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Happiness and Productivity

Andrew J. Oswald, Eugenio Proto and Daniel Sgroi

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Happiness and Productivity

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Abstract

Little is known by economists about how emotions affect productivity. To make persuasive progress, some way has to be found to assign people exogenously to different feelings. We design a randomized trial. In it, some subjects have their happiness levels increased, while others in a control group do not. We show that a rise in happiness leads to greater productivity in a paid piece-rate task. The effect is large; it can be replicated; it is not a reciprocity effect; and it is found equally among males and females. We discuss the implications for economics.

Happiness and Productivity

Andrew J. Oswald, Eugenio Proto, Daniel Sgroi

1. Introduction

There is a large economics literature on individual and economy-wide productivity. There is also a fast-growing one on the measurement of mental well-being. Yet economists know little about the interplay between emotions and human productivity. Although people's happiness and effort decisions seem likely to be intertwined, we lack evidence on whether, and how, they are causally connected.

This paper makes two contributions. First, it attempts to alert economists to a psychology literature in which happiness (or more precisely what psychologists describe as positive affect) has been shown to be associated with higher human creativity and performance. The work of the psychologist Alice Isen has been particularly important¹. The second, and main, contribution of our paper is to design an empirical test that has not been performed in the psychology literature. By doing so, we address a question of special interest to economists (and arguably to economic policy-makers): *Does happiness make people more productive in a paid task?*

The paper finds that it does. We demonstrate this experimentally in a piece-rate setting with otherwise well-understood properties².

2. Background

The links between productivity and human well-being are of interest to many kinds of social scientists.

Argyle (1989, 2001) points out that little is understood about how life satisfaction affects productivity, but that there is (mixed) evidence that job satisfaction exhibits modestly positive correlations with measures of worker productivity. Work by Wright and Staw (1999) examines connections between worker affect and supervisors' ratings of workers. Depending on the affect measure, the authors find interesting but mixed results. Amabile et al (2005) uncovers evidence that happiness appears to provoke greater creativity. Baker et al (1997), Boehm and Lyubomirsky (2008), Paterson et al (2004), Steele and Aronson (1995) and Tsai et al (2007) detect influences of emotion and affect upon performance. In

¹ We list a number of them in the paper's references; they include a series of papers in the 1980s, Ashby et al (1999), Erez and Isen (2002), and the recent work of Hermalin and Isen (2008). Our study also connects to the broaden-and-build approach of Fredrickson and Joiner (2002) and to the ideas of Lyubomirsky et al (2005).

² The psychology experimenters have not examined productivity in paid piece-rate tasks.

contrast to our paper's later argument, Sanna et al (1996) suggests that those individuals who are in a negative mood put forth the most effort.

There is an analytical literature by economists that is especially relevant to our later empirical findings. Although not directly about mood or happiness, it examines the interconnections between psychological forces (in particular, biased perception) and human performance. The paper by Benabou and Tirole (2002) focuses on the interactions between self-deception, malleability of memory, and ability and effort. The authors consider the possibility that self-confidence enhances the motivation to act, so their framework is consistent with the idea that there can be a connection between mood and productivity. They develop an economic model of why people value their self-image, and they use this specifically to justify seemingly irrational practices such as handicapping self-performance or the practising of self-deception through selective memory loss. Compte and Postlwaite (2004) extends this line of work, by seeking to identify circumstances in which biased perceptions might increase welfare. The authors model perceptions as an accumulation of past experiences given gradual adjustment. Benabou and Tirole (2003) provides a formal reconciliation of the importance of intrinsic motivations with extrinsic (incentivised) motivations. Such writings reflect an increasing interest among economists in how to reconcile external incentives with intrinsic forces such as self-motivation. Our later results also have implications for standard microeconomics as described in sources such as Laffont and Tirole (1993). This body of work assumes -- in contrast to later evidence in the paper -- that choices can be viewed as independent of emotions.³

We shall not attempt in the paper to distinguish in a sharp way between happiness and 'mood'. For simplicity, we shall take the distinction, in a short run experiment like the one to be described, to be largely semantic.

Nor shall we discuss the possibility that other stimuli such as music, alcohol or sheer relaxation time -- all mentioned by readers of early drafts -- could have the same or equivalent effects. Nor shall we measure how long-lasting are the effects of emotion upon labor productivity. Our instinct, however, is that these are important topics for future research.

³ A review paper in psychology is Diener et al (1999). A considerable literature in economics has studied happiness and wellbeing as a dependent variable -- including Blanchflower and Oswald (2004), Clark et al (2008), Clark and Oswald (1994), Di Tella et al (2001, 2004), Easterlin (2003), Frey and Stutzer (2002, 2006), Kahneman and Sugden (2005), Luttmer (2005), Oswald (1997), Van Praag and Ferrer-I-Carbonell (2004), and Winkelmann and Winkelmann (1998). For related work on emotions, see Frank (1988), Elster (1998), and Loewenstein (2000).

3. A model of work and distraction

This section describes a theoretical framework. Its aim is partly taxonomic. The main comparative static result stems from a form of internal resource-allocation by a worker.

Think of individuals as having a finite amount of energy. Within any period of time, they must choose how to distribute that across different activities. In one version of the later model, a happiness shock can be seen as raising the psychological resources available to a worker. At the margin, the shock frees an overall energy constraint. That, in turn, allows an individual to devote more effort to solving problems for pay, and to act as though switching away from other distractions.

Let the worker's (randomly distributed) ability be z . This has a density function $f(z)$. Denote p as the piece-rate level of pay. Denote u and v as two different sources of utility to the individual. Let e be the energy the worker devotes to solving tasks at work. Let w be the energy the worker devotes to other things -- to 'distractions' from work. Let R be the worker's psychological resources. Hence $(e + w)$ must be less than or equal to R .

We assume that u , the utility from work, depends on both the worker's earnings and effort put into solving work problems. Then v is the utility from attending broadly to the remaining aspects in life. For concreteness, we shall sometimes think of this second activity as a form of 'worrying'. But it can be viewed as a generalized concern for issues in the worker's life that need his or her cognitive attention. In a paid-task setting, it might be realistic to think of a person as alternating, during the working day, between concentrating on the work task and being distracted by the rest of his or her life. There is a psychic return from the energy devoted to distraction and worry -- just as there is a return from concentrating on the paid task.

Consider an initial happiness shock, h . For the sake of clarity, assume separability between the two kinds of utility going to the individual. People then solve the problem: Choose paid-task energy e to

$$\text{Maximize } \int u(p, e, h, z) f(z) dz + v(w, h) \text{ subject to } R \geq e + w.$$

The first-order condition for a maximum in this problem is

$$Eu_e - v_w = 0. \quad (1)$$

The comparative-static result of particular interest here is the response of productivity, given by work effort e , to a rise in the initial happiness shock, h . Formally, it is determined in a standard way. The sign of de^*/dh takes the sign of the cross partial of the maximand, so that:

$$\text{Sign } de^*/dh \text{ takes the sign of } Eu_{eh} + v_{wh}. \quad (2)$$

Without more restrictions, this sign could be positive or negative. A happiness shock could increase or decrease the amount of work done on the maths task.

To get some insight into the likely economic outcome, consider simple forms of these functions. Assume that workers know their own productivity, so are not subject to the uncertainty. Let R be normalized to unity. Set z to unity.

Assume that the u and v functions are concave and differentiable. This is not strictly necessary, but it follows the economist's modelling tradition, and leads to natural forms of interior solutions. The analysis is easily generalized.

How then might an exogenous happiness perturbation, h , enter a person's objective function? In stylized form, consider three alternative maximands:

$$\text{Model I} \quad u(\cdot) + v(\cdot) + h \quad \text{Additive shift}$$

$$\text{Model II} \quad u(h, \cdot) + v(h, \cdot) \quad \text{Concavity}$$

$$\text{Model III} \quad hu(\cdot) + (1-h)v(\cdot) \quad \text{Convex combination}$$

Additive separability

The additive model is -- we conjecture -- what most economists would write down when asked to think about exogenous emotions and choice. They would view a happiness shock as a vertical shift upwards in the utility function.

Assuming additively separable functions, and that the worker gets the h happiness shock whether or not he or she subsequently works or instead worries about other things, the worker solves:

$$\text{Maximize } u(pe) + v(1-e) + h \quad (3)$$

and at an interior maximum

$$u'(pe)p - v'(1 - e) = 0. \quad (4)$$

This establishes a mathematically elementary but economically useful benchmark case: here the optimal work effort e^* is independent of the happiness shock, h . Thus as the parameter h rises or falls, the marginal return to effort is unaffected. Happiness therefore does nothing. It can be seen as orthogonal to choice. In passing, a variant on this is the simple multiplicative form:

$$\text{Maximize } (1 + h)[u(pe) + v(1 - e)] \quad (5)$$

where shocks to h again have no effect on optimal work-energy e^* .

A concavity case

Another, and arguably more plausible, form of utility function has a happiness shock operating within a concave structure. Imagine the worker solves

$$\text{Maximize } u(pe + h) + v(1 - e + h) \quad (6)$$

which is the assumption that h is a shift variable inside the utility function itself, rather than an additive part of that function.

Now the first-order condition is

$$u'(pe + h)p - v'(1 - e + h) = 0. \quad (7)$$

In this case, the optimal level of energy devoted to solving work problems, e^* , does depend on the level of the happiness shock, h :

The sign of de^*/dh takes the sign of $u''(pe + h)p - v''(1 - e + h)$.

Its first element is thus negative and its second is positive. By the first-order condition, we can replace the piece rate wage term p by the ratio of the marginal utilities from working and worrying.

Hence, after substitution, the sign of the comparative static response of *work effort, e, with respect to the size of the happiness shock, h, is greater than or equal to zero*

as

$$\frac{u''(.)}{u'(.)} - \frac{v''(.)}{v'(.)} \geq 0. \quad (8)$$

These terms can be viewed as unconventional versions of the degrees of absolute risk aversion in two domains -- the utility from work and the utility from worrying. If the marginal utility of worry declines quickly enough as energy is transferred from working to worrying, then a positive happiness shock will successfully raise the worker's chosen productivity, e^* . Put intuitively, as the individual become happier, that allows him or her to divert attention away from other issues in life.

A convex-combination case

A final approach is to think of happiness as tilting people's preferences away from distractions. For instance, assume that the worker solves

$$\text{Maximize } hu(pe) + (1-h)v(1-e) \quad (9)$$

which is the assumption that h acts as part of a convex combination outside the utility function itself -- rather than within it or as an additive part of that function.

In such a circumstance, the first-order condition is

$$hu'(pe)p - (1-h)v'(1-e) = 0. \quad (10)$$

It can be seen that the sign of de^*/dh under such a setup takes the sign of the expression, $u'(pe)p + v'(1-e)$ which is automatically positive because it is the sum of two marginal utilities. A positive happiness shock therefore lifts work effort e^* .

These later approaches, in which effort is not independent of h , also potentially offer economists a way to think about stress in the workplace. Work-life strain could be conceived of as the (rational) need to devote energy and attention away from the job. Happier workers need to do so less, and thus have higher productivity.

4. Experimental design

We now explain the structure of the experiment. We start with a motivation for the choices made within the design, and then provide a description of the tasks and

a time-line for the trial. The experimental instructions, the GMAT MATH-style test and the questionnaires are all set out in an appendix.

The experimental design was built around the desire to understand the productivity of workers engaged in a task for pay. Our focus is the consequences, for their output, of different starting levels of happiness.

We employ the task previously used in a number of existing papers (for example, Niederle and Vesterlund, 2007), which entails asking subjects to add sequences of five 2-digit numbers under timed conditions. This task is comparatively simple but is taxing under pressure. It might be thought of as representing in a highly stylized way an iconic white-collar job: both intellectual ability and effort are rewarded.

Since we are trying to evaluate the relationship between happiness and productivity, we wish ideally to disentangle the effort component and ability component. To this end, we also included two control variables that we hoped would capture underlying exogenous but heterogeneous ability as opposed to effort -- although we were also open to the possibility that changes in underlying happiness might induce shifts in ability or change the nature of the interaction between ability and effort to alter overall productivity. Our control variables came from (i) requiring our subjects to do a brief GMAT MATH-style test (5 multiple choice questions) along similar lines to that of Gneezy and Rustichini (2000) and (ii) obtaining information in a final questionnaire to allow us to construct a measure of subjects' prior exposure to mathematics. The aim was to allow us to control for heterogeneous ability levels.⁴

A key concern was to examine the consequences that happiness has for productivity (be it through effort or ability). We therefore needed some means of inducing an exogenous rise in happiness. The psychology literature offers evidence that movie clips (through their joint operation as a form of audio and visual stimulus) are a means of doing so. They exogenously alter people's feelings and mood. For example, Westermann et al (1996) provides a nice meta-analysis of the methods available.

We used a 10-minute clip based on composite sketches taken from various

⁴ We deliberately kept the number of GMAT MATH-style questions low. This was to try to remove any effort component from the task so as to keep it a cleaner measure of raw ability: 5 questions in 5 minutes is a relatively generous amount of time for an IQ-based test, and casual observation indicated that subjects did not have any difficulty completing the GMAT MATH questions, often well within the 5-minute deadline.

comedy routines enacted by a well-known British comedian. In order to ensure that the clip and subjects were well matched, we restricted our laboratory pool to subjects of an English background who had likely been exposed to similar humor before. As explained later, whether subjects enjoyed the clip turned out to be important to the effects on productivity.

In summary, the data collected were on the successful and unsuccessful numerical additions, a brief GMAT MATH-style test and a questionnaire that included questions relating to happiness and intellectual ability.

Initially, we do not use a ‘placebo’ film. Hence, the control group start the task straight away. We vary this later in the paper.

5. Design in detail

We randomly assigned people into two groups:

- Treatment 0: the control group who were not exposed to a comedy clip.
- Treatment 1: the treated group who were exposed to a comedy clip.

The experiment was carried out on four days, with deliberate alteration of the morning and afternoon slots, so as to avoid underlying time-of-day effects, as follows:

- Day 1: session 1 (treatment 0 only), session 2 (treatment 1 only).
- Day 2: session 1 (treatment 0 only), session 2 (treatment 1 only).
- Day 3: session 1 (treatment 1 only), session 2 (treatment 0 only).
- Day 4: session 1 (treatment 1 only), session 2 (treatment 0 only).

Subjects were only allowed to take part on a single day and in a single session.

On arrival in the lab, individuals were randomly allocated an ID, and made immediately aware that the tasks at hand would be completed anonymously. They were told to refrain from communication with each other. Those in treatment 1 (the

Happiness Treatment subjects) were asked to watch a 10 minute comedy clip designed to raise happiness or ‘positive affect’.⁵ Those in the control group came separately from the other group, and were not shown a clip nor asked to wait for 10 minutes. Isen et al (1987) finds that a control clip without positive affect gives the same general outcomes as no clip.

The subjects in both the movie-clip group (treatment 1) and the not-exposed-to-the-clip control group (treatment 0) were given identical basic instructions about the experiment. These included a clear explanation that their final payment would be a combination of a show-up fee (£5) and a performance-related fee to be determined by the number of correct answers in the tasks ahead. At the recruitment stage it was stated that they would make "... a guaranteed £5, and from £0 to a feasible maximum of around £20 based purely on performance". Technically, subjects received £0.25 per correct answer on the arithmetic task and £0.50 on each correct GMAT MATH answer, and this was rounded up to avoid the need to give them large numbers of coins as payment.

An extra reason to pay subjects more for every correct answer was to emphasize that they would benefit from higher performance. We wished to avoid the idea that they might be paying back effort -- as in a kind of reciprocity effect -- to the investigators for their show-up fee.

The subjects’ first task was thus to answer correctly as many different additions of five 2-digit numbers as possible. The time allowed for this, which was explained beforehand, was 10 minutes. Each subject had a randomly designed sequence of these arithmetical questions. The numerical additions were undertaken directly through a protected Excel spreadsheet, with a typical example as in Legend 1. The spreadsheet necessarily contained more such rows that any subject could hope to add in the ten minutes allowed. The subjects were not allowed to use calculators, and it was explained that any attempt to use a calculator or any outside assistance was deemed to be a disqualification offence, resulting in only a show-up fee being paid. This did not prove to be a problem across the 4 experimental days. The numerical additions were designed to be reasonably simple, if dull and repetitive, and earlier literature has deemed this a good measure of intellectual effort (Niederle and Vesterlund, 2007).

⁵ The questionnaire clearly indicated that the clip was generally found to be amusing and had a direct impact on reported happiness levels. More on this is in the results section.

31	56	14	44	87	
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Legend 1: Adding 2-digit Numbers

The second task for subjects was to complete a simple 5-question GMAT MATH-style test. These questions were provided on paper, and the answers were inputted into a prepared protected Excel spreadsheet. The exact questions are given in an appendix. This test was designed as a brief check on ability, as used before in the research literature (Gneezy and Rustichini, 2000).

The final task, which was not subject to a performance-related payment (and subjects were made aware of this), was to complete a questionnaire. A copy of this is provided in an appendix. The questionnaire inquired into both the happiness level of subjects (before and after the clip for treatment 1), and their level of mathematical expertise. The wording was designed to be straightforward to answer; anonymity was once again stressed before it was undertaken; the scale used was a conventional 7-point metric, following the well-being literature.

To summarize the timeline:⁶

1. Subjects enter and are given basic instructions on experimental etiquette.
2. Subjects in treatment 1 are exposed to a comedy clip for 10 minutes, otherwise not.
3. Subjects are given additional instructions, including a statement that their final payment relates to the number of correct answers, and instructed against the use of calculators or similar.
4. Subjects move to their networked consoles and undertake the numerical additions for 10 minutes.
5. Results are saved and a new task is initiated, with subjects undertaking the GMAT MATH-style test for 5 minutes.
6. Results are again saved, and subjects then complete the final questionnaire.
7. After the questionnaire has been completed, subjects receive

⁶ The full instructions provided in the appendix provide a description of the timing.

payment as calculated by the central computer.

6. Principal results

A group of 182 subjects drawn from the University of Warwick participated in the experiment. Each took part in only one session. A breakdown of the numbers per day and session is given in Table 1. The subject pool was made up of 100 males and 73 females. Table 2 summarizes the means and standard deviations of the main variables. The first variable, the key one in our analysis, is the number of correct additions in the allotted ten minutes. ‘Happiness before’ is the self reported level of happiness (for the treated group before the clip) on a seven point scale. The variable ‘happiness after’ is the level of happiness after the clip for the treated group; GMAT MATH is the number of correct problem solved on that; high-school-grades is an index calculated from the questionnaire. Enjoyment-of-clip is a measure in a range between 1 and 7 of level of how much they said they liked the movie clip.

According to the data, the clip is successful in increasing the happiness levels of subjects. As shown in Figure 1, they report an average rise of almost one point (0.98) on the scale of 1 to 7. Moreover, comparing the ex-post happiness of the treated subjects with that of the non-treated subjects, we observe that the average of the former is higher by 0.85 points. Using a two-sided t-test, this difference is statistically significant ($p < 0.01$). Finally, it is useful to notice that the level of happiness before the clip for the treated group is not statistically significantly different (the difference is just 0.13) from the happiness of the untreated group ($p = 0.20$ on the difference).

In Figure 2 we display the average productivity in the test. The treated group’s mean performance is higher by 1.71 additions than the average performance of the untreated group. This productivity difference is approximately ten percent. It is statistically significantly different from zero ($p=0.04$).

Interestingly, and encouragingly, the performance of those 16 subjects in the treated group who did not report an increase in happiness is statistically non-different from the performance of the untreated group ($p=0.67$). Therefore, the increase in the performance may be linked to the increase in happiness rather than merely to the fact of watching a clip. We return to this.

The clip did not hamper the performance of subjects who did not declare

themselves happier.⁷ For them, the effect is zero.

In Figure 3 we show the performances of male and female subjects. Both groups feature a similar increase in their arithmetical productivity (1.9 additions for male, 1.78 for female).

From the cumulative distributions on the number of correct answers for the treated and untreated groups, shown in Figure 4, we see that the treatment increases the performances of low and medium performers, while the high performers are apparently less affected.

We also performed OLS-based regressions to analyze the determinants of the performances. Table 3 presents the determinants of the number of correct additions; variable Change-in-Happiness is the difference in happiness before and after the clip; GMAT MATH is a test score. High school grades measure school performance. Day 2, Day 3 and Day 4 are day-of-the-week dummies.

Consistent with the result seen in the previous session, the subjects' performances are higher in the session with treatment. As we can see in regression (1), in the first column, this result holds when we control for subjects' characteristics and periods. In regression (2) of Table 3, the performances are increasing in the rise in elicited happiness (for the case of untreated subjects, by definition, Change-in-Happiness=0). This result is still true when we restrict the analysis to the treated subjects as in regression (3). The size of the effect is only slightly smaller at approximately eight and a half percentage points.

Because of the well-known skewness in human performance data, it is natural to use a logged dependent variable. Nevertheless, as a check, Table 4 re-runs the first two regressions of Table 3 with a dependent variable defined on absolute values rather than log values. The variable 'Treatment' remains large and positive. It is statistically significant when, as in regression 2 of Table 4, we exclude the outliers (here we drop the two extreme laboratory subjects, with respectively 2 and 43 correct additions). The coefficient on the variable Change-in-Happiness is statistically significantly different from zero irrespective of whether or not we keep in the two outliers: see regressions 3 and 4.

Could the pattern in the data be a kind of reciprocity effect? Are these laboratory subjects 'repaying', or somehow trying to please, the investigators? Such

⁷ Also, the 17 subjects who did not declare an increase in happiness enjoyed the clip. In a range of values between 1 and 7, the average is 5.41, with a minimum of 5 and a maximum of 7.

difficulties are common in experiments. However, the argument does not apply here. In our experiment, people get paid more for every addition they solve. That money goes to them, so that, if anything, extra productivity hurts rather than aids the investigators. There might be some kind of reciprocity effect -- an implicit gift from the subjects in exchange for their show-up fee -- hidden within the constant term. But that does not interfere with the purpose of this experiment because it is conceptually distinct from the change in paid productivity that we observe.

It seems, therefore, that positive emotion invigorates people. Yet the mechanism here, so far, is unclear. Does happiness have its effect through greater numbers answered or through greater accuracy of the average answer? This distinction is of interest and might be thought of as one between industry and talent -- between the consequences of happiness for pure effort compared to effective skill.

To inquire into this, we estimate a different kind of equation.

Table 5 takes attempted additions (in log terms) as the dependent variable. The results are similar to the ones in Table 3, where we considered the # of correct additions. Then, in Table 6, we run exactly the same regression as in Table 5 but with the different dependent variable. This is an estimated equation for ‘precision’, namely, the ratio of correct-answers to attempted-answers. Interestingly, in Table 6 neither the dummy treatment nor Change-in-Happiness is statistically significantly different from zero. This means that the treatment acts as an upward intercept shifter in the attempts equation; the treatment does not provide extra precision. It is perhaps also worth noticing that subjects’ precision levels are influenced by their underlying mathematical skill, as measured by the mini GMAT MATH score, and to a lesser extent by mathematical knowledge.

7. Empirical checks

We performed further checks. The results of these, with tables, are described in the appendix.

First, we checked the individual subsamples of data. Encouragingly, the positive effect on productivity was visible in a strikingly robust way in the data. This is set out in the first part of the appendix. For example, in Table A2, the productivity boost from the happiness treatment is observable in seven of the eight sub-trials. The only exception is for the male subsample in Session 2, and that is driven by one major

outlier, the individual who scored 47 correct answers. Tables A3 and A4 give further experimental breakdowns.

Second, an extra trial was done in which a 'placebo' film -- a moderately interesting but not intrinsically happy clip -- was shown to a control group. This was to ensure that our productivity findings were not an outcome that any film might be produced. The film clip was "Computer Graphic" on James Gross's resources site: http://www-psych.stanford.edu/~psyphy/movs/computer_graphic.mov. This movie clip depicts patterns of colored sticks. These appear and disappear randomly on screen. The film is considered "neutral" by social psychologists. By setting the process to repeat, it was possible to play the clip for the appropriate length of time.

Importantly, the productivity of individuals was not affected by showing them this placebo film. The number of correct additions declined a little (although not in a statistically significant way) when compared to the control setting used earlier in our paper, namely, where individuals straight away begin work on the additions problems.

Third, a trial was done in which individuals were told an explicit monetary amount -- 25 pence -- for each correct answer. Productivity rose, although not in a statistically significant way. The purpose here was to check that having a specified payment did not alter the tenor of the findings.

These consistency tests are encouraging. Much remains, nevertheless, to be understood. One puzzle generated by data is about the nature of the transmission channel from human happiness to people's labor productivity. The paper's earlier theoretical framework writes down a set of cases in which, as a structural or mathematical matter, the correct empirical prediction emerges. But further projects will have to be designed to try to understand the detailed mechanisms. In continuing work, we are collecting interview evidence from subjects. Such qualitative research may be able to throw up important insights.

Another idea which may be relevant -- we thank Greg Jones for this suggestion -- is that happiness could act to increase cognitive flexibility. In some recent work, this has been proposed in a narrow context, of the perception of local versus global aspects of a visual scene (Baumann and Kuhl, 2005; Tan, Jones and Watson, in press). The argument is simple. If focussing on local aspects, then

positive affect improves processing of global aspects; and if focussing on global aspects, then it encourages local processing. Jones and colleagues have called this "encouraging the perceptual underdog", and is distinct from previous suggestions about, say, positive affect simply promoting global processing. It seems plausible to hypothesize that happiness could have a similar effect on a broader canvas, with labor productivity benefiting from the individual worker being encouraged to try out hitherto neglected strategies.

8. Conclusions

Little is known by economists about how emotions affect productivity. To try to make progress on this, we design a randomized trial. We thereby exogenously 'assign' different emotions to different people. Some of our laboratory subjects have their happiness levels⁸ increased. Others, in a control group, do not. A rise in happiness leads to greater productivity in a paid piece-rate task. The effect is large, can be replicated, is not a reciprocity response, and is found equally in male and female subsamples.

A number of implications emerge. First, if our results can be shown to generalize, economics needs to pay attention to what emotions do. In so far as emotional forces currently play a role in empirical economics, they have typically been viewed, as in the economics of happiness literature, as a dependent variable. Second, better bridges will have to be built between applied psychology and economics. Third, if happiness boosts productivity, this raises the possibility of self-reinforcing spirals -- ones that could operate even at a macroeconomic level. Happiness may lead to greater productivity and that in turn may lead to greater happiness. Such spirals, if they exist, seem likely to be important.

⁸ In alternative language, we study 'positive affect' and mood.

Figure 1: Reported happiness

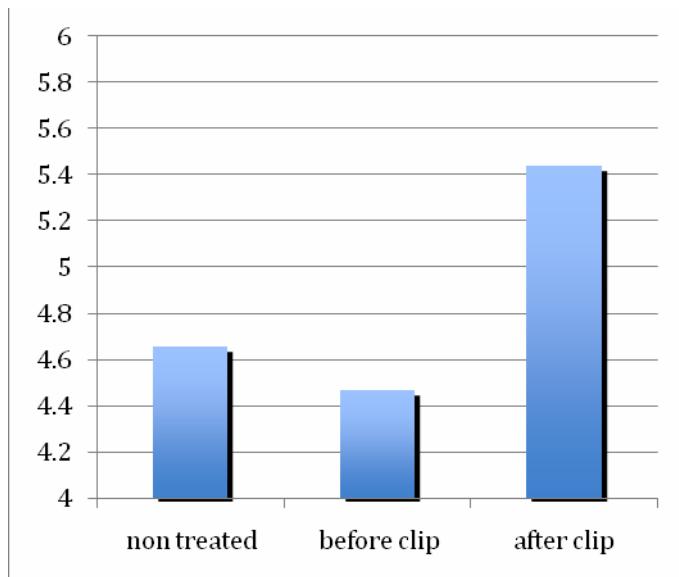


Figure 2: Number of correct additions

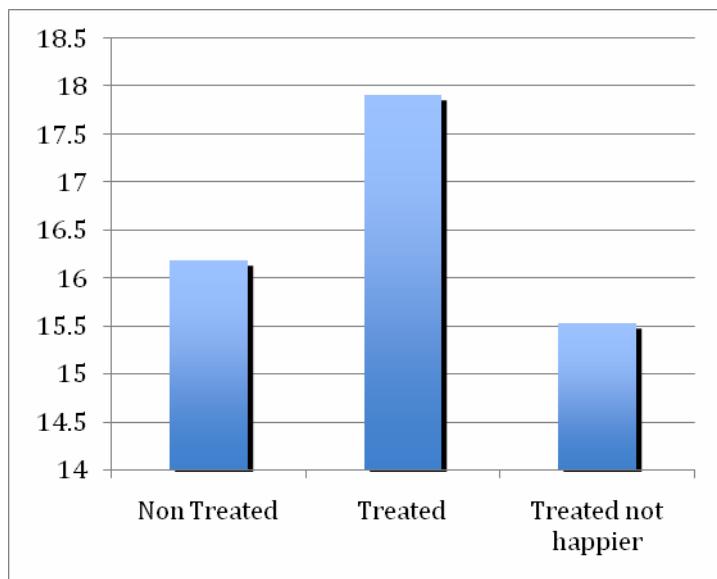


Figure 3: Performance difference between males and females

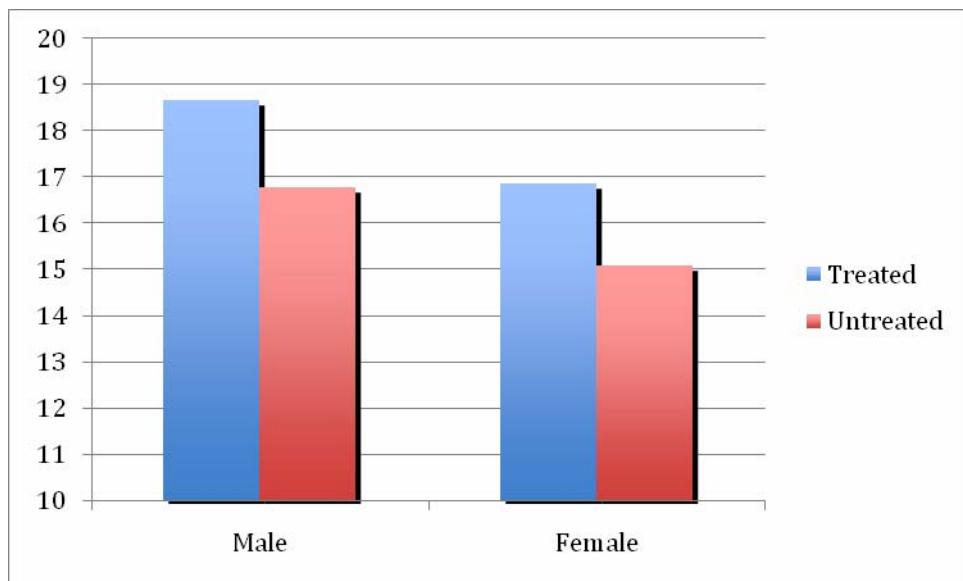


Figure 4: CDF of subjects' performances

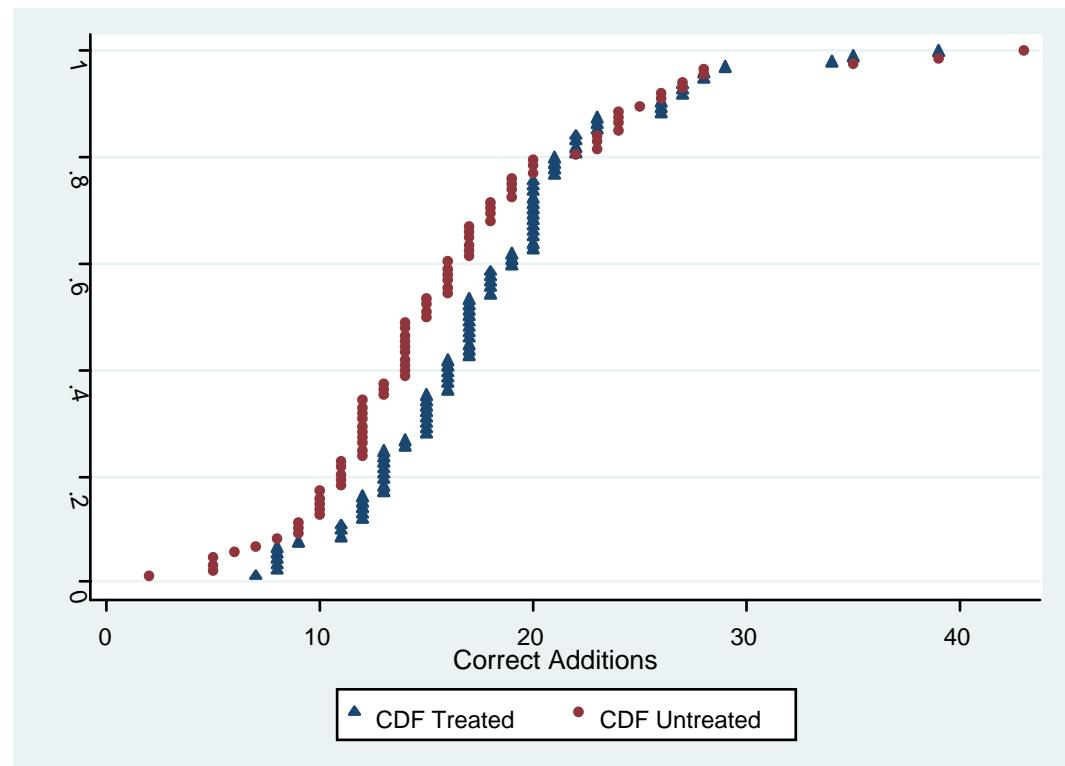


Table 1: Subject numbers for each session and day

Day	Treated	Untreated
1	24	24
2	23	20
3	23	24
4	24	25

Table 2: Data description

Variable	#Observations	Mean	Std Error	Min	Max
#Correct Additions	182	17.09	6.62	2	43
Happiness before	182	4.55	1.03	1	7
Happiness after	94	5.45	0.74	3	7
GMAT MATH	182	3.43	1.38	0	5
High School Grades	178	0.49	0.25	0	1
Enjoyment-of-Clip	94	5.93	0.68	5	7

Definitions

The measure called "High School Grades" asks students to consider all of their qualifications and gives a percentage of those qualifications that are at the highest possible grade. It therefore measures their past performance against the highest possible performance. More precisely, on the questionnaire we asked two questions:

"How many school level qualifications have you taken (including GCSEs, A-levels and equivalent)?" (forming the denominator)

"How many of these qualifications were at the best grade possible? (eg A* in GCSE, A is A-level, etc.)" (forming the numerator)

Table 3: Determinants of subjects' performance⁹

	(1) log(Additions)	(2) log(Additions)	(3) log(Additions)
<i>Treated only</i>			
Treatment	0.118** (0.0548)		
Change-in-Happiness		0.101** (0.0405)	0.0847* (0.0495)
GMAT MATH score	0.104*** (0.0226)	0.100*** (0.0226)	0.0739*** (0.0273)
High School Grades	0.471*** (0.114)	0.477*** (0.114)	0.428*** (0.124)
Male	-0.0257 (0.0609)	-0.0267 (0.0606)	0.00675 (0.0774)
Day 2	-0.0169 (0.0790)	0.000901 (0.0787)	-0.0170 (0.0905)
Day 3	0.0975 (0.0779)	0.106 (0.0776)	0.131 (0.0885)
Day 4	0.0118 (0.0762)	0.00724 (0.0758)	-0.00752 (0.0895)
Constant	2.106*** (0.105)	2.120*** (0.102)	2.244*** (0.126)
Observations	178	178	93
R-squared	0.273	0.280	0.307

Std errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

⁹ Within the table as is standard the notation *** indicates p<0.01, ** p<0.05, * p<0.1, and standard errors are given in parentheses.

Table 4: Determinants of subjects' performance [Non-logged]

	(1)	(2)	(3)	(4)
	Additions (no outliers)	Additions (no outliers)	Additions (no outliers)	Additions (no outliers)
Treatment	1.336 (0.889)	1.572** (0.825)		
Change-in-Happiness			1.316** (0.657)	1.407** (0.608)
GMAT MATH score	1.286*** (0.367)	1.291*** (0.343)	1.243*** (0.366)	1.244*** (0.342)
High School Grades	8.284*** (1.854)	8.349*** (1.710)	8.355*** (1.844)	8.429*** (1.701)
Male	0.824 (0.988)	0.606 (0.919)	0.828 (0.982)	0.607 (0.914)
Day 2	0.472 (1.281)	-0.325 (1.193)	0.693 (1.276)	-0.0707 (1.187)
Day 3	2.105* (1.264)	2.330** (1.173)	2.212* (1.258)	2.455** (1.167)
Day 4	0.868 (1.236)	0.809 (1.140)	0.814 (1.230)	0.749 (1.134)
Constant	6.603*** (1.697)	6.602*** (1.575)	6.680*** (1.657)	6.763*** (1.535)
Observations	178	176	178	176
R-squared	0.245	0.283	0.253	0.290
Std errors in parentheses *** p<0.01, ** p<0.05, * p<0.1				

Table 5: Determinants of attempts

	(1)	(2)
	Log(Attempt)	Log(Attempts)
Treatment	0.0911** (0.0417)	
Change-in-Happiness		0.0812*** (0.0308)
GMAT MATH score	0.0758*** (0.0172)	0.0733*** (0.0171)
High School Grades	0.372*** (0.0869)	0.377*** (0.0863)
Male	-0.0165 (0.0463)	-0.0170 (0.0460)
Day 2	0.0198 (0.0600)	0.0340 (0.0597)
Day 3	0.133** (0.0592)	0.140** (0.0589)
Day 4	0.0767 (0.0579)	0.0732 (0.0576)
Constant	2.432*** (0.0795)	2.441*** (0.0776)
Observations	178	178
R-squared	0.279	0.288

*** p<0.01, ** p<0.05, * p<0.1 Std errors in parentheses

**Table 6: Determinants of the precision
(ie. ratio of correct answers)**

	(1)	(2)
	Correct/ Attempt	Correct/ Attempt
Treatment	0.0128 (0.0185)	
Change-in-Happiness		0.0102 (0.0138)
GMAT MATH score	0.0165** (0.00765)	0.0162** (0.00767)
High School Grades	0.0656* (0.0386)	0.0663* (0.0386)
Male	0.00152 (0.0206)	0.00134 (0.0206)
Day 2	-0.0268 (0.0267)	-0.0249 (0.0267)
Day 3	-0.0201 (0.0263)	-0.0192 (0.0263)
Day 4	-0.0507* (0.0258)	-0.0512** (0.0257)
Constant	0.753*** (0.0354)	0.755*** (0.0347)
Observations	178	178
R-squared	0.095	0.096

Std. errors in parentheses *** p<0.01,

** p<0.05, * p<0.1

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APPENDIX: PART 1
Replication of the findings on subsamples

Table A1: Treatment Dates

The main experiment was carried out on four separate days, as follows:

Session	Treatment	Date	Time
1	Treatment 0	21 May 2008	2.30-3.30pm
1	Treatment 1	21 May 2008	4.00-5.00pm
2	Treatment 0	18 June 2008	2.30-3.30pm
2	Treatment 1	18 June 2008	4.00-5.00pm
3	Treatment 1	10 October 2008	2.30-3.30pm
3	Treatment 0	10 October 2008	4.00-5.00pm
4	Treatment 1	15 October 2008	2.30-3.30pm
4	Treatment 0	15 October 2008	4.00-5.00pm

Recall that treatment 0 is the treatment without a video clip and treatment 1 includes a video clip. Sessions 1 and 2 were undertaken in term 3 of the University of Warwick academic year 2007-8, while sessions 3 and 4 were undertaken in term 1 of the 2008-9 academic year. Since they are separated by a gap of approximately 4 months, we might wish to check for significant changes across the time between sessions 1-2 and sessions 3-4. The key aggregate variables results broken down by session are as follows:

Table A2: Summary Statistics by Treatment

Session	addscore	log addscore	Addscore Male	Addscore Female	happy before	happy after	enjoy clip
1 Treatment 0	15.38**	1.17	14.88**	16.83	4.54	na	na
1 Treatment 1	18.21**	1.23	18.26**	18	4.54	5.63	5.96
2 Treatment 0	16.85	1.18	19.41	13*	4.45	na	na
2 Treatment 1	16.48	1.19	16.36	16.58*	4.43	5.22	5.74
3 Treatment 0	16.26*	1.16	15.75*	17.14	4.79	na	na
3 Treatment 1	19.52*	1.27	20.42*	18.11	4.48	5.39	5.83
4 Treatment 0	16.04	1.15	18.07	14.36	4.92	na	na
4 Treatment 1	17.72	1.22	19.6	15.92	4.36	5.44	6.21

The key column is perhaps *log addscore* (log correct additions) which effectively smoothes outliers in the number of correctly answered numerical additions. The data for sessions 1-2 are very similar to those from sessions 3-4. Importantly, the pattern of results seems consistent across sessions. The only exception comes in session 2 where the raw number of additions does not rise moving from treatment 0 to treatment 1. This is down to one outlier. Using logs brings the results into line with those from the other sessions.¹⁰

¹⁰ Without the outlier who performed 43 exact additions, the average is 16.47 in treated and 16.47 in the untreated group.

We put an asterisk when the difference between treated and untreated groups is statistically significant. In particular, we have that for session 1 (21 May 2008) and session 3 (10 October 2008) the difference for the entire pool is already statistically significant at p-values 0.047 and 0.052 respectively. When we split the group into males and females, we note that they are already statistically significant in 3 out of 8 sub-cases.

Alternatively, we also regressed the key variables for all four sessions individually: b

Table A3: Session Regressions

VARIABLES	(1) ladd	(2) ladd	(3) ladd	(4) ladd	(5) ladd	(6) ladd	(7) ladd	(8) ladd
treatment	0.129 (0.0889)		0.0931 (0.124)		0.184 (0.127)		0.0979 (0.118)	
gmatscore	0.0799* (0.0472)	0.0859* (0.0453)	0.115** (0.0507)	0.110** (0.0510)	0.139*** (0.0434)	0.135*** (0.0448)	0.0739 (0.0473)	0.0722 (0.0469)
qualifs	0.482** (0.198)	0.486** (0.192)	0.398 (0.261)	0.386 (0.266)	0.277 (0.262)	0.332 (0.262)	0.657*** (0.239)	0.652*** (0.236)
male	-0.0729 (0.111)	-0.0373 (0.110)	0.113 (0.127)	0.0985 (0.126)	-0.153 (0.134)	-0.150 (0.136)	-0.0258 (0.136)	-0.0350 (0.133)
dhappy		0.126** (0.0585)		0.0256 (0.112)		0.0993 (0.102)		0.0980 (0.0792)
Constant	2.220*** (0.187)	2.165*** (0.185)	2.022*** (0.218)	2.093*** (0.198)	2.219*** (0.184)	2.256*** (0.184)	2.122*** (0.170)	2.128*** (0.163)
Observations	48	48	40	40	41	41	49	49
R-squared	0.286	0.323	0.288	0.278	0.336	0.315	0.264	0.278

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses

Regression (1) considers *log addscore* from session 1 regressed on treatment, with (2) instead using *dhappy*. *Dhappy* is in general a better measure of the impact of happiness since it controls for those subjects who did not gain in happiness from watching the clip. (3) and (4) are the respective regressions for session 2, (5) and (6) for session 3, and (7) and (8) for session 4. We might also consider merging sessions 1 and 2, and merging sessions 3 and 4:

Table A4: Grouped Session Regressions

VARIABLES	(1) ladd	(2) ladd	(3) ladd	(4) ladd
treatment	0.0989 (0.0712)		0.139 (0.0848)	
gmatscore	0.100*** (0.0333)	0.0987*** (0.0330)	0.111*** (0.0316)	0.108*** (0.0318)
qualifs	0.458*** (0.157)	0.462*** (0.155)	0.468*** (0.169)	0.479*** (0.169)
male	0.0299 (0.0797)	0.0309 (0.0789)	-0.0658 (0.0918)	-0.0720 (0.0916)
dhappy		0.0990* (0.0535)		0.0982 (0.0617)
Constant	2.091*** (0.135)	2.096*** (0.130)	2.147*** (0.122)	2.174*** (0.118)
Observations	88	88	90	90
R-squared	0.268	0.281	0.274	0.273

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses

In Table A4, regressions (1) and (2) group together sessions 1 and 2. Similarly, regressions (3) and (4) group together sessions 3 and 4. As in Table A3, the first regression in each pair considers *treatment*.

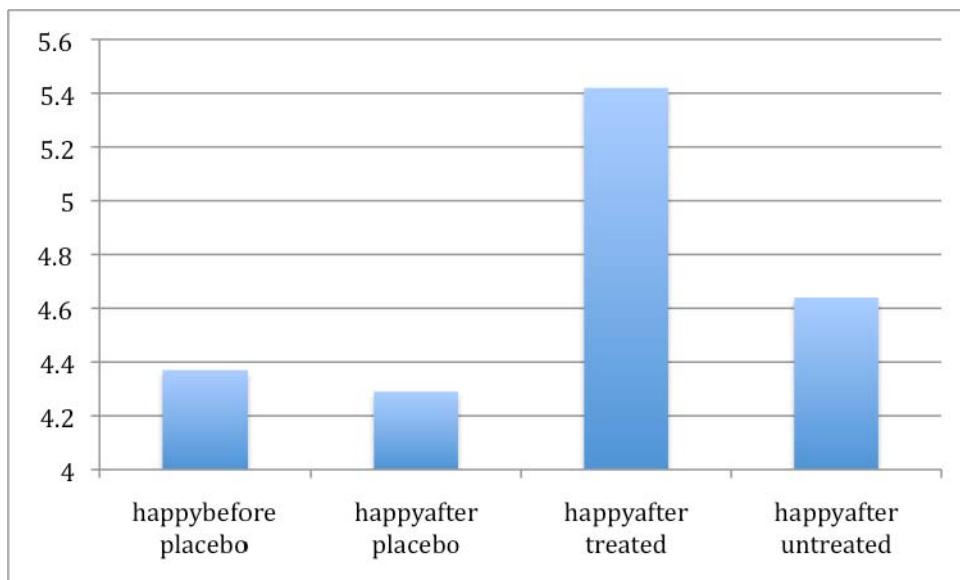
APPENDIX: PART 2
Checking the effects of a placebo film and of exact numerical payment

This describes Day 5 (3/12/08): session 1 (placebo, 25 subjects), session 2 (explicit payment, 25 subjects).

Placebo effect

In the figure below we present the level of reported happiness after and before the placebo. The placebo film had the effect of slightly reducing subjects' happiness but the two levels are not statistically different (p value= 0.39). The level of reported happiness after the placebo is slightly lower than the one of the non treated group (p value=0.093), and statistically lower than the one in the treated group (p value <0.001). All in all we can say that the placebo does not have a statistically significant impact on the level of self reported happiness if compared with the non treated group.

The placebo has, if anything, a negative impact on performances, although this difference is statistically non significant (p value 0.19). The finding is shown in tables A5, A6 and A7, where we can see that placebo has no effect on additions, attempt and precision.



Explicit payment

We announced that each subject will be rewarded with 0.25p for each correct addition. the following table we can observe the performances of the treated subject

and compare them with the treated subject in the sessions where we did not specify the payment. As expected there is an increase in the performances, where the payment has been specified this is only borderline significant (p value 0.1) and becomes insignificant when we compare the logarithm (p value = 0.48). This finding is confirmed in the tables, where we can see that the explicit payment has no effect on additions, attempt and precision.

Table A5 Log Additions

	(1)	(2)
	Log(Additions)	Log(Additions)
Treatment	0.109*	
	(0.0567)	
placebo	-0.0476	-0.0548
	(0.0875)	(0.0867)
payment	-0.0120	-0.00968
	(0.0853)	(0.0831)
GMAT	0.0966***	0.0930***
	(0.0203)	(0.0204)
High school Grade	0.480***	0.494***
	(0.106)	(0.106)
male	0.0325	0.0233
	(0.0552)	(0.0551)
dhappy		0.0910**
		(0.0371)
Constant	2.183***	2.205***
	(0.0820)	(0.0779)
Observations	227	226
R-squared	0.264	0.271

Table A6 Log Attempts Equations

	(1)	(2)
	Log(attempts)	Log(attempts)
treatment	0.0884** (0.0411)	
placebo	-0.0724 (0.0635)	-0.0691 (0.0626)
payment	0.0515 (0.0618)	0.0496 (0.0600)
Gmat	0.0646*** (0.0148)	0.0610*** (0.0147)
High school Grade	0.366*** (0.0771)	0.375*** (0.0767)
male	0.0259 (0.0400)	0.0197 (0.0397)
dhappy		0.0816*** (0.0267)
Constant	2.558*** (0.0595)	2.574*** (0.0562)
Observations	227	226
R-squared	0.277	0.289

Table A7 Precision Equations

	(1)	(2)
	precision	precision
treatment	0.0134 (0.0199)	
placebo	0.00918 (0.0307)	0.00320 (0.0306)
payment	-0.00831 (0.0300)	-0.00614 (0.0294)
GMAT	0.0174** (0.00715)	0.0174** (0.00721)
High School grades	0.0729* (0.0374)	0.0755** (0.0375)
male	0.00928 (0.0194)	0.00736 (0.0194)
dhappy		0.00729 (0.0131)
Constant	0.716*** (0.0288)	0.720*** (0.0275)
Observations	227	226
R-squared	0.072	0.073

APPENDIX: PART 3

Description of Procedures

This part of the appendix includes a full set of subject instructions, a copy of the GMAT MATH-style test, and the questionnaire.

Instructions

[**bold** = only for the clip treatment, X talks directly with subjects, Y, Z, etc. are assistants. Parts in square brackets are not to read out.]

[X invites subjects to enter room **while Y sets up the video clip**]

Welcome to the session. My name is X, and working with me today are Y, Z, etc. Many thanks for attending today. You will be asked to perform a small number of very minor tasks and will be paid both a show-up fee and an amount based on how you perform, **but first we would like to ask you to watch a video clip**. Please do not talk to each other at any stage in the session. If you have any questions please raise your hands, but avoid distracting the others in the room.

Z will now guide you to the seats at the front of the room directly in front of the projector, while Y prepares the video clip. Please make yourselves comfortable: the clip will last about 10 minutes and I will have more instructions for you afterwards.

[10 minutes: video clip]

Thanks for watching. Z will now distribute ID cards to you and you are asked to sit at the computer corresponding to the ID number. Everything is done anonymously – your performance will simply be recorded based on the ID card, and not your names. You will find some paper and a pen next to your computer – use them if you wish, and raise your hand if you wish to request additional paper. Please do not use calculators or attempt to do anything other than answer the questions through mental arithmetic. If we observe any form of cheating it will invalidate your answers and you will be disqualified, and therefore receive only the show-up fee.

For the first task you will have 10 minutes to add a sequence of numbers together and enter your answers in the column labelled “answer”. To remind you, you will be paid based on the number of correct answers that you produce. When the ten minutes are over I will ask you to stop what you are doing and your results will be saved.

Next look at your screens: you will find that a file called “Numberadditions.xls” is open but minimized on your screen. Please now maximize the file by clicking on the tab. You have ten minutes starting now.

[10 minutes: number additions]

Please stop what you are doing, your answers will now be saved. Y and Z will now visit your computers and place a sheet faced down next to your keyboards. Please do not turn over the sheet until I ask.

[Y and Z move to terminals, placing question sheets faced down]

For the second task we would like you answer a small number of questions. You can maximise the file on your computer labelled “GMAT MATH.xls” and you will once again see a column labelled answers. In this column you will have to enter a letter from (a) to (e), corresponding to a multiple-choice answer to the sheet which is faced-down in front of you. Once again, I remind you that you will be paid based on the number of correct answers. You have 5 minutes to attempt these questions, please turn over the sheets and begin.

[5 minutes: GMAT MATH-style test]

Please stop what you are doing, your answers will now be saved. You should next open the final document: a questionnaire that you are asked to complete. You will be given 10 minutes to complete this, though if you need additional time we can extend this deadline indefinitely. Please answer as truthfully as you can and feel free to raise your hands if anything is unclear. To stress, where you are asked to input a number from 1 to 7, “7” is the high number and “1” is the low one.

[10 minutes: questionnaire]

Hopefully you have all had a chance to complete the questionnaire. If you need more time, then please raise your hand. Otherwise we will save your questionnaire replies.

The central computer has calculated your payments. Please remain at your computer for the time being. I will ask you to approach the front in order of your ID numbers and you will need to sign a receipt for your payments and to hand in both your ID cards and the test document before receiving payment. Many thanks for taking part in today’s session.

[Test documents destroyed, ID cards collected, receipts signed and payments handed out]

GMAT MATH-style Test

Questions

Please answer these by inserting the multiple choice answer a, b, c, d or e into the GMAT MATH spreadsheet on your computer.

1. Harriet wants to put up fencing around three sides of her rectangular yard and leave a side of 20 feet unfenced. If the yard has an area of 680 square feet, how many feet of fencing does she need?

- a) 34
- b) 40
- c) 68
- d) 88
- e) 102

2. If $x + 5y = 16$ and $x = -3y$, then $y =$

- a) -24
- b) -8
- c) -2
- d) 2
- e) 8

3. If “basis points” are defined so that 1 percent is equal to 100 basis points, then 82.5 percent is how many basis points greater than 62.5 percent?

- a) .02
- b) .2
- c) 20
- d) 200
- e) 2,000

4. Which of the following best completes the passage below?

In a survey of job applicants, two-fifths admitted to being at least a little dishonest. However, the survey may underestimate the proportion of job applicants who are dishonest, because—.

- a) some dishonest people taking the survey might have claimed on the survey to be honest.
- b) some generally honest people taking the survey might have claimed on the survey to be dishonest.

c) some people who claimed on the survey to be at least a little dishonest may be very dishonest.

d) some people who claimed on the survey to be dishonest may have been answering honestly.

e) some people who are not job applicants are probably at least a little dishonest.

5. People buy prestige when they buy a premium product. They want to be associated with something special. Mass-marketing techniques and price-reduction strategies should not be used because —.

a) affluent purchasers currently represent a shrinking portion of the population of all purchasers.

b) continued sales depend directly on the maintenance of an aura of exclusivity.

c) purchasers of premium products are concerned with the quality as well as with the price of the products.

d) expansion of the market niche to include a broader spectrum of consumers will increase profits.

e) manufacturing a premium brand is not necessarily more costly than manufacturing a standard brand of the same product.

Questionnaire

Questionnaire for Treatment 1.

Questionnaire	
Please insert your answers into the shaded boxes to the right	
Details	
What is your age?	
Are you a 1st year, 2nd year, 3rd year, graduate student, or other? (1/2/3/G/O)	
What is your gender? (M/F)	
The Clip	
How much did you enjoy the clip shown at the beginning? (1-7)	
Note: 1 is completely disliked, 2 very disliked, 3 is fairly disliked, 4 is neither enjoyed nor disliked, 5 is fairly enjoyed, 6 is very enjoyed, 7 is completely enjoyed	
Happiness	
How would you rate your happiness before seeing the clip? (1-7)	
Note: 1 is completely sad, 2 is very sad, 3 is fairly sad, 4 is neither happy nor sad, 5 is fairly happy, 6 is very happy, 7 is completely happy	
Did the clip shown at the beginning make you feel happier? (yes/no)	
IF SO:	
How would you rate your happiness after seeing the clip (1-7)?	
Note: 1 is completely sad, 2 is very sad, 3 is fairly sad, 4 is neither happy nor sad, 5 is fairly happy, 6 is very happy, 7 is completely happy	
School Record	
Have you taken GSCE or equivalent in maths? (yes/no)	
IF SO:	
What was the highest grade possible for this course? (A/A*/etc.)	
What was your grade?	
Give a percentage if you know it	
Have you taken A-level or equivalent in maths? (yes/no)	
IF SO:	
What was the highest grade possible for this course?	

What was your grade?	<input type="text"/>
Give a percentage if you know it	<input type="text"/>
How many school level qualifications have you taken (including GCSEs, A-levels and equivalent)?	<input type="text"/>
How many of these qualifications were at the best grade possible? (eg A* in GCSE, A is A-level, etc.)	<input type="text"/>
University Record	
Are you currently or have you ever been a student (yes/no)	<input type="text"/>
If yes, which degree course(s)?	<input type="text"/>
IF you are a second or third year student what class best describes your overall performance to date? (1/2.1/2.2/3/Fail)	<input type="text"/>

Questionnaire for Treatment 0.

Questionnaire Please insert your answers into the shaded boxes to the right	
Details	
What is your age?	
Are you a 1st year, 2nd year, 3rd year, graduate student, or other? (1/2/3/G/O)	
What is your gender? (M/F)	
Happiness	
How would you rate your happiness at the moment? (1-7)	
Note: 1 is completely sad, 2 is very sad, 3 is fairly sad, 4 is neither happy nor sad, 5 is fairly happy, 6 is very happy, 7 is completely happy	
School Record	
Have you taken GSCE or equivalent in maths? (yes/no)	
IF SO:	
What was the highest grade possible for this course? (A/A*/etc.)	
What was your grade?	
Give a percentage if you know it	
Have you taken A-level or equivalent in maths? (yes/no)	
IF SO:	
What was the highest grade possible for this course?	
What was your grade?	
Give a percentage if you know it	
How many school level qualifications have you taken (including GCSEs, A-levels and equivalent)?	
How many of these qualifications were at the best grade possible? (eg A* in GCSE, A is A-level, etc.)	
University Record	
Are you currently or have you ever been a student (yes/no)	
If yes, which degree course(s)?	
IF you are a second or third year student what class best describes your overall performance to date? (1/2.1/2.2/3/Fail)	