How do Incentives affect Creativity?

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How do Incentives affect Creativity?*

Katharina Eckartz†  Oliver Kirchkamp†  Daniel Schunk§

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Abstract

We compare performance in a word based creativity task under three incentive schemes: a flat fee, a linear payment and a tournament. Furthermore, we also compare performance under two control tasks (Raven’s advanced progressive matrices or a number-adding task) with the same treatments. In all tasks we find that incentives seem to have very small effects and that differences in performance are predominantly related to individual skills.

Keywords: Creativity, Incentives, Real effort task, Experimental economics

JEL Classification: C91, J33

1 Introduction

Innovation and creativity are receiving increasing attention in research. In business, for example, a discussion emerged on how to set the conditions to achieve an optimal level of employee creativity. One potentially influential factor is the payment scheme. While it is difficult to examine this mechanism with field-data, the incentive-research in experimental and behavioural economics has mainly focused on stated effort experiments[1]. Laboratory experiments that involved real-effort tasks focused largely on production tasks, which were cognitively undemanding and did not require creativity. In this paper we attempt to close this gap and examine the impact of different payment-schemes on a creative, real effort task.

[4] This type of task has been used in many gift-exchange experiments; for an overview see Gächter & Fehr (2002)

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1 This type of task has been used in many gift-exchange experiments; for an overview see Gächter & Fehr (2002).
Classic microeconomic labor supply theory suggests that people will provide more effort under performance-pay, irrespective of the task. This holds true also for cognitive tasks, if one regards thinking as a costly activity, as (some) economists do (discussed in Camerer & Hogarth, 1999). There are, however, several examples from the field in which incentives work counterproductively. Camerer et al. (1997) find that New York City Cabdrivers work less when their hourly payment is high. Dandy et al. (2001) find that basketball players perform better during training than during the actual game. Ariely et al. (2009) perform a controlled experiment in rural India where they find that performance can decrease when incentives are high.

Having said that, there are several laboratory experiments with simple real effort production tasks which find a positive impact of incentives on effort. Fahr & Irlenbusch (2000) find that their participants crack more walnuts when their wage is higher. Dickinson (1999)'s participants type more letters when their compensation depends more on their performance. van Dijk et al. (2001) observe that solutions for a two-variable optimisation task are better if payment is based on a tournament.

Incentives in the lab, however, are not always increasing performance. Gneezy & Rustichini (2000) find that payments for performance in an IQ-test actually decrease performance if these payments are too small. Henning-Schmidt et al. (2005) find no positive wage-effort relation when participants in an experiment type abstracts into a computer.

What should we expect for an experiment on creativity? Following standard labor supply theory, participants should perform better under performance-pay as compared to a flat fee. However, one factor that is completely neglected by this approach is that working on some tasks may be in itself rewarding and people might be intrinsically motivated. This may be specifically true for creative tasks. Introducing incentives in such tasks might crowd out intrinsic motivation and therefore not lead to the desired result.

Styhre (2008) examined in an empirical study which incentives motivate researchers. In an occupation like research where both creativity and serendipity play an important role Styhre concludes that the main factor that motivates scientists are not monetary rewards or career opportunities but the excitement of discovering an unknown domain. Due to the dependence on serendipity, a researcher’s motivation to be creative decreases when being under constant pressure to deliver outputs or to fulfil increasing demands.

A related experimental study, focusing on innovation, is Ederer & Manso (2008). They study behaviour of participants in an experiment who operate an

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2There is a large body of experimental psychological research on creativity among others by Amabile and her co-authors as well as by Sternberg and co-authors. This research focuses however, when looking at rewards, mainly on reward- versus non-reward scenarios. From this research it seems that the effects of rewards on creativity depend among others on the task type, the initial levels of intrinsic motivation and the salience of the extrinsic reward. While Amabile notes that it is easier to find laboratory conditions which decrease creative performance, she also identifies conditions under which intrinsic motivation and extrinsic rewards can be additive.

3Motivational crowd out is also discussed in the experimental literature in the context of imposing minimal-effort levels and monitoring (among others Falk & Kosfeld (2006) and Ziegelmeyer et al. (2011).)
artificial lemonade stand which profits depended on the chosen location (explo-
ration) and the product-characteristics (exploitation), while the optimal product-
mix was different for the various locations. Ederer & Manso then compared dif-
ferent wage-schemes: fixed wage, performance-based-pay and an “exploration
contract”. The latter is a partly-performance-based-pay contract: the payoffs de-
pended on the profits during the second half of the experiment. This gave subjects
the possibility to first explore and by that included a “tolerance for early failure”.
The authors find that this exploration contract performs better than standard fixed
wage or performance-based-pay contracts. In contrast to Ederer & Manso who use
an exploration task we will put our focus on creativity.

We will describe our experiment in section 2, report our results in section 3
and conclude in section 4.

2 Experiment

2.1 Tasks

In this study we investigate in a within-subject design how participants perform
under different incentive schemes in a task, which requires not only cognitive
efforts but also creative thinking. We run a pure cognitive effort task as a control.
Finding a task for the experiment that requires creative thinking did not turn
out to be easy. Requirements were that the quality of the solution is easy to assess
and that the task remains interesting when it is repeated. Specific problems like
insight problems (e.g. Schooler et al. 1993) or packing quarters into a box, a task
which has been used by Ariely et al. 2009, are easy to assess but can be used for
each participant only once. After a single round of a treatment participants have
understood the problem and will, with or without incentives, quickly be able to
apply the solution again.4

Open tasks like “painting a creative picture” might remain interesting even af-
after several pictures, but it would be hard for the experimenter to judge the quality
of the solutions that are produced in the laboratory. The “standard” procedures to
use experts (Amabile 1996), one or more researchers, a larger group of students,
or a web based tool (Girotra et al. 2009), to assess the quality of submissions
would all take too much time in a repeated laboratory experiment. Here we will
use tasks that can be quickly and mechanically rated by the computer.

Word task: In our study we use a word task5 as our creative thinking task:
participants are presented with an alphabetically ordered letterset, consisting of
12 letters, e.g. accdeeeginrst. Participants have to construct as many words as
they can within 5 minutes. Rewards were more than proportionally increasing
with the length of the created word (see section 2.2 for a detailed overview). Table
1 gives some examples of words that can be constructed with these letters as well

4For insight problems, like the well-known candle problem Duncker & Lees 1945, partici-
pants that came across the problem before will immediately know the solution.
5This task is partially inspired by word games like Scrabble, partially by a task that Crosetto
2010 used to simulate sequential innovation in the lab.
Table 1 Example: words that can be constructed with acdeeeeginst

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>1 point</td>
</tr>
<tr>
<td>ac</td>
<td>1+2=3 points</td>
</tr>
<tr>
<td>and</td>
<td>1+2+3=6 points</td>
</tr>
<tr>
<td>teasing</td>
<td>1+2+3+4+5+6+7=28 points</td>
</tr>
<tr>
<td>accidents</td>
<td>1+2+3+4+5+6+7+8+9=45 points</td>
</tr>
</tbody>
</table>

as the resulting points. Appendix A.1 shows all English words that a participant could find for the above letterset. Appendix A.2 shows all German words for a similar letterset.

We find that such a “word task” has many aspects of a creative task and that it mimics quite well a creative innovation. Whenever an inventor invents something, an idea is generated and tested against the inventor’s model of nature. The Eureka! moment is the realisation that the idea, often a composition of several simpler principles, passes this test. Similarly in our word task participants have to generate words (not entire ideas, though) and test these words against a simple model of nature, here a dictionary. We concede that the pure exploration aspect of research is not captured by our task. E.g. a developer of a drug who has no idea at all what type of drug might work and who is exploring the range of possible drugs in an unsystematic way is not captured by our model. We suspect, however, that many inventors have a quite good model of the world which is relevant for them, that they search in a structured way for solutions, and that a main and creative ingredient of invention is the realisation that ingredients A, B, and C can be combined in a clever way in order to create D. Patented inventions like the suspension bridge, the commutator type electric motor, the Yale lock, the sewing machine, the safety pin, the mouse trap, barbed wire, the ball-point pen, the zipper, the adjustable wrench, disk brakes, the supermarket, frozen food, the banana protective device, the ice cream bar, the monopoly game, the Lego brick, or the bathing suit are all obvious once one “gets the idea”. In all these cases getting the idea meant putting the underlying principles together.

When designing the lettersets we were aiming at using lettersets which are very similar to each other on a number of potentially relevant dimensions. To create these lettersets we first randomly build 100 000 different lettersets and then determined which words could be constructed out of each set by comparing possible words with the German isoword-list (Knutzen, 1999). This list contains 294897 different words, including forms of words, names, abbreviations, but no swearwords. For all our 100 000 different lettersets we calculated the number of points which could potentially be constructed with each of the lettersets and finally chose the lettersets which were similar in three dimensions: the number of points that could be earned, the number of words that could be created and the similarity among the words. The resulting eight lettersets are displayed in table 2.

After a pilot in which we used all 8 lettersets, we dropped the 2 best- and the

6 Since we ran the experiment in Germany, we used German words.
7 We used the fstrcmp form GNU Gettext 0.17 to calculate for each word the similarity to the most similar word in the set.
Table 2 Lettersets

<table>
<thead>
<tr>
<th>letters</th>
<th>points</th>
<th>words</th>
<th>similarity within</th>
</tr>
</thead>
<tbody>
<tr>
<td>aceehinrssä</td>
<td>5501</td>
<td>323</td>
<td>0.886879</td>
</tr>
<tr>
<td>cdehhlorsstt</td>
<td>5445</td>
<td>323</td>
<td>0.886458</td>
</tr>
<tr>
<td>aehkllprstt</td>
<td>5386</td>
<td>326</td>
<td>0.886948</td>
</tr>
<tr>
<td>aeeeggllmnru</td>
<td>5430</td>
<td>323</td>
<td>0.886883</td>
</tr>
<tr>
<td>dehhimnprrt</td>
<td>5449</td>
<td>321</td>
<td>0.886626</td>
</tr>
<tr>
<td>aaeehhiknstt</td>
<td>5503</td>
<td>329</td>
<td>0.886679</td>
</tr>
<tr>
<td>cdeellrssttw</td>
<td>5427</td>
<td>327</td>
<td>0.887130</td>
</tr>
<tr>
<td>deegilmnnpuw</td>
<td>5405</td>
<td>322</td>
<td>0.887139</td>
</tr>
</tbody>
</table>

Table 3 Raven’s matrices

<table>
<thead>
<tr>
<th>Subset</th>
<th>matrix number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1, 4, 7, 10, 13, 16, 19, 22, 25, 28, 31, 34</td>
</tr>
<tr>
<td>2</td>
<td>2, 5, 8, 11, 14, 17, 20, 23, 26, 29, 32, 25</td>
</tr>
<tr>
<td>3</td>
<td>3, 6, 9, 12, 15, 18, 21, 24, 27, 30, 33, 36</td>
</tr>
</tbody>
</table>

2 worst-scoring ones. Table 4 shows which lettersets were used in the final experiment. During the experiment participants received a feedback after each word-submission on whether the word they entered was accepted, entered wrongly or had been entered before. All correct words were shown as a list on the screen. Participants were not informed about how many points they had.

**Control tasks:** The control tasks differ between the two experimental series. In the first and main experimental series this control task was an IQ-task. In the second experimental series this control task was a number-adding task.

**IQ task:** The IQ-task was based on an intelligence test, Raven’s advanced progressive matrices, set II (see Raven et al., 1998). Raven’s matrices are designed to measure eductive ability: the ability to make sense of complex facts and reproductive ability, i.e. the ability to store and reproduce information. These two components had been identified by Spearman (1923, 1927) as being the two main components of general cognitive ability. The version of Raven’s matrices we used in this experiment was the one designed for subjects with high ability. The set consists of 36 matrices which are increasingly difficult. Since we also wanted to use a within participants design for the intelligence task we split this set into three subsets: the matrices were alternatingly distributed on the three subsets to ensure that the three subsets are of approximately the same difficulty (see table 3).

**Number-adding task:** In a second experimental series we replace the IQ-task with a number-adding task, similar to the one used by Niederle & Vesterlund (2007): participants had to add for five minutes five two-digit numbers. Participants were allowed to use scratch-paper for their calculations. Moreover, after

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8E.g.: 12 + 73 + 05 + 56 + 60. The numbers were drawn randomly. The same numbers were presented to all participants in the same order.
each summation, participants received feedback on whether their solution was correct.

While the performance in the IQ-task may depend mainly on ability, the number adding task depends clearly, as also Niederle & Vesterlund note, on skill and effort. In our opinion the skill component in this task should be less pronounced than in the IQ-tasks, which may lead to more response to the experimental treatments than the pure IQ-task.

**Questionnaire:** At the end of the experiment participants answered a questionnaire including questions on participants’ task-interest for the two tasks as well as how much they enjoyed working on the two tasks. Moreover we collected demographics and language skills. Since preferences for payment-schemes might be related to the participants’ risk-preferences, we elicited those at the end of the experiment using the risk-question of Dohmen et al. (2011).

### 2.2 Treatments

We are interested in differences in participants’ performance under different payment schemes in a given time. In this experiment we compared three different schemes: a flat fee regime, a linear payment regime and a tournament. All parameters were calibrated such that the expected payment for the experiment that lasted for approximately one hour was about 10€. This is considerably more than the average hourly wage of a student assistant at the University of Jena. In this experiment the focus is on how different treatments influence the effort provided by the experimental subjects. Higher effort will result in higher output only if the match between the task and the subject is good enough as, among others, Camerer & Hogarth (1999) argue. We believe that our mainly student subject pool satisfies this criterion.

The experiment consisted of seven stages, each lasting five minutes. In each treatment participants always started with the creativity task and afterwards solved the control task with the same incentive scheme. We varied the sequence of treatments to rule out order effects. No feedback was given during the experiment. Table 4 provides an overview.

During the experiment participants received points for correct solutions. At the end of the experiment one of the seven stages was randomly selected for payment. The respective number of points was converted to Euros with an exchange rate of 1 point = 0.04€. In the flat scheme participants received 250 points (=10€) irrespective of their performance. In all three conditions the instructions asked the participants to build as many and as long words as possible. In the two performance-pay conditions, we rewarded the obvious increasing difficulty to construct long words with more than proportionally more points. More

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9 Dohmen et al. (2011) included the question in the 2004 wave of the German Socio Economic Panel. They found this question to be correlated with real risk-taking behavior while a lottery choice did not predict real risk-taking behavior as well as the simple question.

10 In contrast to other studies who focus on the provided working-time.

11 We do this to prevent participants from hedging between stages.
specifically, points were awarded such that participants received for every cor-
rect word they produced 1 point for the first letter, 2 points for the second, 3 for
the third and so on. This means that a word with 5 letters was awarded with
5+4+3+2+1 = 15 points (see table[1]). In the control task the number of points per
correct solution was constant: every correctly solved IQ-task was awarded with
60 points while every correctly solved number-adding task was awarded similarly
with 25 points [12]. In the tournament participants were matched with three other
participants and the number of acquired points was compared for the respective
task. A winning participant was awarded 25 (if that condition was chosen for
payment) and a losing participant was compensated with 5. The size of these
prizes was chosen such that the winning prize was substantially higher than the
size of the losing prize. We decided not to use a “winner-takes-it-all” design in
the tournament but to also compensate the losing participants with a small prize
to give participants a small compensation for showing up and putting effort into
the experiment [13].

The last stage of the experiment was a self-selection stage. Participants could
choose which of the previously experienced payment-schemes they preferred for
the subsequent word-production-task. If they opted for the tournament condition
their performance was compared to the previous performance of their matching
group members in the first tournament-condition. This was done to avoid con-
 founding preferences for a payment-scheme with beliefs about who might enter a
tournament [14]. We included the self-selection stage as this allows us to investigate
several questions: who selects which payment-scheme, do we find differences in

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12 The piece-rate in the IQ-task and the creativity task were based on our pilot experiment, the
piece-rate in the number-adding task was based on the average number of correct solutions in

13 If in the end a tournament stage was chosen for payment, then points were compared within
a group of four participants who were all facing the same sequence of treatments. Eventual ties
were broken randomly and automatically. Otherwise, participants were working independently
throughout the experiment. They received no information about the identities or the results of
other participants.

14 See, e.g., Niederle & Vesterlund (2010).
performance following self-selection and if so, whether this represents sorting. Niederle & Vesterlund (2007) find gender-differences in the choice of the preferred payment scheme in their number-adding-task: having to chose between a tournament and a linear payment scheme, 73% of the men and less than half as many women (35%) chose the tournament. In a stated-effort experiment Eriksson et al. (2009) look, among others, on the impact of risk preferences and find that risk-averse subjects are less likely to enter tournaments.

2.3 Conducting the experiment

The main experiment was conducted in November and December 2010 in the laboratory of the Friedrich-Schiller-University in Jena. Three additional sessions were run in June 2011. In total the experiment was run in 13 sessions, each having between 14 and 18 participants. In total 216 participants took part in the experiment, of which 50 participated in the second experimental series. Since the experiment contains a tournament treatment, we deliberately invited an equal number of men and women for every session so that potential group-composition effects concerning gender are kept as similar as possible. Small differences are due to non-show-ups. Overall, however, the gender composition was balanced within and across sessions (see the left graph in Figure 10 in the appendix). Before the experiment started participants were waiting in the corridor, so they were aware of the composition of the experimental group.

Of the 216 participants, 198 were undergraduate students of a broad variety of fields of study. The average age of all participants was 23.7. Participants were recruited on-line using ORSEE (Greiner, 2004).

At the end of the experiment the computer chose one of the 7 stages for payment. The payment-procedure was as follows: we first distributed the receipts and then participants exchanged signed receipts for an envelope with their payment. All sessions lasted for about one hour. The average payment amounted to 10.31 €.

The language of instruction was German and participants were informed in the invitation to the experiment that knowledge of German at the level of a native speaker was necessary to be able to participate in the experiment. They also knew that they had to pass a short language-test previous to the experiment (unless they had already passed this test during an earlier experiment). Only participants who had passed this test were admitted to the experiment. The experiment was programmed browser-based using PHP in combination with a MySQL database and an Apache server. All entered words were spell-checked and only words which were spelled correctly were accepted. The browser-settings were set such that the participants saw the experiment on a full screen, just like in any other experiment. The use of the keyboard was restricted such that participants neither had the possibility of moving back- or forwards in the experiment nor could they leave the full-screen mode.

\[15\] The IQ-task was used as a control-task in the experiments in 2010 while the number-adding task was used in the three experiments in June 2011.

\[16\] Nobody in the experiment was aware of the identity or gender of their matching group members.
3 Results

Questionnaire data Since the creative task requires very good knowledge of German, we not only required the participants to pass a short language test, but in addition participants also rated their language skills on a scale from 1 to 5, where 1 represented no knowledge of the language and 5 represented knowledge at the level of mother tongue. The average self-reported language-knowledge of German was 4.8 on a scale from 1 to 5. In addition information about the knowledge of other languages was also collected. The distribution of the language competence for German and other languages is shown in figure 1.

We also collected information about the participants’ hobbies, in particular whether they enjoy reading, discussing, solving crossword puzzles, playing scrabble, being creative and solving logic-puzzles. While the first four obviously are related to the lexis of the participants and their joy of doing word-related task, the last one is collected to have a control variable which might be related to solving Raven’s Matrices (Figure 2). To assess participants’ interest for creative tasks, we included in addition to the question about creativity as a hobby also a questionnaire on self-reported creative potential in the post-experimental questionnaire (DiLiello & Houghton 2008). An overview is given in Figure 3.

Risk-preferences were elicited with the risk-question (Dohmen et al. 2011) which is a 11-point scale, reaching from 0 (being very risk-averse) to 10 (being very risk-loving). The distribution is shown in Figure 3.

Aggregate performance To assess whether we rely on different or rather similar skills with the different tasks we show 95% confidence intervals (based on an ABC bootstrap) for correlations of the performance for the different tasks in figure 4. We see that participants who perform well in one stage in the word task also perform well in the next stage. Similarly, performance within each of the control tasks is correlated. However, correlation of performance in the word task with
Figure 2 Hobbys and interest in languages

<table>
<thead>
<tr>
<th>Hobby</th>
<th>Never</th>
<th>A Little</th>
<th>Medium</th>
<th>A Lot</th>
</tr>
</thead>
<tbody>
<tr>
<td>scrabble</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>read</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>logic</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>discuss</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>crossw</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>creative</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

Interest in languages

1=very low, 4=very high

Figure 3 Creativity and attitude toward risk

Creative potential score

Risk attitude

0=risk averse, 10=risk loving
The segments show 95%-confidence intervals (based on ABC bootstraps). The left graph shows data from the treatment with words and IQ-task, the right graph shows data from the treatment with words and number-adding.

The average contribution of the regressors to the $R^2$ (following Lindeman et al., [1980] p. 119ff) is shown in table 5. We find that for all treatments, words, IQ, and number-adding, the impact of the incentive scheme on performance is very small compared to individual heterogeneity (measured as “subject”) or even compared to learning (measured as the “stage”).

To assess the magnitude of the effect in absolute terms we estimate the following mixed effects equation:

$$\text{Performance} = \beta_0 + \sum_{\text{Incent.}} \beta_{\text{inc.}} \cdot d_{\text{inc.}} + \varepsilon_{\text{stage}} + \varepsilon_{\text{subj.}} + \varepsilon_{\text{subj.} t}$$  \hspace{1cm} (2)
Table 6 Estimation results for equation (2) for words

<table>
<thead>
<tr>
<th></th>
<th>$\beta$</th>
<th>$\sigma$</th>
<th>$t$</th>
<th>p value</th>
<th>95% conf interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>256</td>
<td>33.9</td>
<td>7.54</td>
<td>0.0000</td>
<td>189 322</td>
</tr>
<tr>
<td>linear</td>
<td>14.7</td>
<td>9.05</td>
<td>1.62</td>
<td>0.1056</td>
<td>-3.11 32.5</td>
</tr>
<tr>
<td>tournament</td>
<td>15.7</td>
<td>8.96</td>
<td>1.75</td>
<td>0.0804</td>
<td>-1.91 33.3</td>
</tr>
</tbody>
</table>

Table 7 Estimation results for equation (2) for IQ

<table>
<thead>
<tr>
<th></th>
<th>$\beta$</th>
<th>$\sigma$</th>
<th>$t$</th>
<th>p value</th>
<th>95% conf interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>6.16</td>
<td>1.46</td>
<td>4.23</td>
<td>0.0000</td>
<td>3.29 9.02</td>
</tr>
<tr>
<td>linear</td>
<td>0.14</td>
<td>0.181</td>
<td>0.775</td>
<td>0.4391</td>
<td>-0.216 0.497</td>
</tr>
<tr>
<td>tournament</td>
<td>0.231</td>
<td>0.182</td>
<td>1.27</td>
<td>0.2055</td>
<td>-0.127 0.589</td>
</tr>
</tbody>
</table>

the residual. Estimation results for words, IQ, and number-adding are shown in Tables 6, 7, and 8 respectively. While the treatment effects are small for all tasks, they are not significant for both control tasks and only significant at a 10%-level in the word task.

Complexity and originality
In reality, firms might not mainly be interested in the number of creative answers to one question, but rather in having one single high-quality solution. Above we have seen that incentives do not change very much the overall productivity of participants in our experiment. It might still be that incentives affect the quality. In the context of our word task we might suspect that incentives have an effect on complexity or originality.

E.g. with the letterset acddeegginst a participant could produce many short and simple words like a, i, dan, or ian. A participant could also think harder and produce longer and more complex words like accidents or deceasing. Since accidents has a value of 45 points and dan has only a value of 6 points some participants might find it more profitable to spend more time looking for longer words.

Another relevant dimension might be originality of the product. Participants might resort to a sequence of rather similar items like cease, ceased, and ceasing or they might turn out to be more original and create words that are more diverse like denis, ideas, stance, etc. We measure dissimilarity as the Jaro-Winkler Distance of successive words (Jaro, 1989, Winkler, 1990).

Table 8 Estimation results for equation (2) for number-adding

<table>
<thead>
<tr>
<th></th>
<th>$\beta$</th>
<th>$\sigma$</th>
<th>$t$</th>
<th>p value</th>
<th>95% conf interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>10</td>
<td>2.32</td>
<td>4.31</td>
<td>0.0000</td>
<td>5.4 14.6</td>
</tr>
<tr>
<td>linear</td>
<td>0.085</td>
<td>0.65</td>
<td>0.131</td>
<td>0.8963</td>
<td>-1.21 1.38</td>
</tr>
<tr>
<td>tournament</td>
<td>0.22</td>
<td>0.653</td>
<td>0.337</td>
<td>0.7368</td>
<td>-1.08 1.52</td>
</tr>
</tbody>
</table>
We estimate the following two equations:

\[
\text{Length} = \sum_{\text{Subjects}} \beta_{\text{subj}} \cdot d_{\text{subj}} + \sum_{\text{Stages}} \gamma_{\text{st}} \cdot d_{\text{st}} + \sum_{\text{Incentives}} d_{\text{inc}} \cdot \delta_{\text{inc}} + \epsilon_i \tag{3}
\]

\[
\text{Distance} = \sum_{\text{Subjects}} \beta_{\text{subj}} \cdot d_{\text{subj}} + \sum_{\text{Stages}} \gamma_{\text{st}} \cdot d_{\text{st}} + \sum_{\text{Incentives}} d_{\text{inc}} \cdot \delta_{\text{inc}} + \epsilon_i \tag{4}
\]

Table 9 also shows the average contribution of our regressors to the $R^2$ (Lindeman et al. 1980, p. 119ff) for equations (3) and (4). For comparison the table also shows the contributions to the equation for performance, equation (1). Similar to productivity (see above) also the (aggregate) impact of incentives on the type of the product, either measured as size (word length) or diversity (Jaro-Winkler distance) is very small.

To measure the absolute magnitude of the effect we also estimate the following mixed effects model:

\[
\text{Length} = \beta_0 + \sum_{\text{Incentives}} \beta_{\text{inc}} \cdot d_{\text{inc}} + \epsilon_{\text{stage}} + \epsilon_{\text{subj.}} + \epsilon_{\text{subj.,t}} \tag{5}
\]

Estimation results are shown in Table 9. We see that incentives do have a positive impact on word length, however, only the effect of linear incentives is significant.

To measure the absolute impact of incentives on originality we estimate the following mixed effects equation:

\[
\text{Distance} = \beta_0 + \sum_{\text{Incentives}} \beta_{\text{inc}} \cdot d_{\text{inc}} + \epsilon_{\text{stage}} + \epsilon_{\text{subj.}} + \epsilon_{\text{subj.,t}} \tag{6}
\]

Estimation results are shown in Table 10. The impact of incentives is positive, but small and not significant.

**Individual heterogeneity** Although aggregate reaction to incentives is low (as we have seen above), sensitivity to incentives varies from individual to individual. To measure individual sensitivity to incentives we estimate the following regression

\[
\text{Performance} = \sum_{\text{Incentives}} (\beta_{\text{inc}} \cdot d_{\text{inc}}) + \sum_{\text{Histories}} \beta_{\text{hist}} \cdot d_{\text{hist}} + \epsilon_{\text{subj.,inc.}} \tag{7}
\]
where $\epsilon_{\text{subj,inc.}}$ measures the (remaining) individual component of sensitivity. Figure 5 shows the joint distribution of $\epsilon_{\text{subj,inc.}}$ for the different incentive schemes for the word task. We see that residual performance $\epsilon_{\text{subj,inc.}}$ for the different incentives is always positively correlated. Participants who perform relatively well under one incentive mechanism also perform well under the other.

We find the same effect for IQ (Figure 6) and for number-adding (Figure 7). In all cases performance is positively (and significantly so) correlated.

**Self-selection:** In the last stage of the experiment subjects have the choice to select the payment scheme for another round of the word task. We see from Figure 8 that flat incentives are slightly more popular (40.74%), in particular for females (45.45%), while males seem to be relatively more interested in linear incentives (35.85%). Tournaments seem to be the least favoured choice (chosen by 28.3% of males and 26.36% of females). In contrast to Niederle & Vesterlund (2007), who find that significantly more male than female participants chose the tournament over a linear payment-scheme, we do not observe gender-differences in the likelihood of selecting the tournament. We can, however, not say where this difference
Individual sensitivity to incentives for the numbers task, equation (7)

![Figure 7](image)

\[ r = 0.639, [0.478, 0.790] \]
\[ r = 0.627, [0.445, 0.766] \]
\[ r = 0.760, [0.593, 0.860] \]

(95% confidence intervals for correlations are based on an ABC bootstrap)

### Table 11: Multinomial logit for treatment selection in the final stage, equation (8)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>( \beta )</th>
<th>( \sigma )</th>
<th>( t )</th>
<th>( p ) value</th>
<th>95% conf interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear (intercept)</td>
<td>-2.94</td>
<td>0.731</td>
<td>-4.02</td>
<td>0.0001</td>
<td>-4.38 -1.51</td>
</tr>
<tr>
<td>Tournament (intercept)</td>
<td>-2.4</td>
<td>0.723</td>
<td>-3.32</td>
<td>0.0009</td>
<td>-3.82 -0.982</td>
</tr>
<tr>
<td>Linear: points</td>
<td>0.00218</td>
<td>0.000621</td>
<td>3.51</td>
<td>0.0005</td>
<td>0.000961 0.00339</td>
</tr>
<tr>
<td>Tournament: points</td>
<td>0.00157</td>
<td>0.00063</td>
<td>3.48</td>
<td>0.0130</td>
<td>0.000331 0.0028</td>
</tr>
<tr>
<td>Linear: risk</td>
<td>0.239</td>
<td>0.0838</td>
<td>2.85</td>
<td>0.0044</td>
<td>0.0743 0.403</td>
</tr>
<tr>
<td>Tournament: risk</td>
<td>0.19</td>
<td>0.0839</td>
<td>2.27</td>
<td>0.0233</td>
<td>0.0258 0.355</td>
</tr>
<tr>
<td>Linear: female</td>
<td>-0.547</td>
<td>0.348</td>
<td>-1.57</td>
<td>0.1156</td>
<td>-1.23 0.135</td>
</tr>
<tr>
<td>Tournament: female</td>
<td>-0.321</td>
<td>0.352</td>
<td>-0.912</td>
<td>0.3617</td>
<td>-1.01 0.369</td>
</tr>
</tbody>
</table>

"Flat" is the reference treatment. Effects are shown for the treatments "linear" and "tournament".

in observations stems from: whether it is task-specific\(^{17}\), follows from differences in the experimental design\(^{18}\), or whether it is subject-pool specific.

One potential determining factor for the self-selection are subjects’ risk preferences. The left graph in Figure 9 shows that the likelihood of choosing the flat payment scheme decreases with more risk-loving risk preferences. Subjects’ choice is also likely to be influenced by their ability. Here we interpret the number of previously acquired points in the word task as a measure of task-related ability. Looking at the right graph of Figure 9 it seems that the likelihood to switch from flat to either the linear or the tournament based payment increases with higher performance in the previous word-creation-stages. To confirm what we see in the figures we estimate the following multinomial logit model:

\[
\log \frac{\Pr(\text{treatment})}{\log \Pr(\text{flat})} = \beta_{\text{intercept}} + \beta_{\text{points}} \cdot \text{points} + \beta_{\text{risk}} \cdot \text{risk} + \beta_{\text{female}} \cdot \text{female} \tag{8}
\]

\(^{17}\)In Niederle & Vesterlund (2007) participants chose their payment-mechanism for the number-adding taks while in our experiment participant made this choice for the word task.

\(^{18}\)Our tournament design differed from the one used in Niederle & Vesterlund (2007) in that we offered subjects a larger choice-set and in that the tournament design was slightly different. Niederle & Vesterlund implemented a tournament in which the winner was compensated proportionally to the number of solved tasks, the loser received nothing.
**Figure 8** Self selection into treatments

![Bar chart showing frequency of male and female participants across flat, linear, and tournament treatments.](image)

**Figure 9** Self selection into treatments

![Graphs showing risk preference and total points for flat, linear, and tournament treatments.](image)
We take “flat” as the reference treatment, i.e. “treatment” is either “linear” or “tournament”. “Points” is the sum of points obtained in the previous three rounds of the word task (as in Figure 9). “Risk” is the risk measure according to Dohmen et al. (2011). Estimation results are reported in Table 11. We see that a good performance in the previous rounds makes it more likely to choose an incentivised treatment. This effect is significant for both linear and tournament, with no significant difference between the two ($p = 0.3118$). Also, more risk-loving participants are more likely to select into the incentivised treatments. Again, there is no difference between the effect of risk to select into the linear incentive or the tournament ($p = 0.5878$). Finally, there is no significant effect of gender to select in one of the incentivised treatments.

Performance in the self-selection stage, as shown in the box-plot in the right part of Figure 8, differs between the selected treatments: it seems that participants who selected the flat fee obtained fewer points than those who chose performance-pay. The seemingly higher performance under performance-pay can be interpreted as sorting since the likelihood into select into a performance based payment-schemes (linear or tournament) increases with the ability (measured as total points). Concluding, with more risk-loving preferences or more points in the previous stages, people switch from flat fee to a performance based payment scheme.

4 Conclusion

Using three different tasks, one based on creativity, one on intelligence, and one adding numbers, we have seen that performance depends almost entirely on individual characteristics of participants and can, on the aggregate level, hardly be influenced through incentives. Neither on the aggregate nor on the individual level do we find effects of incentives on performance. We also do not find an effect of incentives on the similarity or complexity of generated words in the creativity task. In the self-selection stage we find no relation between gender and the choice of the tournament. In our experiment it seems that the more able and the more risk-loving people are, the more likely they are to chose an incentivised payment-scheme in contrast to a flat fee. Also we observe higher output in the performance-pay treatment after self-selection.

Given the mixed evidence from many other experiments with real efforts we should be careful in generalising our observations. Still, our results seem to support the view that effects of incentives for a range of tasks, from creative tasks to repetitive calculations, are, if at all, very small. Individual characteristics explain for all tasks more than 60% of the observed variance in the performance. The presence or absence of different incentive schemes explain for all tasks in this experiment less than 1% of the variance.

To us it is in particular striking that we do not observe effects of incentive-schemes in the control tasks. In a follow-up study we check potential factors that might explain this result. In particular we analyse whether task-enjoyment or the availability of opportunity costs contribute to the result. We find that making tasks more difficult or less interesting does not change our results. With the
introduction of opportunity costs, however, we observe differences of incentive-schemes on subjects performance.

References

Crosetto, P. (2010). *To patent or not to patent: A pilot experiment on incentives to copyright in a sequential innovation setting*, Departemental Working Papers 2010-05, Department of Economics, Business and Statistics at Università degli Studi di Milano.


A Lettersets

A.1 A British 75%-quantile letterset

This letterset is similar to the German lettersets that we used in the experiment. The only difference is that it has been built with the British ispell dictionary.

We generated 100,000 random lettersets and calculated for each letterset the number of achievable points (here 7049), the number of words (here 528) and the similarity index\(^\text{19}\) (here 0.888156). We restricted our attention to lettersets which were close (within 1% margin) to the 75% quantile for points. This is why we call this letterset a “75%-quantile letterset”. Similarly we restrict ourselves to lettersets which are within 1% quantile margin for words and similarity of words. Hence, if there are any systematic differences among our lettersets these differences will be small.

<table>
<thead>
<tr>
<th>letters</th>
<th>points</th>
<th>words</th>
<th>similarity within</th>
</tr>
</thead>
<tbody>
<tr>
<td>accdeeginst</td>
<td>7049</td>
<td>528</td>
<td>0.888156</td>
</tr>
</tbody>
</table>

a ac acts aden aeneid ag agnes agli andes angie as at ats c ca cage cain cains candice case cd ci cid cs d dan dane danes dante dean dec decca deccan dee deena degas dena deng denis Denise di diane dina dis e east ed eden edens edna eng end es etna g ge gte ga gaines gates gd ge gena gene genet gide gina i ian ida in ina inc incas ind ines inge it n na nat nate nd ne ned ni nice nita s sade sadie san sand sang sat sc sc se sean sec sega seine sen senate sendai seneca set sgt si sian sid sn sneak st staci stacie stan stein stine t ta tad taine tc ted ti tia tide tina tina tina a accce accced accced accceed accceeding accent accented accents accident accidents ace aced aces acetic acid acids acing acne act acting acts ad ads aegis age aged agencies agent agents ages aid aide aids aid an ands angst an anise aniseed ant ante anted anteed antes anti antic antics antis ants as ascend ascent ascetic aside at ate ats c cacti cad cadence cadences cadet cadets cadge cadges cads cage caged cages cagiest can candies cane caned cans cant canted cants case cased casein casing cast caste casted casting cat cats cease ceased ceasing cede cedes ceding cent cents cite cited cites cs ds dais dance dances date dates dating dean dean deans decant decants decease deceasing deceit deceit deceencies decent dece deice deices deigns den denies dens dense dent dents descant descant descicate design designate destine detain detains dice dices dicta die dies die diet dies dig digest digs din dine dines ding dings dns dint dis disc distance e ease eased easing east east east eaten eating eats edge edges edgliest edgliest edict edicts edit edits enact enacted enactacts encase encased end ends entice enticed entices es etag gad gads gain gained gains gait gaits gas gate gated gates gee geed gees geese gene genetic genetics genie genies gent gents get gets giant giants gin gins gist gnats gs g i ice iced ices id idea ideas ides ids in incest ingest ingested ins insect inset instead is it its n nag nags need neediest needs negate negated negotes negs nest nested net nets nice nicest niece niecesnit nits nes sac sad sag sage said saint sand sane saned sang sat sate sated sateen satin satined sating scad scan scant scanted scat scene scenen scene scent scented science sea seat seated seating secede seceding sect sedan sedate sedating sedge see see seed seeding seeing seen senate send sent set sic side siege sign signed signet sin since sine sing singe singed sit site sited snag snide stag stage staged staid stain stained stance stand stead steed stein steined sting seance t taces tad tads tag tags tan tang tangies tangs tans tea tead teading teas tease teased teasing tee teed teeing teen teenage teenaged teens tees ten tend tending tens tense tensed tic ticced tics tide tides tie tied ties tin tine tined tines ting tinged tinged tinges tings tins ts

\(^{19}\)We used the fstrncpy form GNU Gettext 0.17 to calculate for each word the similarity to the most similar word in the set.
A.2  A German 75%-quantile letterset

This is one of the lettersets we used in the experiment. We generated 100 000 random lettersets and calculated for each letterset the number of achievable points (here 5585), the number of words (here 330) and the similarity index (here 0.888436). We restricted our attention to lettersets which were close (within 1% margin) to the 75% quantile for points. This is why we call this letterset a “75%-quantile letterset”. Similarly we restrict ourselves to lettersets which are within 1% quantile margin for words and similarity of words. Hence, if there are any systematic differences among our lettersets these differences will be small.

<table>
<thead>
<tr>
<th>letters</th>
<th>points</th>
<th>words</th>
<th>similarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>accehhikllist</td>
<td>5585</td>
<td>330</td>
<td>0.888436</td>
</tr>
</tbody>
</table>

ach achilles achse achsel acht achte able ai ak akte aktie akts alice alices all all alle alles als als alte altes asche asket ast at ca cache caches call calls cellist ch chalet chalets chate chi chic chice chicste chile cia echt eh eilst eilt eis eiskalt eklat elch elchs eli elias elis es esc et etc eth ethik ethisch hacke hackst hackt hackte hai hai haies hais hake hakst hakt hakte hall halle halls hallst hallt halte hals halt halte hasche hascht hase haskell hast haste hat he hecht hechts heck hecklucht hecklichts hecks heckt hehl hehlst hehlst heilt hektisch hell hellst hellt hit ich ist it kachel kalte kahl kahle kahles kahlheit kai kais kali kalis kalt kalte kaltes castell keil keils keilst keilt kelch kelchs kiel kiels kile killst killt killte kiste kit kits kitsch klatisch klatische kleist kt lach lache lachs lachst lacht lachte lack lacke lackes lacks laiche laichert laicht laichte laife las lasche last laste lasche least lech lechs leck lecks leckt leica leicht leihst lehte leihst leht leht lekt leiche leicht licht lichts lieb lieh liehst liehst lies liest lila ls list liste lsi lt sache sacht sachte sachtet sachtet sich sichel sichelheit sichelheit schach schacht schachtel schalah schlecht schlecht slack schlacke schlackheit schlacht schlachtest schlachtest schlachtest schlachtest schlecht schlecht schlecht schlecht schlauch schlauch sieh sieh sieh sieh sieck siekt siekt siekt siekt siekt siekt siekt siekt skat sketch ski st stach stachel stache stack stahl stall stalk stick steak steil stich stiche stichel stichle sticke stiel stil stille still stille taille takel takel takels takle tal tales talk talks tal tasche task teich teichs teil teils tel tick ticke ticks tisch tische
B Composition of participants

Figure 10 Composition of participants

- Share of females per session
- Age

Percent of Total

Percent of Total

0 10 20 30 40 50
0.2 0.4 0.6 0.8
Share of females per session

20 30 40 50 60 70
0 10 20 30 40
Age