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# AFFECT AND OVERCONFIDENCE: A LABORATORY INVESTIGATION

By

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(Forthcoming in the *Journal of Neuroscience, Psychology, and Economics*)

## Abstract

*We conduct two incentivized random-assignment experiments to investigate whether overconfidence is impacted by (1) incidental mild positive affect, or (2) incidental mild negative affects—anger, fear, and sadness. We measure overconfidence using overestimation of past quiz-performance and overestimation of past quiz-performance compared to peers. The results of the first experiment indicate that the effect of positive affect on both measures of overconfidence is positive and significant for male subjects. While mood-inducement is equally successful for female subjects, their overconfidence is unaffected by positive affect. These positive-affect results are robust to various specification checks. In the second experiment, we find consistent evidence of neither anger, fear, nor sadness's effect on overconfidence; the lack of a result is attributable either to a genuine lack of relationship between these affects and overconfidence or to confounded mood-inducements. The effect of positive affect on overconfidence may help explain the relationship between mood and speculative bubbles and between mood and trading volume. Further, our results have implications for the effect of happiness on overconfidence and the role of emotions in economic decision-making, in general. Finally, we examine the neural evidence supported by our data.*

Keywords: overconfidence, beliefs, positive affect, mood, emotions, laboratory, experiment, anger, fear, sadness

## **Introduction**

Beliefs are an important facet of standard utility theory. A systematic deviation from standard economic theory about beliefs is overconfidence, defined as the “overestim[ation] of [one’s own] performance in tasks requiring ability, including the precision of [one’s own] information” (DellaVigna 2009). Overconfidence has been shown to be prevalent among the general public as well as investors, managers, and other important economic actors often considered too experienced to be subject to behavioral deviations from rational choice (Barber and Odean 2001). The overconfidence of various economic agents—CEOs, investors, and employees—has been critical in explaining the following phenomena: company underperformance, attractiveness of stock options to employees, overtrading, and gender differences in competitiveness (Barber and Odean 2001; Croson and Gneezy 2009; Malmendier and Tate 2005; and Oyer and Schaefer 2005).

Given the far-reaching and significant implications of overconfidence, identifying its determinants and whether it is subject to manipulation is important. A noteworthy determinant of economic behavior that has been identified in psychological and economic experiments is the decision maker’s affect (or mood). For example, anger and mild positive affect (or good mood) have both been shown to significantly decrease perceived risk, while fear and sadness have both been shown to increase it (Johnson and Tversky 1983; Lerner and Keltner 2001).

More suggestive of a relationship between affect and overconfidence are the following findings. Both positive affect and sadness have been shown to improve self-

evaluations (Jundt and Hinsz 2002; Lyubomirsky et al. 2005; and Silvia et al. 2006), which suggests that both may increase overconfidence. Second, both positive affect and sadness have been shown to improve task performance (Isen 2008), which suggests that both may decrease overconfidence in favor of correctness. Finally, positive affect and negative affect have been shown to impact financial corollaries of overconfidence, e.g., overtrading in a way that would suggest that positive affect would increase overconfidence and sadness would reduce it (Saunders 1993; Hirshleifer and Shumway 2003; and Edmans et al. 2006). Because these suggestive findings do not all point to the same qualitative relationship, and because past attempts at directly quantifying the relationship between various affects and overconfidence have been less than conclusive about the causal relationship, further research is necessary.

In Study 1, we conduct a laboratory experiment to identify the effect of mild positive affect on overconfidence. After completing a monetarily incentivized set of trivia and math questions, the control (treatment) group watches a neutral (positive) affect-inducing film clip. Subjects then estimate their performance, both in absolute terms and relative to other subjects and both with and without monetary incentives. We find that positive affect increases overconfidence, thereby reducing earnings. Subgroup analysis by gender reveals that this result is exclusively true for male subjects. Female subjects exhibit better calibration than men, and their overconfidence is unaffected by positive affect.

From this experiment, though, the effect of negative affect on overconfidence cannot be determined: negative and positive affects do not necessarily have opposing effects, and different negative affects—e.g. fear versus anger—often give rise to different

behaviors, as shown above in the case of perceived risk (Isen 2007). So we conduct a second experiment (Study 2) with one control group corresponding to neutral-affect and three treatment groups, each corresponding to one of three negative affects (anger, fear, or sadness). Affects are induced using the corresponding affect-inducing film clip; all other aspects of the experimental design are identical to Study 1. We find that sadness increases overconfidence among non-Asians. Neither fear nor anger significantly increases overconfidence. This may be because mood-inducement in Study 2 is less successful than in Study 1.

### ***Literature Review: Overconfidence***

Experimental and field evidence of overconfidence abounds. In a range of contexts, decision makers' own-estimated performance exceeds their actual performance, and their estimated ranking among peers exceeds their actual ranking.<sup>1</sup> That people are not good at estimating their performance on trivial topics—topics that are likely novel to them or outside the realm of their expertise—is quite natural. More interesting, though, is that we often tend to be biased toward over- and not under-estimation. Even more interesting is that this tendency does not disappear with experience. Overconfidence has been identified among clinical psychologists, physicians, nurses, investment bankers, engineers, entrepreneurs, lawyers, negotiators, and managers (Barber and Odean 2001). Further, Barberis and Thaler (2003) claim expertise actually exacerbates overconfidence.

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<sup>1</sup> Confidence-interval elicitation has also been used to measure overconfidence. Subjects are asked questions, but instead of simply estimating performance, they give 90% confidence intervals for each question. That these intervals are roughly 2 times tighter than they should be has been used as evidence of overconfidence (Alpert and Raiffa 1982). Recently, this method has been called into question. It has been shown that a good deal of measured overconfidence is simply a result of an aversion against broad-interval responses (Cesarini et al. 2006). Elicitation procedures that do not depend on confidence intervals result in lower estimates of overconfidence; importantly, they do not eliminate overconfidence.

Indeed, many of the conditions faced by experts—e.g., abstractly defined goals, and decisions that are low in frequency or produce noisy feedback—are exactly ones that have been linked to biased and overconfident decision-making (Malmendier and Tate 2005).

Given the broad range of actors subject to overconfidence, it is perhaps no surprise that it has been linked to important economic and financial phenomena. Overconfidence is often appealed to in behavioral finance models (see Barberis and Thaler (2003) for a review of overconfidence in behavioral finance). There is also empirical evidence of overconfidence's effect on economic decisions. Malmendier and Tate (2005) show that overconfident CEOs make inferior corporate investments; they are, among other things, overly sensitive to investment cash flows and prone to overpay for mergers.<sup>2</sup> Oyer and Schaefer (2005) provide empirical evidence of employees' overconfidence to explain firms' use of stock options for compensation.<sup>3</sup>

Of particular relevance to the current paper is research that links overconfidence to economic phenomena—asset-price bubbles and overtrading—on which the effect of positive affect has already been established. A large theoretical literature explains asset price volatility using overconfidence (Daniel et al. 1998). Scheinkman and Xiong (2003) model investors as being overconfident in the accuracy of their own information to help

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<sup>2</sup> This finding is robust to different measures of overconfidence. First, overconfident CEOs are identified as those who hold on to private options longer than is rational. Second, overconfident CEOs are identified using the occurrence in the press of words suggestive of the CEOs' overconfidence.

<sup>3</sup> Using data from roughly 2000 firms, the authors perform calibrations of three competing models that seek to explain firms' use of stock options. The first model is incentive-based, with employees increasing their productivity so that the firm's profits, and hence their stock options, will be enhanced. The second asserts that firms use stock options to attract employees who are overconfident relative to the market about the firms' performance and hence require lower total compensation. The third model contends that stock options, by increasing the employee's cost of leaving a firm, improve the firm's ability to retain employees. The authors patently reject the incentives-based model; show that any one theory is insufficient to explain the data; and conclude that a combination of the overconfidence- and retention-based models explains the data.

explain the creation of speculative bubbles. Further, an alternative explanation of speculative bubbles, the feedback theory (in which the success of investors who profit from speculative price hikes attracts public attention and boosts expectations of further price increases), may itself be a result of overconfidence (Shiller 2003). Michailova (2010) provides experimental evidence of overconfidence's role in speculative bubbles. A psychological test of overconfidence is used to classify subjects as overconfident or "rational." Markets comprising overconfident subjects are more likely to form bubbles, and their bubbles are significantly larger, than markets with rational subjects.

A rich theoretical and empirical literature also exists that explains trading volume using overconfidence. To quote De Bondt and Thaler (1995), "the key behavioral factor needed to understand the trading puzzle is overconfidence. Overconfidence explains why portfolio managers trade so much...." Barber and Odean (2001) exploit the gendered nature of overconfidence, particularly in financial markets where men exhibit more overconfidence than women, to indirectly test whether overconfidence impacts trading volume. Using data from 35,000 households over six years, they find that men trade significantly more than women and that trading reduces net returns more for men than women. Statman et al. (2006) and Kim and Nofsinger (2007) provide empirical evidence that the feedback theory noted above leads to overtrading and argue that overconfidence generates the feedback effect. Glaser and Weber (2007) provide direct empirical evidence. They track four years of trades by individual investors whose overconfidence has been measured with an online psychological questionnaire and find that overconfidence significantly increases trading volume.

There are a number of known precursors of heightened overconfidence. As noted above, aspects of the decision-environment are known to lead to greater overconfidence. Overconfidence can be exacerbated when the choice task is difficult, occurs infrequently, produces noisy feedback, or has abstractly defined goals (Lichtenstein and Fischhoff 1977; Malmendier and Tate 2005). Task repetition and expertise decrease but do not fully cancel overconfidence (Russo and Schoemaker 1992; Barber and Odean 2007 ). Evidence on the effect of monetary incentives on overconfidence has been mixed (Cesarini et al. 2006; Melloy et al. 2006).

Overconfidence has been shown to vary across demographic groups: men generally have been shown to exhibit more overconfidence than women (Lundeberg et al. 1994; Barber and Odean 2001; Niederle and Vesterlund 2007; Croson and Gneezy 2009); inhabitants of some Asian countries have been shown to exhibit more overconfidence than Westerners (Wright et al. 1978; Lee et al. 1995; Yates et al. 1989, 1996, 1997, 1998); and results regarding age are mixed, with some studies finding that overconfidence increases with age and some that it decreases (Pliske and Mutter 1996; Crawford and Stankov 1996). An aim of the current research is to determine whether positive affect is a determinant of overconfidence.

### **Study 1: The Effect of Positive Affect on Overconfidence**

Over time, the themes around which the literature on the effects of positive affect has been organized have evolved. Early positive-affect research found that positive affect reduces effortful processing and increases reliance on heuristics and habits; this is explained by a feelings-as-information theory whereby feeling good signals that one's



heuristics are serving her well (Schwarz 1990). However, evidence suggests that these effects may only hold in low-stakes environments or when information is deemed unimportant or irrelevant (Isen 2000; Aspinwall 1998). For example, many studies have shown that positive affect and optimistic beliefs increase the processing of and response to threatening health information (see Sherman et al. 2000). Other studies find that positive affect increases willingness to receive negative but useful feedback (Trope and Neter 1994; Trope and Pomerantz 1998). These studies in which positive affect reduces defensiveness are of especial interest since they suggest that positive affect improves information-processing even when that information is self-relevant and threatening.

Lyubomirsky et al. (2005) reviews twenty-seven controlled experiments of the effect of positive-affect treatment versus neutral-affect or control on dimensions of creativity and problem solving (e.g., anagram task-performance, problem-solving accuracy, anchoring bias, creative word associations, number of facts used in judgments, recall of information in judgments, decision-making efficiency, etc.), twenty of which support effects in line with improved creativity and problem-solving. The evidence has led to some recent convergence upon a “happier-and-smarter” theory, namely that positive affect improves information-processing and cognitive flexibility (Isen 2008). As explicitly hypothesized by Kuvaas and Kaufmann (2004), this suggests that positive affect should favor correct assessments and reduce overconfidence.

At the same time, the positive-affect literature also indicates that it increases self-efficacy (Brown and Mankowski 1993; Lyubomirsky et al. 2005; and Schuettler and Kiviniemi 2006), which is defined as “people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives

(Bandura 1994).” Self-efficacy is closely linked to overconfidence, in that overconfidence can be thought of as undue perceived self-efficacy.<sup>4</sup> While the link between positive affect and self-efficacy appears to suggest that overconfidence would be increased by positive affect, upon closer inspection, the valence of the relationship is unclear. For one, increased self-efficacy may be a justified response to improved performance (as positive affect has been shown to improve task-performance) or expected performance, leaving positive affect’s effect on *overconfidence* ambiguous: if the effect of positive affect on self-efficacy is less than proportional to its effect on performance, positive affect could give rise to underconfidence. More fundamentally, overconfidence is clearly defined by a schism between actual and estimated performance, whereas self-efficacy is not compulsorily linked to actual performance.

So while there is substantial support for the effect of positive affect on self-efficacy, randomly assigned mood inducement has been used in, to our knowledge, five psychological experiments to study the effect of affect on the difference between actual and self-assessed performance.<sup>5</sup> For various reasons, none of these satisfactorily identify the effect of mild positive affect on overconfidence. Mood-inducement in Allwood and

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<sup>4</sup> Positive affect is also correlated with heightened self-esteem. The discussion above focuses on self-efficacy because self-esteem is loosely if at all related to overconfidence. It is defined as “the extent to which one prizes, values, approves, or likes oneself (Blascovich and Tomaka 1991).” One may have low (high) self-esteem but know that she is an amazing (terrible) soccer player. Similarly, confidence and self-efficacy differ: “the construct of self-efficacy differs from the colloquial term “confidence.” Confidence is a nonspecific term that refers to strength of belief but does not necessarily specify what the certainty is about. I can be supremely confident that I will fail at an endeavor. Perceived self-efficacy refers to belief in one’s agentive capabilities, that one can produce given levels of attainment. A self-efficacy belief, therefore, includes both an affirmation of a capability level and the strength of that belief. Confidence is a catchword rather than a construct embedded in a theoretical system (Bandura 1997).”

<sup>5</sup> Meloy et al. (2006) conduct a controlled experiment to study the effect of monetary incentives on overconfidence with a mediation analysis of mood. They find that monetary incentives increase mood and overconfidence. However, mood is measured at the very end of the experiment. It is plausible that their interpretation that incentives boost positive affect which boosts overconfidence can instead be explained as follows: incentives increase overconfidence, and the combination of overconfidence and higher expected payments improve mood.

Bjorhag (1991) is unsuccessful except in the bad-mood treatment, so the effect of positive affect could not be studied (negative affect has no effect on overconfidence). Allwood et al. (2002) and Kuvaas and Kaufmann (2004) compare the effect of positive to negative without a neutral condition. This research can only answer whether good mood has more or less of an effect on overconfidence than bad mood; both studies find no difference between the overconfidence of subjects undergoing good- and bad-mood inducement.<sup>6</sup> This is consistent with two very different interpretations: that positive affect and negative affect have no effect on overconfidence or that they have the same effect. Kuhnen and Knutson (2011) find exposure to highly arousing scenes of positive (negative) valence increase (decrease) overconfidence. While they extrapolate from their findings to state that positive (negative) emotions increase (decrease) overconfidence, it may well be that their findings are specific to the particular affects they induced (i.e., sexual arousal and disgust). To wit, all of the other positive-affect experiments discussed in this paper involve much milder affect-inducement and none are sexual in nature.

Finally, Kramer et al. (1993) study the effect of positive affect on overconfidence in the context of negotiations, and the researchers are concerned with interacted effects of induced mood and naturally occurring self-esteem. They find that positive affect improves performance but does not impact either expected rank or optimism about own-performance. Further, subjects in the positive-affect treatment are more likely to think they will achieve their own aspirations and, after negotiations, they are more likely to believe that they performed well relative to their negotiation partners. This is the closest

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<sup>6</sup> The effect of negative affect on behavior is complex and depends on the particular negative affect in question (e.g., fear versus anger) and is not necessarily the opposite of positive affect (Isen 2007). This is further addressed in the discussion. We are investigating the effects of negative affect—fear, anger, and sadness—on overconfidence in other research.

the extant literature comes to identifying the effect of positive affect on overconfidence. The effect is only observed on post-negotiation comparisons with others and not on any self-evaluations, either pre- or post-negotiation, controlling for own-performance. Further, the validity of ascribing the results to randomly assigned mood-inducement is questionable. In this paper, mood-inducement is followed by a mood questionnaire, an overview of the negotiation task, a pre-negotiation questionnaire, the negotiations, and a post-negotiation questionnaire. Because of the short-lived nature of experimentally induced mood (Isen and Gorgoglione 1983), it is likely that positive-affect had worn off by the post-negotiation questionnaire. The results attributed to positive affect may well be the consequence of improved performance alone.

Circumstantial evidence of a relationship between positive affect and overconfidence comes from the behavioral finance literature. Specifically, positive affect has well-documented effects on trading volume and bubbles, both corollaries of overconfidence identified in the behavioral finance literature, as noted above. The role of social mood in the formation of bubbles is put forth in Shiller (1984); Redhead (2008) studies the relationship in the 1990s dot-com bubble. Saunders (1993) and Hirshleifer and Shumway (2003) show that positive affect arising from unexpected sunshine increases trading volume; Edmans et al. (2006) shows the same using important and unexpected sports wins. Lahav and Meer (2010) provide an experimental test of the effect of positive affect on asset-market bubbles. Experimental asset markets experience significantly larger bubbles if subjects receive a positive mood-inducement than if they do not. Andrade et al. (2013) get similar results comparing instead induced excitement to neutral-affect. Combined with these and the Michaelova (2010) findings, our research can help

identify a potential chain from positive affect to overconfidence to bubbles and overtrading, although it should be stated that our experiment is not specifically designed to identify such a chain.

### **Experimental Design**

In brief, our experimental procedure was as follows (additional details are provided below): First, subjects read detailed instructions regarding the experimental session; the instructions were also read aloud by the experimenter. Second, subjects read and signed the informed consent form. Third, subjects took a 30-question quiz. Fourth, the mood-inducement procedure was administered. Fifth, subjects evaluated their performance on the quiz. Sixth, subjects answered questions regarding their mood. Seventh, subjects answered questions regarding their demographic and psychological characteristics. Finally, subjects received their certificates of payment and exited the experimental session. In total, the experimental session lasted approximately 45 minutes, and subjects received an average of \$20 for their participation (all instructions and forms are presented in Appendix A).

### ***Subjects***

The laboratory experiment was conducted at Santa Clara University. One-hundred and seven undergraduate students (57 male, 50 female) were recruited from courses that all Santa Clara undergraduate students are required to take. These courses were chosen in an attempt to ensure that the sample was representative of the entire undergraduate student

body. Prospective subjects were told that participation in the study would take less than an hour and that they would be paid for their participation, with an average payment of \$20 and a minimum payment of \$5 (the show-up fee).

### ***Quiz (Activity 1)***

In the first part of the experiment, called Activity 1, subjects were given 15 minutes to complete a 30-question quiz. The instructions for Activity 1, which were also read aloud, stated that subjects would be paid \$0.50 for each answer that was exactly correct, and that no partial credit would be given. The quiz included 20 trivia and 10 math questions. The trivia questions ranged in difficulty from, “The United States shares the longest unguarded border in the world with what country?” (correct answer: “Canada”) to, “Who ruled Iraq before Saddam Hussein?” (correct answer: “Ahmed Hassan al-Bakr”). The trivia questions closely followed those used by Moore and Small (2007). The math questions asked subjects to add five two-digit numbers; the two-digit numbers were generated randomly. The math questions were similar to those used in Niederle and Vesterlund (2007).

### ***Mood inducement***

We attempted to manipulate subjects’ mood by showing them a short film clip. The use of film clips to induce moods is common in psychological and, increasingly, economic experiments (Gross and Levenson 1995; Kirchsteiger et al. 2006; Rottenberg et al. 2007; Ifcher and Zarghamee 2011; and Oswald et al. 2011). Further, the use of film clips has

been shown to be one of the most effective means of inducing mild positive affect (Westerman et al. 1996).

In our experiment, half of the subjects (56 of 107) were randomly assigned to the treatment group and watched a film clip intended to induce positive affect. The other half of the subjects (51 of 107) were assigned to the control group and watched a film clip intended to induce neutral affect. Except for the variant film clip, the experimental procedure was identical for the treatment and control groups.

Our choice of film clips followed Gross and Levenson (1995), in which over 200 film clips were evaluated for their efficacy in inducing each of seven different affects. The positive-affect film clip was a short montage of stand-up comedy bits from the 2002 “Robin Williams – Live on Broadway.” The neutral-affect film clip was also one commonly used by psychologists and featured tranquil images of landscapes and wildlife in Denali National Park, Alaska (for example, Rottenberg et al. 2007). The film clips were both roughly 8 minutes long.

### ***Performance self-evaluation (Activity 2)***

In activity 2 subjects evaluated their performance on the quiz (Activity 1) by answering the following four questions:

1. “How many of the 30 questions in Activity 1 do you think you answered correctly?”
2. “How well do you think you did in Activity 1?” where possible responses ranged from 1, “Very poor,” to 7, “Very well”

3. “I think that I answered \_\_\_\_\_ more / fewer (circle one) questions correctly than did the typical participant in this session.”<sup>7</sup>
4. “In terms of correct answers in Activity 1, how do you think you performed relative to all the other participants in this session?” where possible responses ranged from 1, “Well below average,” to 7, “Well above average”

Two of the four questions, the first and third, were incentivized financially. The instructions to Activity 2, which were also read aloud, informed the subjects in detail about the payment scheme for Activity 2. Specifically, subjects were informed that they would receive \$5 if their answer to question 1 was correct, and \$3 (\$1) if their answer was within 3 (6) of the correct answer. The payment scheme for question 3 was similar, except that subjects had to estimate their relative performance within 2 (4) questions correctly to receive the \$3 (\$1) payment, respectively (again Appendix A contains the instructions for the entire experiment). The instructions for Activity 2 were provided with Activity 2, itself, so subjects were not instructed when taking the quiz that they would be assessing their performance.

### ***Affect check (questionnaire 1)***

Next subjects completed the Positive Affect Negative Affect Schedule (PANAS) to confirm that the mood-inducement procedure had the intended effect (Watson et al. 1988). Specifically, subjects were asked to rate how much of 7 positive and 9 negative

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<sup>7</sup> Immediately preceding this question on the form was the following statement: “Activity 1 had 30 questions. Compared to the typical participant in this session, how many more or fewer questions do you think you answered correctly? (In other words, compare how many of the 30 questions in Activity 1 you think the typical participant answered correctly to your answer to question #1 above).”



affects they felt during the film clip, where possible responses ranged from 1 (“You do not feel even the slightest bit of the emotion”) to 10 (“You feel the most of the emotion you have ever felt in your life”). The seven positive affects are amusement, arousal, contentment, happiness, interest, relief, and surprise; the nine negative affects are anger, confusion, contempt, disgust, embarrassment, fear, pain, sadness, and tension. The PANAS was framed to capture emotions felt during the film clip to avoid any confounding mood-effects from completing the self-evaluation (Activity 2). Further, since the primary objective of this research is to examine the impact of mild positive affect on overconfidence, the self-evaluation (Activity 2) was administered before the Affect Check. This order of events eliminated the possibility that the induced mood would be moderated, or nullified, by the Affect Check.

Subjects were also asked whether seeing the film clip made them “Happier,” “Neither happier, nor sadder,” or “sadder;” and whether the film clip put them in “A better mood,” “Neither a better, nor a worse mood,” or “A worse mood.” This question was included in Questionnaire 2 (described below) as a secondary affect check.

### ***Demographic and personality traits (questionnaire 2) and completing the session***

Finally, subjects were asked about their demographic and psychological characteristics, including happiness and personality traits. The measure of happiness comes from the question, “Taken all together, how would you say things are these days—would you say that you are...,” where possible responses ranged from 1 (completely unhappy) to 7 (completely happy). This measure is similar to the ones used in the General Social

Survey and the World Values Survey, each of which has been used extensively in the happiness-economics literature as a measure of long-term happiness.

When all subjects had completed Questionnaire 2 they received certificates of payments and exited the experimental session. The certificates included detailed instructions regarding redeeming the certificate for cash. The certificates also included the experimenters contact information, and subjects were instructed to contact the experimenters if they encountered problems redeeming their certificate. Certificates could be redeemed for cash one hour after the end of the session, and during all subsequent business hours, at an administrative office on the campus.

## **Results**

### ***Mood Inducement***

Total positive affect—the sum of the seven positive affect scores from the PANAS—is significantly higher for subjects in the treatment than it is for subjects in the control group (29.80 versus 23.46,  $p < 0.005$ ). Further, subjects in the treatment group report significantly higher levels of amusement (6.09 versus 3.32,  $p < 0.001$ ), happiness (5.50 versus 4.43,  $p < 0.05$ ), and interest (5.89 versus 4.28,  $p < 0.001$ ). There is not, however, a significant difference between subjects in the treatment and control groups for the four remaining positive affects: arousal, contentment, relief, and surprise. Given that the target affect for the film clip is amusement, this is not surprising (Gross and Levenson 1995).

Additional evidence that the mood-inducement procedure has the intended effect can be seen in responses to the following two questions from Questionnaire 2: “Did seeing the video clip put you in:” “A better mood,” “Neither a better, nor a worse mood,”

or “A worse mood;” and “Did seeing the video clip make you:” “Happier,” “Neither happier, nor sadder,” or “Sadder.” The proportion of subjects in the treatment group who state that the film clip put them in “A better mood” and made them “Happier” is significantly greater than it is in the control group (0.61 versus 0.27,  $p < 0.005$ ; and 0.64 versus 0.35,  $p < 0.005$ , respectively).

Total negative affect—the sum of the nine negative affect scores from the PANAS—is not significantly different for subjects in the treatment and control groups (15.29 versus 14.80,  $p = 0.773$ ). Interestingly, however, for three of the nine negative affects subjects in the treatment group report at least marginally significantly higher scores: anger (1.64 versus 1.24,  $p < 0.1$ ), disgust (1.88 versus 1.23,  $p < 0.05$ ), and embarrassment (1.48 versus 1.04,  $p < 0.05$ ). We do not believe that these three differences threaten the validity of the mood-inducement procedure for the following reasons: First, the average scores for these three negative affects are small in magnitude, ranging from 1.04 to 1.88. These are quite close to one, the bottom of the response scale (recall that possible responses ranged from one to ten). Second, the average score for these three negative affects is substantially smaller than the average score for the three positive affects that are affected by the mood-inducement procedure (1.41 versus 4.92). Third, the total negative affect score for subjects in the treatment and control groups is statistically indistinguishable. Fourth, the source of the increase in anger, disgust, and embarrassment is clear: there are six subjects (three male, three female) in the treatment group who exhibit extremely high negative affect. For all negative affects except confusion, this subgroup of six exhibits significantly higher negative affect than all other subjects, including those in the control group, making it is easy to control for these

subjects in the regression analysis. A plausible explanation for this subgroup's negative affect is found in the demographic survey, which indicates that the six subjects' rates of religious service attendance are all above the pooled median. Further, their median rate of attendance is at roughly the eightieth percentile of the pooled sample. Presumably, Robin Williams' extensive use of foul language in the positive-affect film clip gave rise to strong negative affect in this subgroup.

### *Summary Statistics and Tests of Means*

Two measures of overconfidence are derived from the responses to questions 1 and 3, the incentivized questions from Activity 2. In particular, "Absolute Overconfidence" (AOC) is defined as the difference between the estimated (question 1 from Activity 2) and actual number of correct answers on the quiz. For example, if a subject estimated that she answered 20 (14) questions correctly but actually answered 17 correctly, then the subject's AOC would be +3 (-3). "Relative Overconfidence" (ROC) is defined as the difference between a subject's estimated (question 3 from Activity 2) and actual number of correct answers on the quiz relative to all subjects in the same session. For example, if a subject estimated that she answered 4 more (4 fewer) questions correctly than the average subject in the same session—and she actually answered 2 more questions correctly than the average in the session—then her ROC would be +2 (-6).

Subjects exhibit both AOC and ROC: in the pooled sample, average AOC is 2.98 (s.e. = 0.39) and ROC is 1.06 (s.e. = 0.29). Further, overconfidence is diffuse: the proportion of subjects exhibiting AOC is 0.72 (s.e. = 0.04), which is statistically significantly higher than half ( $p$ -value < 0.001) and the proportion of subjects exhibiting

ROC is 0.62 (s.e. = 0.05), which is also statistically significantly greater than half (p-value < 0.01). Comparing AOC to actual quiz performance (16.87, s.e. = 0.29), we see that the magnitude of AOC is large: subjects overestimate their own performance by 18.29 percent on average (s.e. = 2.68). Finally, subjects appear to be overconfident regarding other subjects' performance as well, as ROC is on average smaller than AOC (p-value of test of equality < 0.001). That is, if subjects correctly estimated other subjects' performance, then ROC should equal AOC.

Preliminary results indicating the direction of the effect of positive affect (PA) on overconfidence are offered by simple mean-comparisons. First, quiz-performance did not differ between the treatment and control groups (17.16 versus 16.55, p-value = 0.289). AOC is insignificantly higher in treatment than control (3.43 versus 2.49, p-value = 0.231), and ROC is marginally significantly higher in treatment than control (1.55 versus 0.51, p-value < 0.10). The magnitude and significance of these differences increase when the subgroup of six negatively-affected subjects is excluded (AOC: 3.70 versus 2.49, p-value = 0.135; ROC: 1.89 versus 0.51, p-value < 0.05).

Given the well-established finding that men exhibit greater overconfidence than women, it is of interest to examine AOC and ROC by gender. While men's performance on the 30-item quiz was significantly better than women's (17.77 versus 15.84, p-value < 0.001)<sup>8</sup>, men exhibit significantly greater overconfidence than do women (4.04 versus 1.78,  $p < 0.005$ ), and a significantly greater proportion of men than exhibit overconfidence (0.81 versus 0.62,  $p < 0.05$ ). As measured by ROC, however, there is no

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<sup>8</sup> On the 20 trivia questions, men significantly outperform women (9.07 versus 6.74, p-value < 0.001). However, on the ten math questions, performance is not significantly different across gender, with women insignificantly outperforming men (9.10 versus 8.71,  $p = 0.124$ ).

evidence that men exhibit greater overconfidence than do women (1.07 versus 1.04,  $p = 0.957$ ).

It is also of interest to consider the relationship between accuracy on the quiz and accuracy of estimated quiz-performance, or quiz-performance and overconfidence. AOC was insignificantly lower for those with above-average performance on the quiz than below-average (2.77 versus 3.26,  $p = 0.536$ ). The ROC of above-average performers, though, was significantly lower than below-average performers (0.16 versus 2.31,  $p\text{-value} < 0.001$ ). Indeed, the ROC of above-average performers is statistically indistinguishable from zero ( $p\text{-value} = 0.662$ ), while that of below-average performers is significant ( $p\text{-value} < 0.001$ ).

In summary, using simple measures of overconfidence and mean-comparison tests, there is evidence that positive affect increases ROC, that men exhibit more AOC than women, and that above-average quiz-performers exhibit less ROC than below-average performers. We now turn to a more rigorous analysis.

### ***Main Regression Analysis***

To study the effect of mild Positive Affect (PA) on overconfidence, we estimate a model of the following baseline form:

$$\textit{Estimated Performance} = \beta_0 + \beta_1 \textit{Treatment} + \beta_2 \textit{Actual Performance} + u$$

(1)

*Treatment* is a treatment dummy that equals one if the subject is in the treatment group (and watched the positive-affect film clip) and zero otherwise. The dependent variable *Estimated Performance* is measured by the response to one of the four self-evaluation

questions. In specifications concerned with absolute overconfidence, it corresponds to the incentivized responses in which subjects estimated the number of correct answers on the quiz (*Est NC*). In these specifications, *Actual Performance* is given by number of quiz items the subject actually answered correctly (*NC*). In specifications concerned with relative overconfidence, *Estimated Performance* is measured with the incentivized responses in which subjects estimated how many more or fewer question they answered correctly relative to the session-average (*Est Rel NC*). *Actual Performance* in these specifications corresponds to subjects' actual number of correct answers relative to the session-average (*NC – Session Average*). We control for the subset of six negatively-affected subjects with a dummy variable, though we do not include its coefficient estimate in the regression tables. Our results are reported for the pooled sample and separately by gender. All specifications are estimated with Ordinary Least Squares (OLS), and robust standard errors are calculated by clustering observations by session.<sup>9</sup>

The first three columns of Table I show the coefficient-estimates of equation (1) with dependent variable *Est NC*. As shown in Column (1), holding quiz performance constant, positive affect increases subjects' estimates of the number of correct answers on the quiz by a statistically insignificant 1.24 ( $p$ -value = 0.153). As we would expect, the estimated number of correct answers significantly increases with the actual number of correct answers.

To determine whether positive affect impacts overconfidence differently for men and women, we re-estimate the specification in Column (1) separately by gender.

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<sup>9</sup> Because there were a small number of clusters, we performed cluster bootstrap re-estimations of all specifications of equation (1). In all specifications where there were sufficient observations to compute the bootstrap standard errors and where at least 50 replicates were complete, results were consistent with those of Tables I-IV; i.e. estimates of coefficients were identical and significance levels were unaffected.

Column (2) shows that the effect of the positive-affect treatment on men is positive and significant, increasing the estimated number of correct answers by 1.86 (p-value < 0.05) while controlling for actual performance. In contrast, women's estimated number of correct answers is virtually unaffected by positive-affect treatment (see Column (3)). Also, men's and women's estimates of performance are impacted quite differently by actual performance. By comparing the estimates of  $\beta_0$  and  $\beta_2$  across Columns (2) and (3), we see that men with very low levels of performance are predicted to dramatically overestimate the number of questions they answered correctly, but that estimated performance does not increase at pace with actual performance. That is, calibration is increasing with actual performance for men. Women, on the other hand, are almost perfectly calibrated at all levels of performance: in Column (3), the estimate of  $\beta_0$  is statistically indistinguishable from zero (p-value = 0.881) and the estimate of  $\beta_2$  is statistically indistinguishable from one (p-value = 0.545).

The analysis of the first three columns is repeated in the last three of Table I, but with dependent variable *Est Rel NC* measuring *Estimated Performance* and *NC – Session Average* estimating *Actual Performance*. We see much the same pattern as with absolute overconfidence, but less marked both in terms of magnitude and statistical significance. In the pooled sample the effect of positive-treatment is to overestimate performance relative to the session average by an insignificant 1.20 (p-value = 0.177). However, gender-subgroup analysis reveals that while the treatment does not impact estimated relative performance for women, it marginally significantly increases men's estimated relative performance by 1.37 (p-value = 0.072), controlling for actual relative performance.



In summary, the lack of positive-affect treatment-effect in the pooled samples for both incentivized measures of overconfidence belies gender-dependent results wherein men are made more overconfident with treatment and women are unaffected. These gender-disparate results cannot be explained by differential responses to the mood-inducement. Within the treatment group, men's and women's reported total positive affect and amusement are statistically indistinguishable (men: 31.60 versus women: 27.73,  $p$ -value = 0.15); the same is true within the control group (men: 24.92 versus women: 21.65,  $p$ -value = 0.26). Further, restricting the sample by gender, the difference in total positive affect between treatment and control for men (31.60 versus 24.92,  $p$ -value = 0.02) is similar to that for women (27.73 versus 21.65,  $p$ -value = 0.03). So while men and women report similar levels of affect, only men's estimated number of correct answers on the quiz is affect-dependent.

### ***Robustness Checks***

As further tests of the impact of positive affect on overconfidence, we estimate two additional sets of specifications. First, we estimate equation (1) substituting the subjective, unincentivized self-evaluations as dependent variables. While, of course, these dependent variables are merely self-evaluation and not measures of overconfidence, they can shed light on overconfidence in regressions controlling for actual performance. Finally, we estimate equation (1) substituting the total *Positive PANAS* score for *Treatment*. Using this continuous measure allows us to test whether the magnitude of positive affect is related to the magnitude of overconfidence. As a correlational analysis, it complements the intent-to-treat analysis and does not rely on successful mood-

inducement. As such, in the specifications where *Positive PANAS* is substituted for *Treatment*, the subset of six negatively-affected subjects is not controlled for.

Table II shows the estimated coefficients of equation (1)—pooled and by gender—where the dependent variable is the subjective valuation (1-7) of performance (Columns (1) – (3)) and performance relative to other session participants (Columns (4) – (6)). The first three columns show that positive-affect treatment does not have a significant effect on absolute self-evaluations, neither for men nor women. Comparison of the estimates of  $\beta_0$  and  $\beta_2$  for men and women shows that men have higher absolute self-evaluations than do women, but that men’s self-evaluations are less sensitive to actual performance than are women’s.

Positive-affect treatment increases how well subjects assess their relative performance by a marginally significant 0.40 on a scale from one to seven (p-value = 0.055). The gender-specific estimations show that this effect is driven by men. Treatment statistically significantly increases subjective evaluations of relative performance by 0.78 for men (p-value < 0.01), controlling for actual relative performance. For women, the subjective evaluations of relative performance in treatment and control are statistically indistinguishable (p-value = 0.647).

Table III shows the estimates of equation (1) using the incentivized questions, substituting the subject’s sum total of positive PANAS scores (*Positive PANAS*) for *Treatment*. As there are seven positive-affects surveyed on the PANAS, *Positive PANAS* has a maximum possible score of 70 (mean = 26.98, s.d. = 10.21). *Est NC* is the dependent variable in the first three columns and *Est Rel NC* in the last three. Controls for the subsample of six subjects in the positive-affect treatment who experienced high

levels of negative affect have been removed. In the pooled samples, both dependent variables statistically significantly increase with *Positive PANAS* (see Columns (1) and (4)). The gender-specific regressions with dependent variable *Est NC* do not reveal a gendered response to *Positive PANAS*. However, we see that men's estimated performance is high ( $\beta_0 = 13.64$ , p-value  $< 0.05$ ) and insensitive to actual performance ( $\beta_2 = 0.39$ , p-value = 0.121). As in Table I, women are well-calibrated, with estimates of  $\beta_0$  indistinguishable from zero (p-value = 0.973) and  $\beta_2$  indistinguishable from one (p-value = 0.818). The gender-specific regressions with dependent variable *Est Rel NC* reveal that the pooled-sample result is driven by men: controlling for actual relative performance, estimated relative performance is increasing with self-reported positive affect for men, but there is no such effect for women.

Table IV shows the estimates of equation (1) using as dependent variables the unincentivized self-evaluations (on a 1-7 scale) and again substituting *Positive PANAS* for *Treatment*. As with the incentivized measures, in the pooled samples, both absolute and relative self-evaluations are statistically significantly increasing with *Positive PANAS* (see Columns (1) and (4)). The impact of positive affect is in both cases positive and at least marginally significant for men (see Columns (2) and (5)). As in all specifications, positive mood does not impact women's self-evaluations (see Columns (3) and (6)).

In general, the robustness checks support the results that both absolute and relative overconfidence increase with positive affect. There is further support for a gendered dimension to overconfidence and the impact of positive affect on it. The robustness checks support that women are better calibrated than men and that their self-evaluations are not dependent on positive-affect. For men, positive affect has a robust

positive impact on self-evaluations and overconfidence. Because positive affect and negative affect do not necessarily have opposing effects (Isen 2007), our positive-affect results does not suggest that negative affect will decrease overconfidence. To consider the effect of negative affect on overconfidence, we conduct Study 2.

### **Study 2: The Effects of Anger, Fear, and Sadness on Overconfidence**

The effects of negative affect, though equally important, are not as easily organized or summarized as those of positive affect. The independence of positive and negative affect is well-established in psychology, so positive and negative affect do not necessarily have opposite effects (Norman M. Bradburn 1969; Diener and Emmons 1984; Watson et al. 1988; Lyubomirsky et al. 2005; and Isen 2007). Further, distinct negative affects are likely to have variant effects on behavior so, so the negative-affect literature must be considered separately by affect; positive affects are less likely to have variant effects (Isen 2007)<sup>10</sup>. Thus one can neither rely on the positive affect literature nor conduct experiments with generalized negative affect to fully examine the effect of negative affects on behavior.

The most current theoretical structure for conceptualizing the effect of affects on behavior and judgment is the appraisal-tendency framework. The theory relies upon each emotion's characterization along a range of dimensions—the emotion's appraisal tendencies (Smith and Ellsworth 1985; and Lerner and Keltner 2001). The appraisal

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<sup>10</sup> Much of this is due to the fact that the distinct positive affect that most studies are concerned with is a happy mood. Also, many studies that consider negative affect elicit only a particular affect—usually sadness.

tendencies are pleasantness, certainty, personal responsibility/control, situational responsibility/control, attention, and anticipated effort. The appraisal tendencies determine how the emotion alters our perceptions or motives, what information it conveys, and ultimately how it impacts our behavior. For example, disgust is associated with unpleasantness, effort, certainty, and another person having control (Smith and Ellsworth 1985). The theory is supported by experimental evidence that disgust increases judgments of immorality (Wheatley and Haidt 2005; Inbar et al. 2009) and harshness of punishments (Schnall et al. 2008). Further, it “revolves around the appraisal theme of being too close to an indigestible object or idea (Lerner et al. 2004, p. 337), therefore encouraging expulsion. This is illustrated by experimental results that disgust reduces status quo bias (Han et al. 2010), increases adjustments from anchors (Inbar and Gilovich 2011), and eliminates the endowment effect (Lerner et al. 2004). Below, we review the appraisal tendencies of anger, fear, and sadness and the empirical evidence of their behavioral effects.

### *Anger*

Anger is associated with certainty about the circumstances of a negative situation and who is to blame for it, and with a sense of personal control over fixing or coping with it (Lerner and Tiedens 2006). Further, the sense of certainty it imbues is thought to reduce the motivation to process new information carefully (Inbar and Gilovich 2011).

Controlled experiments have found that it increases risk-seeking (Lerner and Tiedens 2006), stereotyping (Bodenhausen 1994), preferences for in-group members versus out-group (Mackie et al. 2000; and DeSteno et al. 2004), rejection of unfair ultimatum-game

offers (Andrade and Ariely 2009), and punishing behavior (Goldberg et al. 1999); and decreases perceived risk (Johnson and Tversky 1983; Lerner and Keltner 2001), trust (Dunn and Schweitzer 2005), and preference for public welfare assistance (Small and Lerner 2005). Because it enhances a sense of personal control and diminishes careful thought-processing, anger is hypothesized to increase overconfidence.

### *Fear*

Fear, like anger, is a negative emotion, but is anger's opposite in many dimensions. The appraisal-tendencies associated with fear are unpleasantness, high uncertainty over outcomes, and low control over the situation (Smith and Ellsworth 1985). Indeed, in controlled experiments, induced fear has been shown to increase perceived risk (Johnson and Tversky 1983; Lerner and Keltner 2001). The appraisal-tendency framework thus suggests that the reduction of uncertainty and avoidance of risk would be motives associated with fear (Raghunathan and Pham 1999). Controlled experiments confirm this: induced fear increases preference for low-risk, low-reward lotteries over high-risk, high-reward lotteries (Raghunathan and Pham 1999). Uncertainty-reduction and risk-avoidance suggest, albeit indirectly, that induced fear may decrease overconfidence.

### *Sadness*

The appraisals associated with sadness are loss, helplessness, and diminished sense of control over the situation (Smith and Ellsworth 1985; Lerner et al. 2004). Controlled experiments have found that sadness evokes behavior that rewards both the self and others: it increases self-efficacy (Jundt and Hinsz 2002); consumption of tasty, fattening

foods (Garg et al. 2007; valuation of, willingness to pay for, and spending on new products (Lerner et al. 2004; Cryder et al. 2008); preference for high-risk, high-reward lotteries over low-risk, low-reward lotteries (Raghunathan and Pham 2005) despite increased perceived risk (Johnson and Tversky 1983; Lerner and Keltner 2001); helping behavior (Manucia et al. 1984); and reciprocity in gift-exchange games (Kirchsteiger et al. 2006).

The above findings are consistent with mood-repair: sad individuals take actions to improve their affective states (Clark and Isen 1982). Another account relies on the consistent finding that sadness increases self-focus (Wood et al. 1990; Salovey 1992; and Silvia et al. 2006). Cryder et al. (2008) demonstrate that the effect of sadness on spending is mediated by self-focus, and they hypothesize that sadness and self-focus indirectly “trigger[] an implicit desire to enhance the self (p. 526).”

From these findings, we would expect sadness to increase overconfidence. Further support for this hypothesis is offered from papers that explicitly study the effect of sadness on overconfidence. Although Allwood and Bjorhag (1991) find that negative affect has no effect on overconfidence, Allwood et al. (2002) and Kuvaas and Kaufmann (2004) compare the effect of positive to negative affect (sadness, specifically) on overconfidence without a neutral condition and find no difference. This would be consistent with sadness increasing overconfidence, given that Study 1 finds that positive-affect increases overconfidence relative to neutral-affect.

## **Experimental Design**

The experimental procedure followed that of Study 1: First, subjects read detailed instructions regarding the experimental session; the instructions were also read aloud by the experimenter. Second, subjects read and signed the informed consent form. Third, subjects took the 30-question quiz. Fourth, the mood-inducement procedure was administered. Fifth, subjects evaluated their performance on the quiz. Sixth, subjects answered questions regarding their mood. Seventh, subjects answered questions regarding their demographic and psychological characteristics. Finally, subjects received their payments and exited the experimental session. In total, the experimental session lasted approximately 45 minutes, and subjects received an average of \$15 for their participation (all instructions and forms are presented in Appendix A). The only procedural deviations from Study 1 were in the subject pool and the film clips utilized to elicit mood. These are discussed below.

### ***Subjects***

The laboratory experiment was conducted at the Center for Experimental Social Science (CESS) laboratory at New York University. One-hundred and seventy-nine students were recruited using CESS's online recruitment tool. Prospective subjects were told that participation in the study would take less than an hour and that they would be paid for their participation, with an average payment of between \$15 and \$20, a minimum payment of \$10, and a maximum payment of \$25.

### ***Mood inducement***



Subjects were randomly assigned either to one of three treatment groups—fear (44 out of 179), anger (44 out of 179), and sadness (49 out of 179)—and watched a film clip intended to induce the appropriate negative affect; or to the control group (42 out of 179) and watched a film clip intended to induce neutral affect. Except for the variant film clip, the experimental procedure was identical for the treatment and control groups, and identical to Study 1.

Our choice of film clips also followed Gross and Levenson (1995). All clips were roughly 4 minutes long. The film clip in the anger treatment was a scene from *My Bodyguard* (Simon, 1980), in which bullies taunt and beat-up a silent, teenage boy. The film clip in the fear treatment was a scene from *Silence of the Lambs* (Goetzman, 1991), in which a female FBI agent pursues a suspect into a dark and eerie basement. The film clip in the sadness treatment was a scene from *The Champ* (Lovell, 1979), in which a boy’s father, a boxer, dies after a match while the boy is watching. The neutral-affect film clip was a “screensaver”-like animation of colored sticks. It is important to note that this was different from the neutral-affect film clip in Study 1. The elicitation of neutral affect can err on the side of either pleasantness or boredom (Rottenberg et al. 2007). To avoid type I errors, the relatively pleasant Denali clip served as the control against the positive-affect treatment in Study 1, while the more tedious “sticks” clip served as a control against negative affects in Study 2; both clips were drawn directly from Rottenberg et al. (2007).

## **Results**

### *Sample*

In addition to coming from a different university, the subjects in this study are demographically different from those in Study 1 in other ways: over half of the subjects are female (64 percent); over half of the subjects are Asian (56 percent), with white as the next biggest ethnic group (29 percent); and a substantial minority are not U.S. citizens (21 percent). We will explore the extent to which results vary for Asians versus non-Asians.

### *Mood Inducement*

Subjects in each treatment group report significantly higher levels of the target affect than subjects in the control group: 5.19 versus 2.56,  $p$ -value  $< 0.001$ , for anger; 4.48 versus 1.98,  $p$ -value  $< 0.001$ , for fear; and 5.18 versus 1.80,  $p$ -value  $< 0.01$ , for sadness (see Table 2). Further evidence that the mood-inducement procedure has the intended effect can be seen in responses to the following questions from Questionnaire 2: “Did seeing the video clip make you?” (1) “angrier,” (2) “more fearful,” or (3) “sadder.” The proportion of subjects in each treatment group who state that the film clip changes their mood as intended is significantly greater than it is in the control group: 0.46 versus 0.12,  $p$ -value  $< 0.01$ , for angrier; 0.36 versus 0.10,  $p$ -value  $< 0.01$ , for more fearful; and 0.63 versus 0.10,  $p$ -value  $< 0.01$ , for sadder (see Table 2). Finally, total negative affect—the sum of the nine negative affect scores from the PANAS—is at least marginally significantly greater for subjects in each treatment group than it is for subjects in the control group: 37.63

versus 22.22,  $p < 0.001$ , for anger; 27.60 versus 22.22,  $p < 0.10$ , for fear; and 31.53 versus 22.22,  $p < 0.01$  for sadness.

Total positive affect—the sum of the seven positive affect scores from the PANAS—is marginally lower for subjects in anger and sadness treatments than for subjects in the control group: 16.91 versus 20.54,  $p < 0.10$ , for anger; and 16.87 versus 20.54,  $p < 0.10$ , for sadness. Interestingly, however, total positive affect is greater, but not significantly so, for subjects in the fear treatment than for subjects in the control group: 22.21 versus 20.54,  $p\text{-value} = 0.456$ . This difference arises because the fear treatment’s film clip increases *interest* scores compared to the neutral-affect film clip: 6.09 versus 4.05,  $p < 0.01$ ; neither of the other negative-affect film clips has this impact. As a matter of fact, all other positive-affect scores for subjects in the three treatment groups are weakly less than the scores for subjects in the control group. Thus, the negative-affect film clips do not increase positive-affect scores in general. Finally, subjects in the fear treatment report that they enjoy watching the film clip significantly more than subjects in the control group: 4.68 versus 3.54 ( $p < 0.01$ ). Again, neither of the other negative-affect film clips has this impact.<sup>11</sup> In the econometric analysis, we control for the eight subjects in the fear-treatment who had unusually high enjoyment of the clip and levels of interest. Specifically, these subjects are identified by having reported both of the following: (i) enjoyment of the clip of greater than or equal to 6 out of 7 (there were 15 such subjects out of the total 179 subjects in the whole experiment) and (ii) interest greater than or equal to 7 out of 10 (there were 45 such subjects out of the total

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<sup>11</sup> We believe these two unanticipated effects—elevated *interest* scores and greater enjoyment—stem from the fact that *Silence of the Lambs* is a well-known film that many subjects may have already seen featuring a contemporary celebrity many subjects are familiar with. The other negative-affect film clips are less well-known.

179 subjects in the whole experiment). Only eight subjects, all in the fear treatment, satisfied both criteria, and our econometric analysis includes an indicator variable that takes a value of one for these eight subjects and zero otherwise.

Finally, each negative-affect film clip significantly ( $p < 0.01$ ) increases untargeted negative-affect scores. The anger treatment's film clip significantly increases *contempt*, *disgust*, *embarrassment*, *sadness*, and *tension* scores; the fear treatment's film clip increases *disgust*, and *tension* scores; and the sadness treatment's film clip increases *disgust*, *fear*, *pain*, and *sadness* scores. Further, the proportion of subjects in the anger treatment who state that the film clip made them sadder is significantly greater than it is in the control group: 0.57 versus 0.10,  $p < 0.01$ . Thus, we were not able to induce the three negative affects—anger, fear, and sadness—without “spillover” to other negative affects, so this should be kept in mind when interpreting the results.

### ***Summary Statistics and Tests of Means***

As in Study 1, subjects exhibit both AOC and ROC: in the pooled sample, average AOC is 1.57 (s.e. = 0.29) and ROC is 0.85 (s.e. = 0.25). Comparing pooled samples, the level of AOC is statistically significantly in Study 2 than in Study 1 (1.56 versus 2.98,  $p$ -value  $< 0.005$ ); this is also reflected with marginal statistical significance in a comparison of the AOC of the control groups (0.81 in Study 2 versus 2.49 in Study 1,  $p$ -value = 0.06). The proportion of subjects exhibiting AOC is 0.63 (s.e. = 0.04), which is statistically significantly more than half ( $p$ -value  $< 0.001$ ) and statistically indistinguishable from the corresponding proportion in Study 1, 0.72 ( $p$ -value = 0.13). The proportion of subjects exhibiting ROC is also 0.63 (s.e. = 0.04), which is statistically significantly more than

half ( $p$ -value  $< 0.001$ ) and statistically indistinguishable from the corresponding proportion in Study 1, 0.62 ( $p$ -value = 0.99).

Subjects got an average of 18.35 (s.e. = 0.23) items correct on the quiz, which is statistically significantly higher than the average of 16.87 in Study 1 ( $p$ -value  $< 0.001$ ). Thus subjects overestimate their quiz performance by 9.2 percent on average (s.e. = 1.84), significantly lower than the comparable figure of 18.29 percent in Study 1 ( $p$ -value  $< 0.005$ ). As in Study 1, subjects appear to be overconfident regarding other subjects' performance as well, as ROC is on average smaller than AOC ( $p$ -value of the test of equality  $< 0.01$ ).

We will now turn to simple mean-comparisons for preliminary results of the effects of anger, fear, and sadness on overconfidence. First, quiz-performance did not differ between the control (17.98) and treatment groups (anger: 17.89,  $p$ -value of test of equality with control = 0.901; fear: 18.87,  $p$ -value = 0.31; sadness: 18.78,  $p$ -value = 0.227). AOC is statistically insignificantly lower in control (0.81) than in any of the treatment groups (anger: 1.61,  $p$ -value = 0.409; fear: 1.98,  $p$ -value = 0.190; sadness: 1.82,  $p$ -value = 0.210). Similarly, ROC is statistically insignificantly lower in control (0.55) than in any of the treatment groups (anger: 0.74,  $p$ -value = 0.811; fear: 1.30,  $p$ -value = 0.346; sadness: 0.81,  $p$ -value = 0.714). Excluding the eight positively-affected subjects in the fear treatment increases the magnitude and significance of these differences (AOC: 2.39 versus 0.81,  $p$ -value  $< 0.10$ ; ROC: 1.54 versus 0.55,  $p$ -value = 0.241).

For comparability to Study 1, we examine AOC and ROC by gender. While men's performance on the 30-item quiz was significantly better than women's (19.60

versus 17.64,  $p$ -value  $< 0.001$ )<sup>12</sup>, men exhibit marginally significantly greater overconfidence than do women (2.29 versus 1.16,  $p < 0.10$ ), although the proportions of men and women exhibiting overconfidence is statistically indistinguishable (0.67 versus 0.61,  $p < 0.342$ ). In Study 1, the gender difference in AOC was greater both in magnitude and statistical significance, and the proportion of men exhibiting AOC was statistically significantly greater than the proportion of women. As in Study 1, men's and women's ROC are statistically indistinguishable (0.86 versus 0.84,  $p = 0.961$ ).

Given the large proportion of Asians in the sample, we examine AOC and ROC by Asian self-identification. While Asians have statistically insignificantly lower quiz performance than non-Asians (18.05 versus 18.78,  $p$ -value = 0.121)<sup>13</sup>, they exhibit significantly lower levels of AOC (0.91 versus 2.36,  $p$ -value  $< 0.05$ ) and a significantly smaller proportion exhibits AOC (0.54 versus 0.74,  $p$ -value  $< 0.01$ ). Asians and non-Asians do not significantly differ in ROC (0.83 versus 0.94,  $p$ -value = 0.822).

Turning to the relationship between quiz-performance and overconfidence, we find that AOC was insignificantly higher for those with above-average performance on the quiz than below-average (1.69 versus 1.44,  $p = 0.671$ ), which is the reverse of what was found in Study 1. As in Study 1, the ROC of above-average performers was significantly lower than below-average performers (0.04 versus 1.72,  $p$ -value  $< 0.001$ ). Indeed, as in Study 1, the ROC of above-average performers is statistically

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<sup>12</sup> On the 20 trivia questions, men significantly outperform women (10.60 versus 8.50,  $p$ -value  $< 0.001$ ). However, on the ten math questions, performance is not significantly different across gender, with women insignificantly outperforming men (9.14 versus 9.00,  $p = 0.512$ ).

<sup>13</sup> On the 20 trivia questions, non-Asians significantly outperform Asians (10.12 versus 8.60,  $p$ -value  $< 0.001$ ). However, on the ten math questions, non-Asians perform significantly lower than Asians (8.66 versus 9.45,  $p = 0.512$ ).

indistinguishable from zero (p-value = 0.896), while that of below-average performers is significant (p-value < 0.001).

In summary, using simple measures of overconfidence and mean-comparison tests, there is no evidence that any of the negative affects impacts either of the measures of overconfidence. We do find overconfidence-differences between men and women, between Asians and non-Asians, and between above- and below-average performers. As in Study 1, these demographic differences will guide our subgroup regression analysis.

### ***Main Regression Analysis***

To study the effect of fear, anger, and sadness on overconfidence, we estimate a model of the following baseline form:

$$\begin{aligned} \text{Estimated Performance} = & \beta_0 + \beta_1 \text{Anger Treatment} + \beta_2 \text{Fear Treatment} + \beta_3 \text{Sadness} \\ & \text{Treatment} + \beta_4 \text{Actual Performance} + u \end{aligned} \quad (2)$$

All variables are defined as in equation (1), with the dummy variables *Anger Treatment*, *Fear Treatment*, and *Sadness Treatment* equal to one if the subject is in the corresponding treatment group (and watched the corresponding affect's film clip) and zero otherwise. As in Study 1, all specifications are estimated with Ordinary Least Squares (OLS), and robust standard errors are calculated by clustering observations by session.

Table V show the coefficient-estimates of equation (2) with dependent variable *Est NC*. As shown in Column (1), holding quiz performance constant, anger increases subjects' estimates of the number of correct answers on the quiz by a statistically insignificant 0.80 (p-value = 0.593), fear increases estimates by a marginally significant

1.65 (p-value < 0.10), and sadness increases estimates by a statistically insignificant 1.07 (p-value = 0.203). As we would expect, the estimated number of correct answers significantly increases with the actual number of correct answers.

Next we attempt to determine whether negative affect impacts estimated quiz performance differently by demographic subgroup. We re-estimate the specification in Column (1) separately for men and women in Columns (2) and (3), respectively. For neither gender does any of the negative-affect treatments have a statistically significant impact on estimated quiz-performance. In Columns (4) and (5), we re-estimate the Column (1) specification separately for non-Asians and Asians, respectively. The anger- and fear-treatments have no statistically significant impact on estimates for either Asians or non-Asians. Sadness, though, statistically significantly increases estimates of quiz-performance by 2.71 for non-Asians (p-value < 0.05), with no statistically significant effect for Asians (p-value = 0.402). Coefficient estimates of the effects of the negative affects on estimated quiz performance, while mostly insignificant, are all positive with the exception of the anger-treatment for the women-only specification.

The analysis of Table V is repeated in Table VI, but with dependent variable *Est Rel NC* measuring *Estimated Performance* and *NC – Session Average* estimating *Actual Performance*. All treatment-coefficients are statistically insignificant, with the exception of one: for non-Asians, the sadness treatment reduces subjects' estimate of their performance relative to others by 0.86 (p-value < 0.10). All fear-treatment coefficients are positive, while anger and sadness coefficients are negative in the men-only and non-Asian-only specifications.



Within the sadness-treatment group, non-Asian's reported higher levels of each of the negative affects than did Asians, statistically significantly so for fear (3.86 versus 2.60,  $p$ -value  $< 0.05$  and marginally statistically significantly so for the sum of all negative PANAS items (36.57 versus 29.51,  $p$ -value = 0.063). Sadness itself was insignificantly higher for non-Asians than Asians (6.07 versus 4.83,  $p$ -value = 0.131); and the sum of all positive PANAS items was statistically indistinguishable for non-Asians and Asians (17.29 versus 16.70,  $p$ -value = 0.818). Further, in the control group, non-Asians reported lower levels of all negative affects than did Asians; the difference was marginally statistically significant for contempt, disgust, and embarrassment, and statistically significant for sadness (1.07 versus 2.35,  $p$ -value  $< 0.05$ ), anger (1.33 versus 3.42,  $p$ -value  $< 0.05$ ), confusion (3.33 versus 5.50,  $p$ -value  $< 0.005$ ), pain (1.27 versus 2.91,  $p$ -value  $< 0.05$ ), and the sum of all negative PANAS items (27.70 versus 14.87,  $p$ -value  $< 0.05$ ). Further, restricting the sample by Asian self-identification, we find that both non-Asians and Asians have increased sadness in the sadness-treatment compared to control, though the difference is much larger for Asians (non-Asians: 6.07 versus 1.07,  $p$ -value  $< 0.001$ ; Asians: 4.83 versus 2.35,  $p$ -value  $< 0.001$ ). For non-Asians, the sum of all negative PANAS items is higher in the sadness-treatment compared to control (36.57 versus 14.87,  $p$ -value  $< 0.001$ ), but for Asians the sum of all negative PANAS items is statistically indistinguishable between the sadness treatment and control (29.51 versus 27.70,  $p$ -value = 0.647). Thus, the disparity between the effect of the sadness-treatment on overconfidence for non-Asians' and Asians' may be attributable to differential responsiveness to mood inducement. Note, this differs from the gender-differences in the

effect of positive affect on overconfidence, as those were not attributable to differential responsiveness to mood inducement.

### ***Robustness Checks***

When repeating Tables V and VI but with the unincentivized self-evaluations as dependent variables, all treatment coefficients in all specifications are statistically insignificant (see Tables VII and VIII). Interestingly, when repeating Tables V-VII but with the PANAS scores as regressors instead of the treatments and removing the control for the eight subjects in the fear treatment with high enjoyment and interest, the sign of the corresponding PANAS items flips. That is, while the anger-, fear-, and sadness-treatments tend to be positively associated with overconfidence, the levels of self-reported anger, fear, and sadness are often negatively correlated with overconfidence. Given the confounding of affects induced by the negative-affect treatments and the disparate mood-inducement of non-Asians and the Asian majority, attributing any correlations between the treatments and control to the mood being induced is difficult.

### **General Discussion**

To identify the effect of affect on overconfidence, we conduct two random-assignment experiments in which subjects evaluate their performance on a quiz after experiencing either an affective or neutral shock. Prior literature supports hypotheses in either direction for the effect of positive affect on overconfidence in Study 1; in Study 2, we hypothesized that anger, fear, and sadness would have positive, negative, and positive effects on overconfidence, respectively. The results from Study 1 consistently indicate

that positive affect induces overconfidence in men but not women. Study 2 found very little consistent support for any effect of the negative affects on overconfidence; this could be attributable to the ethnically non-standard sample, the arousal of interest and enjoyment by some of the clips intended to induce negative affect, or, of course, a truly negligible and/or inconsistent effect of these negative affects on overconfidence.

To determine the magnitude of the effect of positive affect on overconfidence, we control for the actual number of correct responses and find that the positive-affect shock increases male subjects' estimated number of correct responses by 1.86, an 8.9% increase in estimated performance relative to the male, control-group mean. The magnitude of the increase in relative overconfidence is even more dramatic: controlling for actual performance relative to session participants, the positive-affect shock increases male subjects' estimated relative performance by 1.37, an 86.7% increase in estimated performance relative to the male, control-group mean. The financial consequences of these increases in overconfidence are sizable. While not statistically significant, payments corresponding to the incentivized absolute (relative) overconfidence questions were 6.5% (13.8%) lower for subjects in the positive-affect treatment relative to control.

Overconfidence is a problem of beliefs, and beliefs are a precursor to observable behavior. As noted in the introduction, overconfidence may explain the effect of positive affect on trading volume and the persistence of speculative bubbles. Further, the effect of positive affect on overconfidence also has implications for how we interpret other existing research on the effect of positive affect on human behavior. For example, positive affect may decrease time preference by making us more overconfident of our ability to be patient or stave off future self-control problems.

As expounded in Ifcher and Zarghamee (2011), it is important to provide guidance on what can be extrapolated from research investigating the impact of mood on behavior. First, the behavioral effects of intense mood-states are not necessarily amplifications of the effects of mild ones, so intense positive affect will not necessarily dramatically increase overconfidence (Isen 2007). Finally, since it has been claimed by psychologists that, “frequent positive affect is both necessary and sufficient to produce the state we call happiness, whereas intense positive experience is not (Diener et al. 1991),” our result suggests that happier individuals may exhibit more overconfidence.

Our result also has implication for the interpretation of neural evidence. Knutson et al. (2008) study neural correlates of risk-taking after mood-inducement. In an all-male laboratory experiment where mood was induced with erotic images, they find that the ensuing activation in the nucleus accumbens—a region that processes rewards, motivates approach of rewarding cues, and is associated with excitement—is associated with a higher likelihood of making risky investments. In later work, Kuhnen and Knutson (2011) find that positive mood-inducement using erotic images leads increased risk-taking and negative mood-inducement using images like rotting food reduce risk-taking. It is assumed, but not explicitly shown in the research, that activation of the nucleus accumbens drives the positive-affect effect and activation of the anterior insula—a region linked to processing losses and punishment and the avoidance of aversive stimuli—drives the negative-affect effect. It should be noted that these neural correlate may not be relevant to our experiment since, in Study 1, we elicit a milder positive affect (amusement) and not arousal, and in Study 2, we do not attempt to induce on disgust.

Kuhnen and Knutson (2011) also find that the subjects who saw erotic images updated beliefs about financial investments in a way so as to maintain a positive mood, a finding that supports positive-mood-maintenance as a byproduct of positive affect. This means that positive affect can increase overconfidence if positive self-assessment helps maintain positive affect; in contrast, positive affect can promote accuracy if accuracy helps maintain positive affect. Our results support the former: that positive self-assessment helps maintain positive affect.

The neuropsychological literature on overconfidence suggests that it can be understood as heuristic processing that can be corrected with cognitive control (Beer and Hughes 2011). Specifically, it has been shown that the accuracy of self-evaluations—both of one’s own performance and in relation to others—is associated with activity in the orbitofrontal cortex and dorsal anterior cingulate cortex, with the magnitude of activity positively proportional to the magnitude of overconfidence (Beer and Hughes 2011). These same neural regions have also been associated with overcoming susceptibility to incidental yet salient characteristics like emotions and framing in gambling judgments (Beer and Hughes 2011). The medial prefrontal cortex, on the other hand, has been implicated in exaggerating overconfidence (Beer and Hughes 2011).

Ashby et al. (1999) theorize that the effect of positive affect on behavior is associated with dopamine, the neurotransmitter released after the presentation of rewarding stimuli. Dopamine agonists elevate mood, while dopamine antagonists flatten affect (see Ashby et al. 1999). Of specific relevance to our research, the researchers posit that positive affect is associated with dopamine release from the ventral tegmental area to, among other areas, the anterior cingulate. Dopamine in the anterior cingulate

facilitates the selection of cognitive perspective. One of the many cognitive-flexibility tasks with which this has been illustrated, namely word fluency, has also been shown to be performed better under positive-affect inducement (see Ashby et al. 1999). There is also evidence that the anterior cingulate is involved in affective processes including conditioned emotional learning and the assignment of emotional valence to stimuli (see Ashby et al. 1999). If positive affect increases cognitive flexibility by facilitating the selection of cognitive perspective, we would expect behavior to be modified to one's benefit. In utility-maximization terms, facilitated selection of cognitive perspective can be thought of as relaxing a cognitive constraint. The implications of cognitive flexibility for overconfidence are *ex ante* ambiguous. As noted above, Kuvaas and Kaufman (2004) predict that the cognitive flexibility positive affect affords should increase accuracy (and thereby decrease overconfidence). It may be, though, that idiosyncratic preferences favor self-enhancement to accuracy, in which case improved cognitive flexibility would increase overconfidence. Again, the results of Study 1 support this latter interpretation.

In summary, the positive-affect result adds an important dimension to the emerging picture of positive affect's impact on human behavior. It has been posited that positive affect increases cognitive flexibility by broadening focus and attention, promoting openness to information, and enabling improved integration of information (Ashby et al. 1999; Isen 2008). This suggests that positive affect should decrease overconfidence. That positive affect increases overconfidence and hence exacerbates mistaken belief-formation and reduces earnings suggests that improved cognitive flexibility is not always positive affect's primary effect. Individuals may look to self-enhancement as a means of maintaining a positive mood or may fall back on it at the

heuristic level. While our findings suggest that positive affect exacerbates overconfidence, we find no effect of negative affects on overconfidence. Further research is necessary to determine whether this lack of result reflects a true absence of a relationship or failed mood inducement.

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Table I: Estimating treatment effect, incentivized self-evaluations as dependent variables

	(1)	(2)	(3)	(4)	(5)	(6)
	Estimated NC All Subjects	Estimated NC Male Only	Estimated NC Female Only	Estimated Rel NC All Subjects	Estimated Rel NC Male Only	Estimated Rel NC Female Only
Treatment	1.24 0.77	1.86 0.79 **	0.00 1.00	1.20 0.80	1.37 0.65 *	0.60 1.02
Number correct (NC)	0.93 0.12 ***	0.47 0.12 ***	1.15 0.24 ***			
NC - Session Average				0.53 0.07 ***	0.34 0.08 ***	0.66 0.15 ***
Constant	3.68 2.39	12.56 2.31 ***	-0.57 3.71	0.58 0.67	1.06 0.53 *	0.53 0.74
Observations	107	57	50	104 <sup>a</sup>	55 <sup>a</sup>	49 <sup>a</sup>

standard errors reported next to coefficients  
 \*, \*\*, and \*\*\* signify that means are significantly different with a p-value  $\leq 0.10$ , 0.05, and 0.01, respectively.  
<sup>a</sup> 3 subjects (2 male, 1 female) did not properly indicate their Est Rel NC

Table II: Estimating treatment effect, unincentivized self-evaluations as dependent variables

	(1)	(2)	(3)	(4)	(5)	(6)
	How did you do? All Subjects	How did you do? Male Only	How did you do? Female Only	Compared to others All Subjects	Compared to others Male Only	Compared to others Female Only
Treatment	0.26 0.27	0.19 0.31	0.26 0.25	0.40 0.17 *	0.78 0.21 ***	-0.12 0.25
Number correct (NC)	0.16 0.02 ***	0.08 0.02 **	0.19 0.03 ***			
NC - Session Average				0.17 0.02 ***	0.13 0.02 ***	0.20 0.03 ***
Constant	1.77 0.31 ***	3.49 0.32 ***	1.11 0.57 *	4.45 0.15 ***	4.49 0.14 ***	4.52 0.20 ***
Observations	107	57	50	107	57	50

standard errors reported next to coefficients  
 \*, \*\*, and \*\*\* signify that means are significantly different with a p-value  $\leq 0.10$ ,  $0.05$ , and  $0.01$ , respectively.

Table III: Estimating effect of positive PANAS scores, incentivized self-evaluations as dependent variables

	(1)	(2)	(3)	(4)	(5)	(6)
	Estimated NC All Subjects	Estimated NC Male Only	Estimated NC Female Only	Estimated Rel NC All Subjects	Estimated Rel NC Male Only	Estimated Rel NC Female Only
Positive PANAS	0.08 0.03 **	0.05 0.03	0.02 0.08	0.06 0.02 **	0.05 0.02 **	0.02 0.03
Number Correct (NC)	0.85 0.13 ***	0.39 0.22	1.07 0.31 ***			
NC - Session Average				0.48 0.08 ***	0.29 0.12 **	0.63 0.18 ***
Constant	3.46 2.78	13.64 4.81 **	0.15 4.48	-0.46 0.65	0.34 0.82	0.14 0.77
Observations	101 <sup>a</sup>	55 <sup>a</sup>	46 <sup>a</sup>	100 <sup>a,b</sup>	54 <sup>a,b</sup>	46 <sup>a,b</sup>
standard errors reported next to coefficients						
*, **, and *** signify that means are significantly different with a p-value $\leq 0.10$ , 0.05, and 0.01, respectively.						
<sup>a</sup> 6 subjects (2 male, 4 female) did not properly indicate their PANAS scores						
<sup>b</sup> 3 subjects (2 male, 1 female) did not properly indicate their Est Rel NC						

Table IV: Estimating effect of positive PANAS scores, unincentivized self-evaluations as dependent variables

	(1)	(2)	(3)	(4)	(5)	(6)
	How did you do? All Subjects	How did you do? Male Only	How did you do? Female Only	Compared to others All Subjects	Compared to others Male Only	Compared to others Female Only
Positive PANAS	0.03 0.01 ***	0.03 0.01 *	0.02 0.01	0.02 0.01 ***	0.02 0.01 **	0.00 0.01
Number Correct (NC)	0.16 0.03 ***	0.08 0.04 *	0.19 0.06 **			
NC - Session Average				0.16 0.02 ***	0.08 0.04 *	0.21 0.05 ***
Constant	1.07 0.54 *	2.84 0.59 **	0.55 1.04	3.99 0.20 ***	4.28 0.30 ***	4.29 0.32 ***
Observations	101 <sup>a</sup>	55 <sup>a</sup>	46 <sup>a</sup>	100 <sup>a,b</sup>	54 <sup>a,b</sup>	46 <sup>a,b</sup>

standard errors reported next to coefficients  
\*, \*\*, and \*\*\* signify that means are significantly different with a p-value  $\leq 0.10$ , 0.05, and 0.01, respectively.  
<sup>a</sup> 6 subjects (2 male, 4 female) did not properly indicate their PANAS scores  
<sup>b</sup> 3 subjects (2 male, 1 female) did not properly indicate their Est Rel NC

Table V: Estimating treatment effects, incentivized self-evaluation of performance as dependent variable



	(1)	(2)	(3)	(4)	(5)
	Estimated NC All Subjects	Estimated NC Male Only	Estimated NC Female Only	Estimated NC Non-Asian Only	Estimated NC Asian Only
Anger Treatment	0.80 1.44	1.87 1.35	-0.15 1.72	0.50 1.75	1.26 1.40
Fear Treatment	1.65 0.83 *	0.64 1.10	2.11 1.23	0.97 1.12	1.71 1.82
Sadness Treatment	1.07 0.79	0.77 1.18	1.09 0.82	2.71 1.06 **	0.80 0.92
Number correct (NC)	0.92 0.09 ***	0.71 0.20 ***	0.95 0.13 ***	0.64 0.12 ***	1.12 0.11 ***
NC - Session Average					
Constant	2.26 2.03	7.30 4.57	1.50 2.63	8.32 2.98 **	-2.00 2.51
Observations	179	65	114	77	100

standard errors reported next to coefficients  
\*, \*\*, and \*\*\* signify that means are significantly different with a p-value  $\leq 0.10$ , 0.05, and 0.01, respectively.

Table VI: Estimating treatment effects, incentivized self-evaluation of performance relative to others as dependent variable

	(1)	(2)	(3)	(4)	(5)
	Estimated Rel NC All Subjects	Estimated Rel NC Male Only	Estimated Rel NC Female Only	Estimated Rel NC Non-Asian Only	Estimated Rel NC Asian Only
Anger Treatment	0.18 0.78	-0.38 1.28	0.18 0.66	-0.90 0.87	0.76 1.03
Fear Treatment	1.18 0.65	0.42 0.78	1.30 1.04	0.73 0.40	0.54 1.22
Sadness Treatment	0.35 0.79	-0.05 0.86	0.32 0.85	-0.86 0.45 *	0.85 1.16
Number correct (NC)	0.50 0.05 ***	0.28 0.11 **	0.54 0.09 ***	0.33 0.09 ***	0.66 0.07 ***
NC - Session Average					
Constant	0.53 0.57	1.71 0.84 *	0.29 0.57	1.45 0.34 ***	0.21 0.91
Observations	169	64	105	72	95

Table VII: Estimating treatment effects, unincentivized self-evaluation of performance as dependent variable

	(1)	(2)	(3)	(4)	(5)
	How did you do? All Subjects	How did you do? Male Only	How did you do? Female Only	How did you do? Non-Asian Only	How did you do? Asian Only
Anger Treatment	0.01 0.39	-0.45 0.39	0.11 0.40	-0.15 0.38	0.21 0.48
Fear Treatment	0.38 0.27	-0.14 0.39	0.52 0.31	0.39 0.33	0.06 0.48
Sadness Treatment	-0.14 0.30	-0.62 0.18 ***	0.00 0.35	-0.23 0.19	-0.04 0.48
Number correct (NC)	0.14 0.03 ***	0.08 0.05	0.15 0.03 ***	0.07 0.05	0.21 0.03 ***
NC - Session Average					
Constant	1.96 0.61 ***	3.73 1.04 ***	1.57 0.63 **	3.47 0.99 ***	0.55 0.79
Observations	179	65	114	77	100

standard errors reported next to coefficients  
 \*, \*\*, and \*\*\* signify that means are significantly different with a p-value  $\leq 0.10$ , 0.05, and 0.01, respectively.

Table VIII: Estimating treatment effects, unincentivized self-evaluation of performance relative to others as dependent variable

	(1)	(2)	(3)	(4)	(5)
	Compared to others? All Subjects	Compared to others? Male Only	Compared to others? Female Only	Compared to others? Non-Asian Only	Compared to others? Asian Only
Anger Treatment	-0.09 0.25	-0.16 0.37	-0.18 0.21	-0.17 0.17	-0.04 0.36
Fear Treatment	0.33 0.18	0.20 0.23	0.16 0.22	0.30 0.18	0.14 0.38
Sadness Treatment	-0.05 0.31	-0.38 0.28	0.02 0.36	-0.34 0.23	0.11 0.41
Number correct (NC)					
NC - Session Average	0.15 0.02 ***	0.07 0.04	0.15 0.04 ***	0.10 0.03 ***	0.19 0.03 ***
Constant	4.52 0.18	5.04 0.25 ***	4.40 0.18 ***	4.69 0.12 ***	4.44 0.30 ***
Observations	179	65	114	77	100
standard errors reported next to coefficients					
*, **, and *** signify that means are significantly different with a p-value $\leq 0.10$ , $0.05$ , and $0.01$ , respectively.					

Table IX: Estimating effects on PANAS items, incentivized self-evaluation of performance as dependent variable

	(1)	(2)	(3)	(4)	(5)
	Estimated NC All Subjects	Estimated NC Male Only	Estimated NC Female Only	Estimated NC Non-Asian Only	Estimated NC Asian Only
Anger PANAS	-0.10 0.19	0.24 0.22	-0.24 0.21	-0.09 0.30	-0.06 0.21
Fear PANAS	0.00 0.14	-0.15 0.15	0.15 0.16	-0.03 0.19	-0.04 0.20
Sadness PANAS	-0.05 0.18	-0.11 0.19	-0.06 0.18	-0.03 0.32	0.03 0.17
Number correct (NC)	0.90 0.09 ***	0.69 0.20 ***	0.91 0.14 ***	0.66 0.14 ***	1.10 0.10 ***
NC - Session Average					
Constant	3.94 0.19 *	8.41 4.47 *	3.40 2.63	9.26 3.00 **	-0.61 0.19
Observations	176	64	112	77	97

standard errors reported next to coefficients  
 \*, \*\*, and \*\*\* signify that means are significantly different with a p-value  $\leq 0.10$ , 0.05, and 0.01, respectively.  
 3 subjects did not properly indicate their affects on the PANAS

Table X: Estimating effects on PANAS items, incentivized self-evaluation of performance relative to others as dependent variable

	(1)	(2)	(3)	(4)	(5)
	Estimated Rel NC All Subjects	Estimated Rel NC Male Only	Estimated Rel NC Female Only	Estimated Rel NC Non-Asian Only	Estimated Rel NC Asian Only
Anger PANAS	-0.17 0.10	-0.03 0.29	-0.18 0.12	-0.29 0.10 **	-0.09 0.15
Fear PANAS	-0.10 0.09	-0.12 0.11	-0.07 0.11	-0.04 0.13	-0.13 0.16
Sadness PANAS	0.07 0.07	-0.08 0.21	0.12 0.11	-0.12 0.09	0.23 0.12 *
Number correct (NC)	0.46 0.05 ***	0.31 0.11 **	0.49 0.10 ***	0.30 0.09 ***	0.62 0.05 ***
NC - Session Average					
Constant	1.49 0.42 ***	2.24 0.43 ***	1.02 0.54 *	2.51 0.45 ***	0.67 0.47
Observations	166	63	103	72	92

standard errors reported next to coefficients  
 \*, \*\*, and \*\*\* signify that means are significantly different with a p-value  $\leq 0.10$ , 0.05, and 0.01, respectively.  
 3 subjects did not properly indicate their affects on the PANAS  
 10 subjects did not properly indicate their Est Rel NC

Table XI: Estimating effects on PANAS items, unincentivized self-evaluation of performance as dependent variable

	(1)	(2)	(3)	(4)	(5)
	How did you do? All Subjects	How did you do? Male Only	How did you do? Female Only	How did you do? Non-Asian Only	How did you do? Asian Only
Anger PANAS	-0.02 0.04	-0.04 0.12	-0.03 0.04	-0.01 0.03	-0.01 0.05
Fear PANAS	-0.02 0.03	-0.22 0.07 ***	0.07 0.03 **	-0.05 0.02 *	-0.02 0.05
Sadness PANAS	-0.04 0.03	-0.03 0.07	-0.04 0.04	-0.08 0.05	0.01 0.04
Number correct (NC)	0.14 0.03 ***	0.10 0.04 **	0.15 0.03 ***	0.06 0.05	0.20 0.03 ***
NC - Session Average					
Constant	2.37 0.50 ***	3.71 0.68 ***	1.83 0.57 ***	4.04 1.08 ***	0.76 0.70
Observations	176	64	112	77	97
standard errors reported next to coefficients					
*, **, and *** signify that means are significantly different with a p-value $\leq$ 0.10, 0.05, and 0.01, respectively.					
3 subjects did not properly indicate their affects on the PANAS					

Table XII: Estimating effects of PANAS items, unincentivized self-evaluation of performance relative to others as dependent variable

	(1)	(2)	(3)	(4)	(5)
	Compared to others? All Subjects	Compared to others? Male Only	Compared to others? Female Only	Compared to others? Non-Asian Only	Compared to others? Asian Only
Anger PANAS	-0.02 0.04	0.04 0.08	-0.02 0.04	-0.05 0.04	0.00 0.05
Fear PANAS	-0.01 0.03	-0.02 0.07	0.00 0.03	0.03 0.05	-0.04 0.04
Sadness PANAS	0.01 0.04	-0.13 0.04 ***	0.05 0.04	-0.02 0.06	0.03 0.05
Number correct (NC)	0.14 0.02 ***	0.09 0.04 *	0.15 0.04 ***	0.09 0.03 ***	0.19 0.04 ***
NC - Session Average					
Constant	4.63 0.13 ***	5.27 0.24 ***	4.25 0.15 ***	4.76 0.17 ***	4.50 0.19 ***
Observations	176	64	112	77	97
standard errors reported next to coefficients					
*, **, and *** signify that means are significantly different with a p-value $\leq 0.10$ , 0.05, and 0.01, respectively.					