Does Happiness Raise Test Scores? Does Fear Lower Them? Experimental Evidence

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Abstract

In this paper, we consider whether emotional state affects test performance using a new experiment. Happiness and fear are induced with 360-degree videos shown in virtual reality before participants take a test consisting of Mathematics SAT questions. The results show that scores improve by .48 standard deviations under the Happiness condition, and the effect is particularly large for women (.75 s.d.). Inducing fear has no effect on test scores.

1. Introduction

It is well-established that happiness, in the sense of subjective well-being or life satisfaction, is correlated with better scholastic performance (see Valiente et al (2012) for a survey). A number of studies document this relationship for students at various educational levels (Gilman and Huebner, 2006; Verkuyten and Thijs, 2002; Proctor et al., 2010: Crede et al., 2015). In this literature, however, it is clear that endogeneity may be present, since good academic performance can presumably exert a positive impact on emotional state, and vice-versa. This means that the causal inference that happiness improves academic performance cannot necessarily be drawn. Quinn and Duckworth (2007) do report suggestive evidence for a bi-directional relationship, but do not establish a causal link between emotional state and performance.[2] This interesting literature considers long-term associations between overall happiness and academic performance over the course of semesters, years, or entire academic careers.

In this paper, we consider whether the relationship between positive emotional state and test performance can be harnessed in the short run to increase test scores. That is, can a quick intervention

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[2] In the Quinn and Duckworth (2007) study, grade school students completed surveys of subjective well-being and an intelligence test at the beginning and at the end of an academic year. Participants reporting higher well-being at the beginning of the year were more likely to earn higher final grades that year, controlling for IQ and other factors. In turn, students earning higher grades tended to go on to report greater well-being at the end of the year, controlling for IQ, age, and previous well-being. However, because individuals are not randomly assigned into emotional states, the causal inference that a positive emotional state causes better performance can not necessarily be drawn from their analysis.

lasting a few minutes that increases the positivity of one's emotional state improve test scores a few minutes later? Such a relationship would mean that the association between happiness and academic performance can operate at a vastly shorter time scale than has been previously established. It would also mean that there is a causal relationship pointing from emotion to performance over a very brief time interval. If such a simple and inexpensive intervention has the capacity to improve academic performance, it may be an interesting and very valuable tool to use to enhance test scores.

Another interesting line of research has focused on the role of test anxiety in the reduction of test scores. This literature studies a link between emotions and performance on the very short time scale that we are interested in here. Steinmeyr et al. (2016) find that anxiety is correlated with lower test scores. Von der Embse et al. (2015) find that appeals to fear harm student test performance. Foley et al. (2017) show that the negative relationship between anxiety and test scores holds in many different countries. However, this correlation between fear, especially in the form of test-taking anxiety, and test performance is also subject to endogeneity. The test-taking situation itself may induce fear, and presumably would induce on average greater fear on the part of those individuals already likely to perform worse on the test. There is also some contrarian evidence that a modest level of anxiety can actually increase performance on math tests (Wang et al., 2015) and other work showing that anxiety has no effect on test scores (Reteguiz, 2006). Thus, the connection between fear and performance seems less consistent than that between happiness and performance. It must also be noted that in this literature, the fear that is measured is integral, in the sense that it originates from the task itself. Our interest here is in incidental fear, which arises from a cause other than the task at hand.

Thus the second question we consider in this study is whether an increase in incidental fear causally improves or hurts test performance. As with the happiness described earlier, fear is induced exogenously rather than arising from the testing situation itself. Studying incidental fear is of interest in that it might also be used as a tool to motivate test performance. A state of fear increases arousal and attention, and if accompanied with an appropriate focus, might improve test performance. On the other hand, incidental fear may operate as suggested by the negative correlation between integral fear and test performance and serve to lower scores.

In this paper, we investigate these questions using a laboratory experiment. Our design allows us to establish causal relationships between emotional states and test scores. Undergraduate student participants are randomized into one of three treatments, *Happiness*, *Fear* and *Neutral*, which differ only in the emotion that is induced. The emotion induction occurs with 360-degree videos shown in virtual reality. The videos have been validated in previous studies (see Medai and Noussair (2021), and Nguyen and Noussair (2022)) and are subject to an additional manipulation check with the participants in this study. This ensures that the

videos are inducing the intended emotions without also increasing any unintended ones. After the emotion induction, participants are given a test consisting of 24 problems drawn from the mathematics Scholastic Aptitude Test (SAT). This test is typically taken during the process of application to Bachelor's programs at universities in the United States, and serves as a standard measure of academic performance. In our experiment, the tests are incentivized in that subjects receive $1 US for each correct answer on their test.

The data show that the Happiness treatment yields scores that are 8.0 percentage points higher than the Neutral treatment. This is a significant effect of .48 standard deviations in magnitude, equivalent to 48 points on the actual mathematics SAT test administered in the field.[3] While the experiment was not designed to consider gender differences, breaking down the analysis by gender shows that the significance of the effect is specific to women, who experience an improvement of 11.1 percentage points, which is equal to .75 standard deviations or 75 points on the test. For men the improvement is 5.3 percentage points but not significant at conventional levels. The evidence thus suggests that getting an individual into a positive emotional state just before an exam can be an highly effective strategy to improve performance for test takers, and especially so for women. There is no difference in scores between the Fear and the Neutral treatments for the pooled data from the entire sample or for each gender separately, indicating that an induction of incidental fear has no effect on performance.

The rest of the paper is organized in the following manner. Section 2 describes the experiment and Section 3 reports the results. We offer a brief discussion in Section 4. The online appendices contain the materials used in the experiment and some additional analysis.

2. Experimental Design

2.1. Procedures Common to all Treatments

This experiment was an individual decision-making task, where subjects acted completely independently of each other and could not communicate during their session. Participants were University of Arizona undergraduate students. The study took place between August 2021 and December 2021. Students were assigned to one of three treatments- Happiness (41 participants), Neutrality (39 participants) and Fear (39 participants). Between two and eight subjects participated in each session and no subjects participated more than once. All sessions were conducted at the Economic Science Laboratory at the University of Arizona, located in Tucson, Arizona, USA. This is a large room and participants were spaced well apart. There were no other tasks conducted in the session, either before or after those described here. The subjects were recruited from the laboratory's subject pool and were enrolled in a variety of programs

[3] The possible scores on the mathematics SAT test range from 200 to 800. In the year 2020, the mean score was 523 and the standard deviation is normalized to 100 when calculating individual scores.

at the university. Of a total of 119 subjects, 61 were male and 58 were female.[4] All sessions were conducted by the same (female) experimenter.

At the beginning of a session, subjects reported to the Economic Science Laboratory facility, and were instructed to sit at a desk until further instruction. The experiment began with individuals watching a video using a wireless Oculus Quest virtual reality headset for approximately 5 – 6 minutes[5]. These videos were played using a program called Virtual Desktop and induced either a state of Happiness, Fear or Neutrality. We consider a video to induce Neutrality if it does not alter one's emotional state from that prior to the viewing of the video. The videos are filmed from the perspective of someone inside the video and displayed in 360 degrees to render the experience immersive. The subject sees the video no matter in which direction she is looking and feels like an active participant in the video. The use of the specific videos involved was approved with the Institutional Review Board at the University of Arizona. Subjects were informed that they would be receiving $5 for viewing the video and completing the questionnaire that followed.

After viewing the video, subjects were instructed to sit at their desk and to immediately fill out an abbreviated PANAS-X (Watson et al., 1988) questionnaire to measure their emotional state after watching the video. The abbreviated questionnaire is shown in Appendix A. The forms were then collected and subjects were given verbal instructions for a timed mathematics test displayed on the computers at their desks. Subjects then had 30 minutes to answer 24 SAT questions, and they filled in their answers on a paper form provided to them. The questions were taken from old SAT tests published in a SAT preparation book that we purchased from a local bookstore. The form and the questions are available from the authors. There were two versions of the test, each used in different sessions. The average score on each set of questions was nearly identical (63.4% on Test 1 and 62.3% on Test 2). There was no penalty for incorrect answers. There were dividers between each desk that prohibited subjects from cheating or referencing other subjects in their exam, and subjects were seated well apart from the closest individual. These procedures ensured that no participants were within view of each other when the test was ongoing and that subjects could not discuss the questions with each other before submitting them. Earnings averaged $20 US for a 60-minute session (including the $5 payment for watching the video).

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[4] Gender was identified based on how individuals classified themselves when they enrolled in the laboratory's participant database from which subjects for this experiment were recruited.

[5] The videos inducing Happiness and Fear were roughly three minutes long and subjects viewed them twice. The video inducing Neutrality was roughly six minutes in length and shown once. The video inducing Happiness can be found at https://www.youtube.com/watch?v=MKWWhf8RAV8, the one for inducing fear at https://www.youtube.com/watch?v=JtAzMFcUQ90, and the video for the Neutral treatment at https://www.youtube.com/watch?v=SmhuzTzUKQY.

The allotted time available was announced to subjects and they were required to stop taking the exam after thirty minutes, regardless of whether or not they had attempted all of the questions. The exams were then collected by the experimenter and taken into a closed room where they were graded against the answer key. Subjects were then individually and privately given the amount that they earned (the $5 for viewing the video and $1 per correct test answer) in cash at their desks. After receiving their payment, they were asked to leave the laboratory.

2.2. The Treatments

The treatments differed from each other only in the emotion that was induced at the beginning of the session. Subjects were shown one of three 360-degree videos in virtual reality, depending on the treatment. The experimental design had a between-subject structure, in that each subject was only shown one video and took an exam once. No subject participated in the experiment more than once.

The video shown in the Neutral control treatment was a simple video of a tulip field on a sunny day. The video is taken from the point of view of an individual sitting in the field. There is faint music in the background and the sound of birds chirping and soft unintelligible chatter. The video was trimmed to 6 minutes in length. Prior testing confirms that viewing the video has no effect on emotional state (Kugler et al., 2020; Medai and Noussair, 2021, Nguyen and Noussair, 2022)

The video inducing a state of happiness was a video shown from the point of view of surfers in the South Pacific. Viewers feel that they are paddling out to sea, swimming in the ocean, and then surfing on large waves. Upbeat music is playing. The view in several directions is of tropical islands in the background. The video was approximately three minutes long and subjects were shown the video twice consecutively. The video was immediately played again once it finished playing for the first time, to render the length of time that the video was played roughly the same as in the Neutral treatment.

Fear was induced with a video taken from the viewpoint of an individual walking a tightrope over a canyon several hundred feet deep. If one looks downward, one sees their feet precariously balancing on the tightrope. The audio depicts a conversation between the tightrope walker whose perspective you are viewing from and a person on another tightrope walking over the canyon. At one point, the other person loses their balance and falls off their line, over the open canyon. After a few seconds of uncertainty, one sees that the other person is tethered to their line and is unharmed. The approximately 3-minute-long video was also played a second time for the subjects immediately after the first to achieve the appropriate length of time of exposure to the video.

The data from the abbreviated PANAS-X survey administered right after the videos were shown verify that the manipulation was successful and that the videos created the intended emotions. The average values of the five emotional states measured in the survey is given in Table 1. The feasible range of each measure

is from 1 – 5. Each individual participant constitutes an independent observation.[6] The two pooled variance t-tests of interest are indicated in bold font. These are the tests of whether the Happiness video induced greater Joviality than the Neutral condition and whether the Fear video leads to greater expressed fear than Neutral. The data show that the Happiness video led to greater Joviality ($p < .06$) and the Fear video created greater fear ($p < .001$). There are no significant differences between the Happiness and other treatments in any of the other emotion indices. The Fear video leads to a significantly higher level of expressed fear than the other two treatments, though it also leads to borderline significant greater hostility than the Neutral video.

Table 1: Average value of emotional indices after viewing the Neutral, Happiness, and Fear videos, with standard deviations in parentheses, and tests of differences between treatments

Video		Average Value of Emotion Index				
		Joviality	Fear	Hostility	Sadness	Attentiveness
Neutrality N = 39	After Video	2.92 (.95)	1.40 (.81)	1.21 (.53)	1.39 (.50)	2.95 (.92)
Happiness N = 41	After Video	3.27 (.96)	1.26 (.34)	1.23 (.56)	1.54 (1.21)	3.16 (.97)
Fear N = 39	After Video	2.68 (1.32)	2.29 (0.85)	1.47 (.61)	1.70 (.93)	3.21 (.88)
N vs H		**p < .06**	p > .1	p > .1	p > .1	p > .1
N vs F		p > .1	**p < .001**	p < .1	p > .1	p > .1

Joviality score = (happy + joyful + cheerful + excited + enthusiastic + energetic)/6, fear score = (afraid + scared + frightened + nervous)/4, hostility score = (excited + hostile + irritable + disgusted)/4, sadness score = (sad + downhearted + alone + lonely)/4, attentiveness score = (alert + attentive + concentrating + determined)/4. Last two rows contain results of pooled variance t-tests of differences between treatment averages. Bold font indicates tests of interest with signed hypotheses and one-sided p-values are used for these two tests. Other tests, which have no signed hypotheses, use two-sided p-values. Survey instrument shown in Appendix A.

However, if the data are broken down by gender, it is apparent that the emotion induction for Happiness was only successful for women. The average level of Joviality for women was 3.30 under the Happiness treatment compared to 2.47 in the Neutrality treatment ($t = 2.14$, $p < .025$, one-sided). In contrast,

[6] We have also conduced manipulation checks of the same three videos in the studies of Medai and Noussair (2021) and Gotsman and Noussair (2022), as well as for the Neutral video in Kugler et al. (2019), with different participants. The results are very similar to those that we find for the subjects in this study.

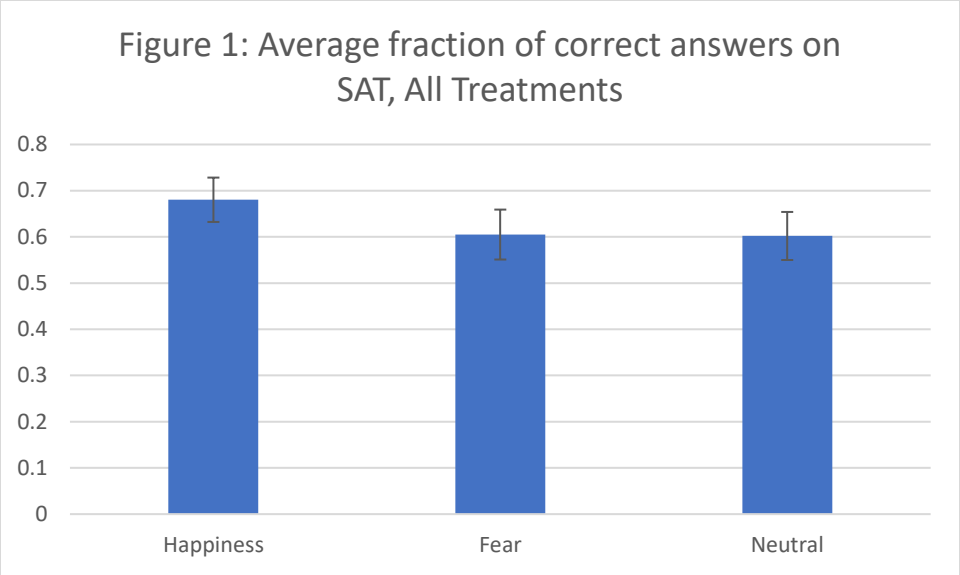
the average Joviality score for men was 3.25 in the Happiness treatment and 3.21 under Neutrality, not significantly different at conventional thresholds. Thus, the difference lies in the emotional state of the two genders after the Neutral treatment.[7]The Fear induction was successful in achieving a greater average level of fear for both women (from 1.30 under Neutrality to 2.31 in the Fear treatment, $t = 4.57$, $p < .0005$) and men (from 1.32 to 2.2, $t = 3.96$, $p < .005$).

The sample sizes are specified based on the statistical power to detect a medium sized effect of a 0.5 standard deviation difference (Cohen, 1988) in test scores between treatments. We have the power of .716 to detect an effect of this size of the Happiness treatment compared to the Neutral condition, and a power of .707 to detect the effect between Fear and Neutral.

3. Results

The following figure shows the average number of questions answered correctly in each of the three conditions. The average in the Happiness treatment is 68.0% while it is 60.5% in the Fear and 60.0% in the Neutral treatments. The average score under Happiness is .460 standard deviations higher than Fear, and .480 standard deviations greater than under Neutral. A t-test of the differences in the mean score between Happiness and Neutrality is significant according to a pooled variance t-test ($t = 2.187$, $p < .025$, one-tailed). The difference between Fear and Neutrality is not significant at $p < .05$, with average scores in the two treatments nearly identical. The average score is significantly higher under Happiness ($p < .05$) than under Neutrality, even if one corrects the p-values for multiple hypothesis testing.

[7] While our data do not allow us to establish this for our data, it is likely that the average initial emotional state at the beginning of their session of men who participate in the experiment is more positive than that of women. Our prior testing in which a PANAS-x questionnaire was administered both before and after the video was viewed, shows that the Neutrality video tends to leave people at s similar emotional state as they were in before the video was shown (Gotsman and Noussair, 2022; Kugler et al., 2019). Furthermore, in the Gotsman and Noussair (2022) study, in which gender data was retained, men tend to be in a more Jovial emotional state at the beginning of laboratory sessions than women.



Note: The error bars are 95% confidence intervals for the mean score in each treatment.

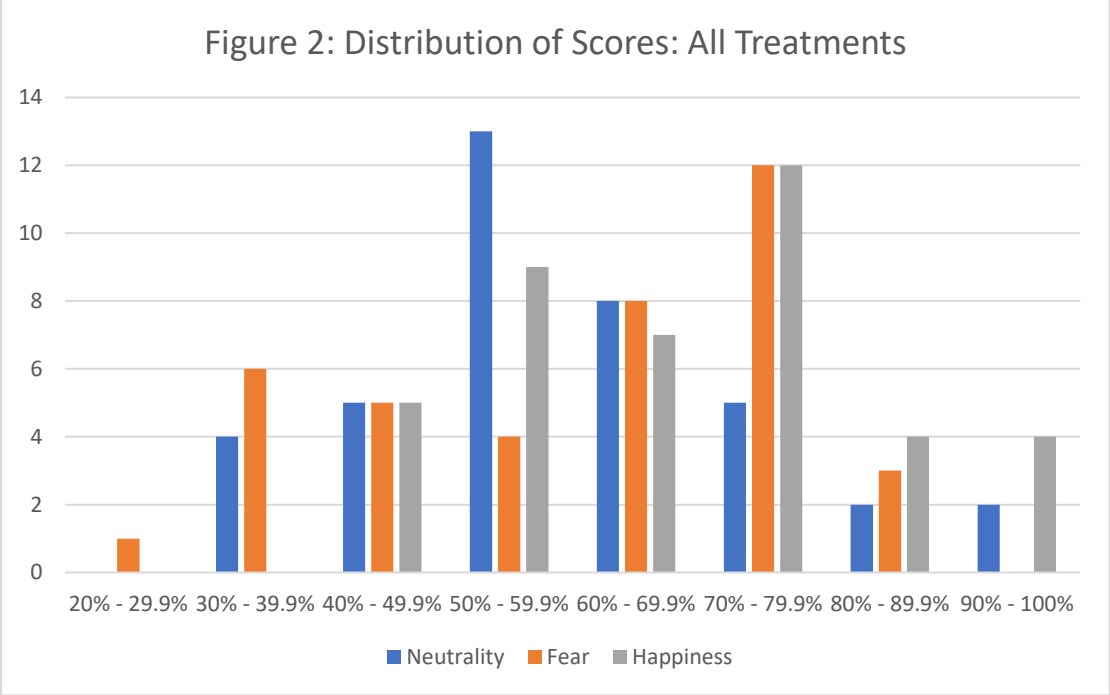


Figure 2 shows the distribution of scores under each treatment. It confirms that the distribution in the Happiness treatment lies to the right of the other two. In the Happiness treatment, no individual scores below 40% and 20 of 41 individuals score at least 70%. In contrast, under the Neutral treatment 4/39 of test-takers score below 40% and only 8 of 39 score higher than 70%. Fear has a similar distribution to Neutrality, though with more scores in the 70 – 79.9% range and fewer in the 50 – 59.9% range.

Table 2 shows the estimates from a regression analysis of the determinants of test scores. The independent variables are gender and dummy variables for the Happiness and Fear treatments. The table shows that there is no gender difference in performance in the baseline Neutral treatment, indicating that the task was gender neutral. There was no significant effect of the Fear treatment on test scores. On the other hand, the Happiness treatment exerted a significantly positive effect on test score ($p = .034$) of approximately eight percentage points.[8]

While there is no overall gender difference in performance on the task when emotions are not induced, the effect of the Happiness condition is stronger for women than for men. The determinants of test score are analyzed separately for women and men and reported in Tables 3a and 3b. The tables show that the coefficient on the Happiness treatment is greater in magnitude for women (.111) than for men (.053), and significant at the $p < .05$ level only for women. The Fear treatment remains insignificant when each gender is considered separately, though the sign of the effect is positive for women and negative for men. The effect of Happiness is particularly large for women in terms of standard deviations of test scores, since the standard deviation of scores is smaller for women (.148) than for men (.181).

Table 2: Test Score as a Function of Treatment and Gender

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Constant	0.601608	0.030071	20.00633	2.97E-39	0.542043	0.661172
Gender	-0.00256	0.031836	-0.08034	0.936106	-0.06562	0.060503
Happiness	0.079466	0.037041	2.14535	0.034028	0.006095	0.152837
Fear	0.005206	0.037824	0.137626	0.890777	-0.06972	0.080129

OLS regressions, N = 119, Adj. $R^2 = 0.05$, Gender = 1 if female, Happiness = 1 under Happiness condition, Fear = 1 under Fear

4. Discussion

Our data show that inducing Happiness prior to a standardized test improves performance by roughly one-half of a standard deviation. The SAT is designed to be a general measure of mathematics

[8] The results including a dummy variable to distinguish between the two tests are nearly identical. The regression is shown in Appendix B.

aptitude and is widely used, so it is unlikely that the result is specific to the particular test that we have chosen. The improvement in a test score from a 6-minute exposure to a video is equivalent to 48 points on the SAT math section. An increase of this magnitude is quite considerable and can often be the difference between acceptance or rejection for admission at a university. The intervention is simple and easy to implement for a test-taker. It also suggests that stronger interventions which are more intense or longer in duration might have an even more powerful effect. The result is similar in spirit with the, albeit scant evidence from experimental economics that incidental happiness increases productivity (Oswald et al., 2015), but shows that performance on a cognitively demanding task can be achieved by changing a test taker's emotional state.

Table 3a: Test Score as a Function of Treatment: Women Only

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Constant	0.56713	0.034245	16.56081	8.09E-23	0.498472	0.635787
Happiness	0.111481	0.054147	2.058884	0.044342	0.002924	0.220039
Fear	0.058364	0.04421	1.320144	0.192356	-0.03027	0.147001

N = 58, Adj. R^2 = .041

Table 3b: Test Score as a Function of Treatment: Men Only

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Constant	0.628968	0.038888	16.17368	2.35E-23	0.551153	0.706784
Happiness	0.052066	0.051063	1.019648	0.312058	-0.05011	0.154243
Fear	-0.06994	0.064489	-1.08453	0.282541	-0.19898	0.059102

N = 61, Adj. R^2 = .033

In contrast, incidental fear does not have any significant effect on test scores. It is not the case that an emotional state of fear serves as an effective motivator that improves test scores. However, we also observe no evidence that incidental fear lowers performance. It appears to us that the relationship between fear and poor performance observed in earlier studies may be specific to integral fear and anxiety originating from the upcoming test itself, rather than indicative of a general relationship between the emotional state of fear and test performance.

The experiment was not designed to consider the effects of the treatments for men and women separately, and the study has low power to detect such effects. Nevertheless, the effect of the Happiness induction on the performance of women is striking. The .75 standard deviation difference in scores between the Happiness and Neutral treatments is equivalent to 75 points on the mathematics SAT on a feasible range of scores from 200 to 800. The effect for men, .29 standard deviations was not significant. However, a follow-up study with a larger sample might be able to establish whether the Happiness intervention is significant for men.

This study does not allow us to establish the mechanism behind the positive effect of Happiness on test scores. It may be that the Happiness mood induction insulates individuals from test anxiety to some extent. However, this is speculative and we have not measured test anxiety. Our measurement of emotional state was taken before participants knew that they would be taking a test. There are a number of plausible potential mechanisms that future studies might be able to directly observe. For example, a happy emotional state may improve recall, in this case of the appropriate mathematical operation to use in a problem. It may facilitate the focus of attention on the task at hand. Alternatively, or perhaps additionally, it may enhance creativity, which is often helpful in obtaining the solutions for some of the problems we have included in our tests. To gain further insight into the mechanism, the effect of Happiness on performance in different tasks in which attention, creativity and the recall of prior knowledge is required to varying degrees, would have to be studied in follow-up work.

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Appendices

Appendix A: Questionnaire used in the manipulation check

This scale consists of a number of words and phrases that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you feel this way right now. Use the following scale to record your answers:

1	2	3	4	5
Very Slightly	A Little	Moderately	Quite a Bit	Extremely
Afraid __	Angry __	Shaky __	Nervous __	Attentive __
Calm __	Determined__	Alert __	Excited __	Concentrating __
Frightened __	Irritable __	Downhearted __	Enthusiastic __	Hostile __
Cheerful __	Disgusted __	Happy __	Energetic __	Scared __
Lonely __	Joyful __	Sad __	Alone__	Relaxed __

Appendix B: Additional Regression Specification

Table B1: Determinants of Test Scores, Dummy for Set of SAT Questions Included

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.601751	0.032083	18.75583	1.23E-36	0.538194	0.665308
Test	-0.00042	0.031717	-0.01323	0.989464	-0.06325	0.062411
Gender	-0.00252	0.032114	-0.07842	0.937633	-0.06614	0.061099
Happiness	0.079434	0.037281	2.130669	0.035266	0.00558	0.153288
Fear	0.005207	0.03799	0.137069	0.891218	-0.07005	0.080466

N = 119, R^2 = .050