choose an experience in which there was a moment **when you were feeling [intense joy/intense hope/completely neutral] and were not feeling any [other] emotions at the same time.**

For example, you should choose an experience in which there was a moment when you felt [intense joy/intense hope/completely neutral], and you were not feeling [sadness, fear, or hope/ sadness, fear, or hope/ sadness, fear, hope, or joy. If you can think of more than one experience like this, choose one that is as recent as possible.

**When you've thought of an experience in which there was a moment when you felt [intense joy/intense hope/completely neutral], and not any [other] emotions, click the Continue Button below. "PAUSE (Until participant clicks Continue)**

Continue

**\*The text above should have played in your headphones. If you could not hear it, please raise your hand for assistance\*.**

TEXT YOU WILL BE ABLE TO HEAR THROUGH HEADPHONES:

**Now, close your eyes until we ask you to open them again.**

"Relax, and make yourself comfortable. Focus your attention on the instructions you are about to hear. Now, think of the moment when you felt [intense hope/intense joy/completely neutral], and did not feel any [other] emotions, such as [sadness, fear, or hope/sadness, fear, or joy/sadness, fear, hope, or joy]. Picture the events happening to you, as vividly as you can. See all the details of the situation. Picture in your "mind's eye" the surroundings as clearly as possible. See the people or objects; hear the sounds; experience the event happening to you. Think the thoughts you actually thought in this situation. Feel the same feelings you felt. Let yourself react as if you were actually there. Please re-experience the [intense joy/intense hope/completely neutral state] you felt in this situation, and continue to re-experience it for the next half a minute. Then you will hear the next instruction."

PAUSE (20 seconds)



“At this point, we would like you to think about what it was in that moment that directly caused you to feel [intense joy/intense hope/completely neutral], and not any [other] emotions”

PAUSE (5 seconds)

“Now, take a moment or two to re-experience just the feeling of [intense hope/intense joy/being in a completely neutral state]. When you are re-experiencing the feeling of [intense hope/intense joy/ being in a completely neutral state] as much as possible, open your eyes, and click the Continue button.”

Continue

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