THE ROLE OF NONCOGNITIVE SKILLS IN EXPLAINING COGNITIVE TEST SCORES

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This article examines whether noncognitive skills—measured both by personality traits and by economic preference parameters—influence cognitive tests' performance. The basic idea is that noncognitive skills might affect the effort people put into a test to obtain good results. We experimentally varied the rewards for questions in a cognitive test to measure to what extent people are sensitive to financial incentives. To distinguish increased mental effort from extra time investments, we also varied the questions' time constraints. Subjects with favorable personality traits such as high performance motivation and an internal locus of control perform relatively well in the absence of rewards, consistent with a model in which trying as hard as you can is the best strategy. In contrast, favorable economic preference parameters (low discount rate, low risk aversion) are associated with increases in time investments when incentives are introduced, consistent with a rational economic model in which people only invest when there are monetary returns. The main conclusion is that individual behavior at cognitive tests depends on noncognitive skills. (*JEL* J20, J24)

I. INTRODUCTION

This article reports findings of an experiment to examine whether measured cognitive test scores are influenced by noncognitive skills. The basic idea of our analysis is that the performance on a cognitive test not only depends on the actual cognitive abilities but also on the willingness to put mental effort in answering difficult questions in the absence of extrinsic rewards. A relationship between noncognitive skills and cognitive test scores can exist for two reasons. First, people who are motivated to perform well and who have a positive attitude toward work might be more inclined to do their best at tests, irrespective of the rewards offered. If so, high IQ scores might partly reflect favorable noncognitive skills, and correlations between cognitive skills and outcomes are upward biased. Second, people with favorable behavioral or labor-market outcomes might have an attitude to put in effort only when there are sufficient rewards. This could serve as an explanation for a successful career, despite lower cognitive test scores at school.

To investigate the relationship between noncognitive skills and cognitive test scores, we performed an experiment in which we first measured psychological traits and economic preference parameters of 128 students. Next, these students carried out a cognitive test. Initially, there were no rewards for right answers, but later on, we introduced payments for right answers. To disentangle the effect of increased mental effort from increased time investments, we also varied the time available for each question. To investigate whether our results are affected by heterogeneity in the marginal value of time, we ended the experiment by measuring the marginal price for the willingness to spend time doing nothing.

We find that students put substantially more time in answering IQ questions when rewards are higher. The effect of extra time

*We thank Flavio Cunha, Bart Golsteyn, James Heckman, Joan Muysken, and Inge Sieben for useful comments and conversations; participants at the 2006 WEAI in San Diego for feedback on an earlier version of this paper; and Anton de Vries for advice about the use of cognitive tests. This research has been supported by the Maastricht Graduate School of Governance.

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Economic Inquiry
(ISSN 0095-2583)
Vol. 46, No. 1, January 2008, 2–12
doi:10.1111/j.1465-7295.2007.00073.x

investments on test scores is less obvious and depends on the type and difficulty of the IQ question. When time constraints are very binding, the effects disappear, suggesting that people cannot increase mental effort as a substitute for investing more time. We find several personality traits for which the effect of rewards on the time spent to answer a question is significantly smaller than average: performance motivation, internal locus of control, and curiosity. Also, components from the 5-factor model of personality structure, such as emotional stability and conscientiousness, are associated with a low effect of rewards on extra time investments. Students with a high preference for leisure (measured by psychological tests) and a negative fear of failure increase their efforts to answer questions more than average when rewards go up. This also holds for the component measuring openness to new experiences from the 5-factor model of personality structure.

For the economic preference parameters, we find the opposite result. Students with high discount rates, high risk aversion, and a high preference for leisure (measured by questions in which the respondent has to trade-off time and money) tend to decrease time spent on an IQ question more than others, when rewards are increased. Again, the incentives do not always increase performance. Since in general, low discount rates and low levels of risk aversion are also associated with favorable behavioral or labor-market outcomes, this is surprising. A potential explanation is that economic preference parameters are measured by questions about economic trade-offs. Possibly, people differ in their ability to deal with such trade-offs, explaining why the psychological measures might pick up other aspects of noncognitive skills than the economics preference parameters.

II. EXPERIMENT

A. Design

We conducted an experiment with different time constraints and financial incentives on IQ questions to examine the influence of different preferences and types on the performance in this cognitive test. One hundred and twenty-eight subjects participated in the experiment. They were all Dutch students from Maastricht University, and the experiment was conducted in Dutch. The experiment was conducted in four stages. The instructions and set-up of the experiment are explained in more detail in Borghans, Meijers, and Ter Weel (2006a).

B. Personality

In the first stage, subjects were giving answers to statements to determine psychological traits and were asked to make trade-offs to determine relevant economic preference parameters. We selected ten psychological traits that appear to be potentially relevant for the decision to put effort in a test, regardless of the reward. In psychology, there is a long tradition to search for traits explaining differences in the tendency to perform well. Following the work of Atkinson and Reitman (1958), Edwards (1959), Hermans (1975) developed Dutch tests for this purpose, which are still considered as the norm in the field. We applied shortened versions of Hermans' test of performance motivation, preference for leisure, positive fear of failure, and negative fear of failure. We added tests for internal locus of control and social desirability (Rotter scale), enjoyment of success (Steers and Black 1994), and resilience (Siebert 1993) because the attitude to relate success and failure to one's own performance and to stay motivated after failure are generally regarded as important elements for success. We also added a test for curiosity (Steers and Black 1994) because curious people might have more fun solving questions in cognitive tests. The attitude toward work from the World Value Study has been added since this test is available for a wide variety of countries. In all tests, respondents had to answer on a 5-point scale to what extent statements hold for them. We checked for the reliability of the statements included using Cronbach's alpha. Average normalized scores (reversing scores on negative statements) are used as measures in our analyses.[1]

We also included items from the 5-factor model of personality structure ("big five"), measuring emotional stability, introversion, openness, agreeableness, and conscientiousness. Here, respondents have to characterize themselves on a 5-point scale between two extreme characterizations. The 5-factor model

1. Scores based on weights obtained from factor analyses provide similar results.

of personality structure described by Goldberg (1990) is introduced as an attempt to summarize the wide spectrum of psychological traits that matter for behavior (e.g., Allport and Odbert 1936).

C. Preference Parameters

Additionally, we included questions to measure economic preference parameters. By posing questions in which respondents are asked to make a trade-off between current and future rewards, certain and risky rewards, and money and leisure, we measured time preference, risk aversion, and preference for leisure. In the analyses, we apply average scores for each parameter. Risk preference is measured by two series of questions. There are two questions describing a situation in which risk-taking behavior is assessed and two sets of questions on deals people can strike with probabilities of getting nothing. By increasing the amount of money at stake, we can determine how risk-averse subjects are.

The discount rate is measured in a similar way, with questions referring to possible future benefits or money that can be consumed at some cost in the present. By assessing the willingness to postpone present consumption for future consumption, we determine the discount rate.[2]

Preference for leisure can be measured both by statements as in the psychological tradition and by imposing explicit trade-offs. We measured the preference for leisure by two questions, giving subjects the opportunity to either trade leisure for money or exchange money for leisure time.

D. Cognitive Tests

The second stage of the experiment was a cognitive test consisting of ten IQ questions selected randomly from a set of 80 possible questions. The ten IQ questions are of the following types. Two Raven matrices, two sequences or matrices of numbers, two filling in linking words, one anagram, one sequence or matrix of characters, one "stranger in our midst," and one question from the Cognitive Reflection Test by Frederick (Frederick 2005). The first row in Table 1 reports the mean levels and standards errors of the total score (Panel A) and duration (Panel B) in the second stage, and the same numbers disaggregated by type of IQ question.

The third stage was a cognitive test consisting of seven sets of ten questions, in which in each set there was a possible time constraint (no time constraint, 60 or 30 sec) and incentive pay (no pay, €0.10, €0.40, or €1.00 for each correct answer). Subjects always had to complete one set of questions without incentive pay and two sets of questions under each incentive pay regime. So the maximum earnings in the third stage are €30.00. The average earnings were €16.53 (with a SD of €3.44). All respondents had to answer the full set of 80 IQ questions, but we randomized the order to separate the effect of tiredness and experience with the questions from the difficulty of the question. The composition of each set of ten questions was always the same as in the first set described above. After each block of ten questions, there was a 1-min break during which subjects could recover but were not allowed to do anything else than sit still. We report in Table 1, from Row 2 onward, the scores (Panel A) and duration (Panel B) under different time constraints and incentive pay combinations. The overall picture shows that—in comparison with later questions without time constraints—subjects thought longest when they were first confronted with the IQ questions (81.601 sec) and scored relatively well (0.622) during this second stage of the experiment. The first column of Table 1 shows that, in general, higher incentive pay increases time investments in answering the questions. The scores are higher for any incentive pay compared to the no-pay situation, although not for the questions with a time constraint of 30 sec. In this latter case, the time constraint seems to be binding because 24.8% of the questions are not answered within the 30-sec time frame. For the 60-sec time limit, this is true for only 10.4%.

The remaining columns show the mean score and duration by type of IQ question. The scores in Panel A reveal that the Raven matrices, the sequences or matrices of numbers, and the Frederick questions have been answered relatively well and that filling in missing words has been most difficult.

2. The discount rates reported in the literature vary substantially, which seems to be due to the wording of the questions. Evidence shows that the relative position of individuals on the scale is rather stable across questions (e.g., Frederick, Loewenstein, and O'Donoghue 2002). The discount rate reported here is relatively low.

TABLE 1
Cognitive Test Scores

	All Types	Raven	Numbers	Words	Anagram	Characters	Stranger	Frederick
A: Fraction of correct answers								
Stage 2	0.622 (0.014)	0.891 (0.020)	0.688 (0.029)	0.391 (0.031)	0.563 (0.044)	0.492 (0.044)	0.523 (0.044)	0.703 (0.041)
Stage 3								
No limit								
No pay	0.598 (0.021)	0.880 (0.031)	0.556 (0.048)	0.426 (0.048)	0.648 (0.066)	0.481 (0.069)	0.444 (0.068)	0.685 (0.064)
€0.10	0.636 (0.017)	0.881 (0.025)	0.684 (0.035)	0.423 (0.038)	0.583 (0.054)	0.512 (0.054)	0.548 (0.055)	0.738 (0.048)
€0.40	0.620 (0.018)	0.908 (0.025)	0.647 (0.040)	0.437 (0.042)	0.437 (0.059)	0.479 (0.060)	0.620 (0.058)	0.676 (0.056)
€1.00	0.646 (0.016)	0.924 (0.020)	0.694 (0.035)	0.459 (0.038)	0.553 (0.054)	0.541 (0.054)	0.424 (0.054)	0.788 (0.045)
60 sec								
No pay	0.503 (0.027)	0.786 (0.049)	0.514 (0.060)	0.371 (0.058)	0.457 (0.085)	0.229 (0.072)	0.486 (0.085)	0.514 (0.086)
€0.10	0.539 (0.017)	0.865 (0.026)	0.517 (0.038)	0.264 (0.033)	0.562 (0.053)	0.449 (0.053)	0.461 (0.054)	0.629 (0.052)
€0.40	0.540 (0.016)	0.855 (0.026)	0.575 (0.036)	0.312 (0.034)	0.473 (0.052)	0.376 (0.050)	0.494 (0.052)	0.570 (0.052)
€1.00	0.575 (0.017)	0.859 (0.027)	0.565 (0.038)	0.365 (0.037)	0.529 (0.054)	0.329 (0.051)	0.612 (0.053)	0.706 (0.050)
30 sec								
No pay	0.431 (0.025)	0.679 (0.053)	0.397 (0.056)	0.231 (0.048)	0.564 (0.080)	0.231 (0.068)	0.692 (0.075)	0.205 (0.066)
€0.10	0.435 (0.017)	0.687 (0.036)	0.403 (0.038)	0.229 (0.033)	0.554 (0.054)	0.217 (0.046)	0.566 (0.055)	0.373 (0.053)
€0.40	0.452 (0.016)	0.717 (0.033)	0.461 (0.037)	0.326 (0.035)	0.337 (0.050)	0.228 (0.044)	0.522 (0.052)	0.413 (0.052)
€1.00	0.427 (0.017)	0.709 (0.035)	0.459 (0.038)	0.198 (0.030)	0.430 (0.054)	0.221 (0.045)	0.570 (0.054)	0.314 (0.050)
B: Duration								
Stage 2	81.601 (2.601)	54.381 (2.523)	87.726 (6.724)	126.12 (8.372)	88.874 (6.677)	112.02 (7.205)	28.164 (2.008)	50.856 (3.466)
Stage 3								
No limit								
No pay	45.356 (1.867)	30.978 (1.962)	56.166 (5.709)	56.702 (4.716)	42.761 (4.158)	63.952 (6.244)	18.224 (2.729)	40.929 (3.984)
€0.10	57.145 (2.040)	39.892 (2.551)	68.162 (5.657)	75.530 (6.013)	59.768 (5.074)	72.711 (6.390)	23.932 (1.679)	47.989 (3.953)
€0.40	68.242 (2.556)	42.104 (2.261)	82.536 (7.310)	90.492 (6.565)	73.525 (7.483)	104.58 (8.598)	23.379 (2.338)	50.668 (4.989)
€1.00	72.410 (2.882)	49.099 (4.035)	85.189 (9.015)	92.426 (7.820)	77.035 (5.892)	103.13 (8.480)	27.377 (2.255)	63.124 (5.134)
60 sec								
No pay	34.978 (1.025)	30.644 (1.766)	32.693 (2.639)	34.319 (2.173)	33.579 (3.149)	40.148 (2.689)	18.585 (2.371)	28.691 (2.500)
€0.10	38.092 (0.635)	31.556 (1.151)	34.007 (1.694)	39.543 (1.548)	41.659 (1.718)	43.308 (1.577)	23.882 (1.670)	34.724 (1.557)
€0.40	36.404 (0.627)	31.142 (1.053)	31.527 (1.658)	35.755 (1.550)	39.368 (1.678)	43.235 (1.484)	20.787 (1.587)	35.773 (1.525)
€1.00	39.097 (0.635)	31.665 (1.000)	33.892 (1.692)	38.966 (1.577)	43.468 (1.713)	47.523 (1.398)	24.856 (1.732)	37.084 (1.634)

continued

TABLE 1
Continued

	All Types	Raven	Numbers	Words	Anagram	Characters	Stranger	Frederick
30 sec								
No pay	23.708 (0.420)	20.940 (0.848)	20.049 (1.311)	21.463 (0.986)	22.426 (1.072)	26.604 (0.829)	15.182 (1.413)	23.207 (1.043)
€0.10	23.711 (0.292)	21.124 (0.529)	20.683 (0.871)	21.869 (0.846)	22.744 (0.781)	24.759 (0.814)	15.447 (0.850)	23.376 (0.760)
€0.40	24.155 (0.280)	22.103 (0.492)	18.882 (0.854)	20.792 (0.821)	25.097 (0.735)	26.797 (0.730)	16.560 (0.861)	23.584 (0.719)
€1.00	24.347 (0.284)	22.098 (0.563)	19.424 (0.835)	21.057 (0.902)	24.149 (0.676)	25.466 (0.689)	16.338 (0.881)	23.946 (0.783)

Notes: Standard errors are given in parentheses. Stage 2 is a stage in which ten IQ questions have to be answered. In Stage 3, seven sets of ten IQ questions have to be answered, of which six involve payment.

Furthermore, time limits reduce scores on almost all questions. The most striking effects of time constraints are found for filling in missing words, the sequence or matrix of characters, and the Frederick questions. Compared to the no-limit case, scores are reduced by some 50% with a 30-sec time limit. In general, scores weakly rise with incentive pay, but not in case of the 30-sec time limit. The most prominent increases are found for the Raven matrices, the sequences or matrices of numbers, and the Frederick questions (except for the 30-sec time limit).

Panel B shows that subjects spend more time on difficult questions because we observe a negative relationship between duration and scores, with the exception of the "stranger in our midst" questions. Time spent on answering questions increases with incentive pay, except for questions with a 30-sec time limit. The time spent on answering a question reduces dramatically when comparing the no limit to the 60-sec limit questions. Comparison of the distributions reveals that most questions that would have taken more time than the limit allows for are answered in the last 10 sec before the time limit (or too late).

Overall, Table 1 shows that time constraints exert more impact on test scores than incentive pay does. Putting in time constraints reduces scores, whereas incentive pay increases scores in the no-limit case only. Moreover, subjects significantly increase time investments in the case of incentive pay. A further analysis shows that thinking longer affects scores of relatively easy questions (on which people do well) and also the scores of some of the Frederick questions, the sequence or matrix of numbers, the Raven matrices, and the stranger in our midst questions (see Borghans, Meijers, and Ter Weel 2006b for more elaborate results).

E. Value of Time

To ensure that students traded off the benefits of giving a right answer with the costs of investing more time, they were instructed at the beginning of the experiment that every student could leave the experiment room and get paid when ready. However, we also told them that there was the opportunity to stay and take part in the fourth stage. Beforehand, this was told to subjects, without them knowing

what this stage would be other than that they could earn some additional money. Subjects could participate by sitting still and doing nothing else than watching for a minute to go by. After the first minute, they earned €0.75. After each minute, they could choose to either stay or leave. They could wait for 30 min, with the 30th minute paying €0.01. The total amount of money at stake during this half an hour was €7.10.

A considerable fraction of subjects (5.5%) left the experiment immediately. At the other extreme, 13.2 % of the population waited until the 29th minute or stayed until the end. The average waiting time equals 15.92 min, with a standard deviation of 8.18 min. This equals average earnings of €5.47 (SD €1.77). The average marginal earnings equal €0.20/min, with a standard deviation of €0.18, which equals an hourly rate of €12.00, which is well above the legal minimum hourly wage and the average wage earnings of students.

The purpose of this exercise is to measure differences in the value of time and the value of money. In addition, if some subjects were in a hurry and only interested in completing the experiment as soon as possible, the average duration of completing a question could be affected.[3]

III. NONCOGNITIVE SKILLS

Unconditional and residual correlations between the ten personality traits and the 5-factor model of personality structure are low, which confirms the measurement of distinct traits. There are some stronger correlations between the ten traits and the big-five items, reflecting the clusters to which these traits apparently belong. Interesting correlations are obtained between performance motivation and the preference for leisure. The strong negative and significant coefficient is consistent with motivated subjects being less eager to enjoy leisure time. The negative correlation between negative fear of failure and emotional stability is consistent with emotionally stable persons being less vulnerable to fears, which is also reflected by the positive correlation between emotional stability and resilience. Introverted subjects do not enjoy success as much as extroverted subjects, and conscientious subjects have an internal locus of control and score higher on performance motivation. The correlations between personality traits and the economic preference parameters are significant but low. Most correlations are not surprising, such as the negative correlation between internal locus of control and the discount rate, the positive correlation between risk preference and resilience, and the negative correlation between the preference for leisure and negative fear of failure. For the correlation tables, we refer to Borghans, Meijers, and Ter Weel (2006a).

3. The experiments were run at different periods during the day. There were no significant differences across sessions.

IV. RESULTS

A. Which Types Perform Better?

The first question when analyzing the link between noncognitive and cognitive skills is whether personality types are correlated with cognitive skills.[4] Panel A of Table 2 first shows the estimates of a probit model in which we one by one regress personality types on the probability of giving the correct answer. Three different models have been estimated: one without any additional controls; one with controls for the type of cognitive test question; and one with controls for the type of cognitive question, the amount of incentive pay, and the time constraint. Comparison of the three columns shows that there are no large differences between the three different equations. Subjects who report to have higher levels of performance motivation, who have a higher positive fear of failure, and an internal locus of control and those who are more curious have a higher probability of giving a correct answer. In addition, subjects suffering from negative fear of failure have a lower probability of giving the correct answer.[5]

The measures from the 5-factor model of personality structure show that introversion as opposed to extraversion is related to the probability of giving the correct answer. Openness and agreeableness reduce this

4. This analysis includes the answers to questions in the third stage only.

5. Positive fear of failure is associated with tense feelings that improve performance, whereas negative fear of failure is associated with feelings that are harmful for performance.

TABLE 2
Cognitive Test Scores, Personality, and Preferences

	A: The Effect of Personality and Preferences on the Probability of Giving a Correct Answer			B: The Effect of Personality and Preferences on Duration		
Independent Variable	**No Controls**	**Control for Question Type**	**Controls for Question Type, Incentive Pay, and Constraint**	**No Controls**	**Control for Question Type**	**Controls for Question Type, Incentive Pay, and Constraint**
Personality						
Performance motivation	0.067 (3.077)**	0.096 (3.787)**	0.096 (3.699)**	0.030 (2.216)**	0.031 (2.989)**	0.027 (2.857)**
Preference for leisure	−0.024 (−1.039)	−0.036 (−1.346)	−0.037 (−1.373)	−0.046 (−3.253)**	−0.045 (−4.067)**	−0.042 (−4.213)**
Positive fear of failure	0.039 (1.853)*	0.051 (2.106)**	0.058 (2.352)**	0.044 (3.443)**	0.045 (4.471)**	0.046 (5.077)**
Negative fear of failure	−0.080 (−3.523)**	−0.114 (−4.305)**	−0.123 (−4.582)**	0.038 (2.716)**	0.036 (3.329)**	0.033 (3.397)**
Internal locus of control	0.079 (3.361)**	0.121 (4.432)**	0.125 (4.466)**	0.009 (0.611)	0.009 (0.761)	0.009 (0.850)
Social desirability	−0.026 (−0.874)	−0.048 (−1.403)	−0.036 (−1.042)	−0.007 (−0.374)	−0.003 (−0.183)	0.007 (0.530)
Curiosity	0.090 (3.881)**	0.124 (4.582)**	0.125 (4.530)**	−0.014 (−1.013)	−0.016 (−1.418)	−0.017 (−1.644)
Resilience	0.009 (0.392)	0.025 (0.893)	0.021 (0.733)	0.032 (2.198)**	0.027 (2.347)**	0.023 (2.217)**
Enjoyment of success	−0.026 (−1.119)	−0.031 (−1.153)	−0.037 (−1.375)	0.053 (3.764)**	0.049 (4.472)**	0.046 (4.651)**
Attitude toward work	−0.013 (−0.568)	−0.015 (−0.563)	−0.022 (−0.798)	0.016 (1.134)	0.013 (1.223)	0.009 (0.898)
5-factor model of personality structure						
Emotional stability	0.024 (1.135)	0.037 (1.509)	0.036 (1.436)	0.009 (0.701)	0.008 (0.762)	0.003 (0.375)
Introversion	0.061 (3.012)**	0.078 (3.331)**	0.080 (3.379)**	−0.034 (−2.758)**	−0.029 (−3.042)**	−0.031 (−3.584)**
Openness	−0.070 (−4.488)**	−0.099 (−5.415)**	−0.101 (−5.406)**	−0.002 (−0.231)	−0.002 (−0.242)	0.000 (0.028)
Agreeableness	−0.093 (−4.001)**	−0.124 (−4.594)**	−0.134 (−4.849)**	0.053 (3.739)**	0.047 (4.287)**	0.044 (4.395)**
Conscientiousness	0.005 (0.284)	0.009 (0.424)	0.007 (0.302)	0.005 (0.458)	0.008 (0.826)	0.005 (0.625)
Preference parameters						
Discount rate	−0.494 (−4.475)**	−0.690 (−5.366)**	−0.717 (−5.462)**	0.099 (1.465)	0.083 (1.564)	0.097 (2.024)**
Risk preference	−0.110 (−4.424)**	−0.150 (−5.188)**	−0.148 (−4.988)**	0.041 (2.711)**	0.037 (3.136)**	0.050 (4.610)**
Preference for leisure	0.042 (0.781)	0.087 (1.407)	0.077 (1.218)	0.055 (1.668)	0.050 (1.958)*	0.040 (1.714)

Notes: *T* values are given in parentheses. All coefficients are the result from individual regressions.
*Implies significant at the 10% level; **implies significant at the 5% level or below.

probability. Generally, the coefficients of the personality test and the 5-factor model of personality structure are consistent with self-disciplined and motivated subjects achieving higher probabilities of giving the correct answer.

The estimates for the economic preference parameters show that subjects with lower discount rates have a higher probability of giving the correct answer, as well as those who are more risk-averse. The first estimate is consistent with the economic literature suggesting that intelligent people have lower discount rates. The coefficient for risk preference is surprising since the economic literature suggests that more intelligent people are more able to foresee future events and as a result less risk-averse.

Panel B presents estimates for the same models, with duration as the dependent variable. Duration is measured as the log of the number of seconds a subject spends on answering a question. The estimates show that subjects with higher levels of motivation and those who are more eager to do well on the test invest more time in answering a question. This can be seen from the positive coefficients on performance motivation, positive fear of failure, resilience, and enjoyment of success and the negative coefficient for the preference for leisure under personality. Another interesting observation is that the other coefficients are associated with fear of failure, implying that people who are afraid to give the wrong answer spend more time answering the question (e.g., negative fear of failure, enjoyment of success, and agreeableness).

The results from the economic preference parameters show that less risk-averse subjects and subjects with higher discount rates spend more time answering the questions, which could be explained as these persons having lower levels of self-confidence.

B. Who is Sensitive to Incentives?

The mere correlation between personality traits, preference parameters, and cognitive test scores can be the result of causal mechanisms that go in opposite directions. People who are more motivated or more willing to invest might put more effort in their learning and consequently do better on an IQ test, or people with higher cognitive abilities might better understand the importance of certain noncognitive traits and therefore invest more in the development of these traits. A full understanding of these correlations also requires taking parents and teachers into account. In this article, we focus on the question whether noncognitive skills influence the way students perform on a cognitive test, conditional on their true cognitive abilities at the time of the test.

Panel A of Table 3 reports the estimates of the following model:

$$\Pr(C_q) = A + \beta_1 P_q + \beta_2 I_q + \beta_3 (P \times I)_q + \varepsilon_q,$$

where $\Pr(C_q)$ represents the probability of a correct answer to question q, P_q is a personality trait or a preference parameter, I_q is the amount of incentive pay (€0, €0.10, €0.40, or €1.00), $(P \times I)_q$ is an interaction between incentive pay and a personality trait or a preference parameter, and ε_q is an error term with the usual assumptions. The coefficient for the $(P \times I)_q$ term is of interest because it reveals the responsiveness of different types to incentive pay. There are two potential ways in which a student can adjust his efforts when answering questions in an IQ test. First, subjects might think harder about a question and as a result obtain a higher probability of giving the correct answer. Second, subjects might invest more time on each question. To disentangle these effects, we varied the time restrictions for the questions in the test. We estimate two version of this model. First, we estimate the model in which we only consider the case in which there is no time constraint for answering a question. Second, we estimate the model with dummies for the different time constraints (no constraints, 60 or 30 sec). Both models include fixed effects for the type of cognitive test question.

We only report the coefficients on $(P \times I)_q$, as the coefficients for P_q are generally similar to the ones presented in Table 2. A positive (negative) coefficient implies that subjects obtain higher (lower) scores when they receive incentive pay. Almost all coefficients are insignificant, revealing no substantial differences between personalities in improving scores when incentives are introduced. This can be the result of either a low preference for money or the inability to respond to incentives by improving scores. Including our measure for

TABLE 3
The Responsiveness of Personality Traits and Preference Parameters to Incentive Pay

	A: Probability of Giving a Correct Answer		B: Duration	
Independent Variable	**No Constraints $(P \times I)_q$**	**Fixed Effects for Constraints $(P \times I)_q$**	**No Constraints $(P \times I)_q$**	**Fixed Effects for Constraints $(P \times I)_q$**
Personality				
Performance motivation	0.010 (0.085)	−0.101 (−1.537)	−0.130 (−2.624)**	−0.079 (−3.158)**
Preference for leisure	−0.097 (−0.812)	0.078 (1.091)	0.181 (3.681)**	0.061 (2.368)**
Positive fear of failure	0.060 (0.496)	−0.005 (−0.077)	0.045 (0.951)	0.000 (0.010)
Negative fear of failure	0.008 (0.065)	0.024 (0.352)	0.183 (3.576)**	0.047 (1.770)
Internal locus of control	0.004 (0.033)	−0.063 (−0.871)	−0.139 (−2.455)**	−0.037 (−1.336)
Social desirability	−0.126 (−0.742)	−0.107 (−1.207)	−0.087 (−1.217)	−0.055 (−1.783)
Curiosity	0.048 (0.372)	−0.013 (−0.191)	−0.120 (−2.228)**	−0.052 (−2.080)**
Resilience	0.151 (1.239)	−0.074 (−1.024)	−0.080 (−1.442)	0.004 (0.142)
Enjoyment of success	0.259 (1.953)*	0.069 (0.990)	−0.078 (−1.372)	0.001 (0.020)
Attitude toward work	0.022 (0.178)	−0.061 (−0.875)	−0.049 (−0.940)	0.025 (0.959)
5-factor model of personality structure				
Emotional stability	0.201 (1.777)	−0.036 (−0.564)	−0.106 (−2.086)**	0.008 (0.317)
Introversion	−0.113 (−0.996)	0.042 (0.668)	0.085 (1.797)	−0.024 (−1.028)
Openness	−0.037 (−0.448)	0.011 (0.226)	0.114 (3.390)**	0.064 (3.622)**
Agreeableness	−0.033 (−0.269)	−0.158 (−2.251)**	0.002 (0.034)	0.027 (1.038)
Conscientiousness	0.134 (1.377)	0.055 (0.940)	−0.112 (−2.676)**	−0.043 (−2.000)**
Preference parameters				
Discount rate	1.356 (2.228)**	−0.240 (−0.716)	−0.869 (−3.311)**	−0.242 (−2.017)**
Risk preference	0.074 (0.523)	−0.011 (−0.137)	−0.246 (−4.244)**	−0.050 (−1.810)*
Preference for leisure	0.265 (0.875)	0.063 (0.383)	−0.389 (−3.061)**	−0.099 (−1.674)

Notes: T values are given in parentheses. All coefficients are the result from individual regressions.
*Implies significant at the 10% level; **implies significant at the 5% level or below.

the preference for money or the value of time does not change the results, suggesting that the results are not shaped by differences in the preference for money. The estimates are also consistent with the figures presented in Table 1 where we showed that subjects do not seem to be able to improve scores when we introduce incentive pay.

Panel B of Table 3 reports the estimates of the same models for duration:

$$D_q = A + \beta_1 P_q + \beta_2 I_q + \beta_3 (P \times I)_q + \varepsilon_q,$$

where D_q is the log of the time taken to answer each question. From this analysis, it becomes clear that subjects do respond to incentives in the sense that they invest more time in answering the questions. This is consistent with the numbers in Table 1. The $(P \times I)_q$ coefficients for successful traits are negative, which implies that subjects with higher scores for these traits invest less time in answering a question when there is incentive pay compared to those who score lower on this trait. The coefficients for performance motivation suggest that subjects who are intrinsically motivated tend to think longer when answering a question but less so if they are paid relative to subjects who are less motivated. The same goes for curious persons and those who have a relative internal locus of control. When looking at the coefficients for the 5-factor model of personality structure, the same result is obtained for relatively emotionally stable and conscientious persons. Finally, the economic preference parameters point into the

opposite direction. In particular, subjects with lower discount rates are more sensitive to incentive pay and invest less in general. On the other hand, risk-averse persons spend less time when there is no incentive pay and respond stronger to incentive pay.

The general message from these estimates is that particular types of persons seem to be more or less sensitive to incentive pay, although the effects on scores are limited.

C. Implications for Economic Theory

The overall picture emerging from the estimates presented in this article is that our estimates are consistent with different explanations. Motivation and self-discipline seem to be important traits to be successful in real life (e.g., Duckworth and Seligman 2005; Heckman and Rubinstein 2001), and people with these traits generally perform better on the cognitive test (Table 2). However, the response to incentives is twofold.

First, it might be the case that people with successful characteristics respond stronger to incentives because they are economically rational and are only interested in optimizing income. This implies that people with successful traits under-perform on cognitive tests if there is not much at stake. Such a theory is consistent with the findings of Heckman and Rubinstein (2001) who reported that high school dropouts obtaining a GED do equally well on cognitive test scores but lack motivation and self-discipline to succeed in most jobs.

Second, it might be the case that people with successful characteristics are always motivated to do their best and do not calculate the net benefits of every action. This shows that persons with favorable noncognitive skills over-perform on cognitive tests.

Our estimates of the responsiveness of economic preference parameters to financial incentives point toward the rational economic model, while our estimates of the personality traits and the 5-factor model of personality structure point toward the second view in which highly motivated people try as hard as they can. Perhaps, persons with low discount rates respond more to incentives because they are more intelligent and rational. Such an interpretation would be consistent with the findings in Table 1 and those of Frederick (2005) who showed that more intelligent people have lower discount rates. On the other hand, estimates for the personality traits show that favorable traits such as performance motivation, internal locus of control, emotional stability, and conscientiousness go along with lower responses to financial incentives. Reviewing the correlations between the economic parameters and the personality traits and the measures of the 5-factor model of personality structure reveals a relatively low correlation coefficient. Our reading of the evidence is that apparently these measures are capturing different dimensions of traits and preferences. This observation is strengthened by the at first sight inconsistent correlation between preference for leisure measured as personality trait and preference for leisure measured in the way economists tend to think about preference for leisure (giving up money for leisure time).

V. CONCLUSIONS

This article has presented the first direct estimates of the impact of noncognitive skills on cognitive test scores. Our estimates show that subjects respond to financial incentives by investing more time in answering a question. This investment is generally not increasing test scores. In an effort to determine whether different types of persons respond differently to financial incentives, we find that favorable economic preference parameters, such as low discount rates and low risk aversion, are associated with strong responses to incentives. On the other hand, favorable psychological characteristics, such as performance motivation and internal locus of control, are associated with lower responses to financial incentives.

Research in this area is relatively new and much can be learned from establishing solid links between the psychological and economic literature. Psychologists have measured behavior and traits in many ways, whereas economists have focused on preference parameters. Our estimates suggest that both are capturing different dimensions of preferences and traits. Research is needed to improve understanding concerning the links between these fields to be really able to capture the effects of noncognitive skills and behaviors on cognitive test scores and economic outcomes.

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